Duke Power
A Duke Energy Company

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March 20, 2006

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

Subject: Duke Energy Corporation
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413, 50-414
Request for Additional Information (RAI) Regarding License Amendment Request to Take Partial Credit for Soluble Boron in Spent Fuel Pools and Revise Technical Specification Sections 3.7.16 (Spent Fuel Assembly Storage) and 4.3 (Fuel Storage)
(TAC Nos.MC8439 and MC8440)

Reference: Letter from Duke Energy Corporation to U.S. NRC, "Proposed Technical Specification Amendment to Revise Technical Specifications 3.7.16 (Spent Fuel Assembly Storage) and 4.3 (Fuel Storage)" dated September 13, 2005

By letter dated September 13, 2005, Duke Energy Corporation submitted a license amendment request to take partial credit for soluble boron in the Spent Fuel Pool and to revise Technical Specifications for Spent Fuel Assembly Storage and Fuel Storage. During a telecom, the staff requested additional information associated with this submittal. The responses to the staff's requests are provided in the attachment.

There are no commitments contained in this letter.

The previous conclusions of the No Significant Hazards Consideration and Environmental Analysis as stated in the

A001

September 13, 2005 submittal are not affected by this response.

Pursuant to 10 CFR 50.91, a copy of this letter is being sent to the appropriate state official.

If you have any questions about this letter, please contact Allison Young at (803) 831-3051.

Very truly yours,

D. M. Jamil
Site Vice President

Attachment

D. M. Jamil, being duly sworn, affirms that he is the person who subscribed his name to the foregoing statement, and that all matters and facts set forth herein are true and correct to the best of his knowledge.

D. M. Jamil, Site Vice President

Subscribed and sworn to me: 3/20/06

Anthony P. Jackson Notary Public

My commission expires: 7/2/2014

SEAL

xc:

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ATTACHMENT

Catawba Nuclear Station Units 1 and 2
Response to Request for Additional Information (RAI)

In the staff's safety evaluation for WCAP-15516-P, "Westinghouse Spent Fuel Rack Criticality Analysis Methodology," the staff stated that all licensees proposing to credit soluble boron should identify potential events which could dilute the spent fuel pool soluble boron to the concentration required to maintain the .95 k-eff limit and should quantify the time span of these dilution events to show that sufficient time is available to enable adequate detection and suppression of any dilution event. The staff also stated that the effects of incomplete boron mixing, such as boron stratification, should be considered, and that the boron dilution analysis should also be used to justify the surveillance interval used for verification of technical specification minimum pool boron concentration. In order to complete our review, the Nuclear Regulatory Commission staff requests that Duke Energy Corporation provide the following information.

1. **A summary of the boron dilution analysis performed in support of this license amendment request. Include a description of the potential boron dilution sources, dilution events that were considered in the evaluation, and the resulting dilution times and volumes. Explain how the dilution event will be detected and mitigated, and provide the basis for your selection of the worst-case dilution scenario.**

   RESPONSE: A detailed analysis of boron dilution scenarios in the spent fuel pools at Catawba is contained in the calculation, "Evaluation of Potential Boron Dilution Accidents for the Catawba Spent Fuel Pools." Sources addressed in the calculation include:

   - Fire Protection
   - Recycle Holdup Tanks (RHTs)
   - Recycle Monitor Tanks (RMTs)
   - Reactor Makeup Water Storage Tanks (RMWSTs)

- Low Pressure Service Water
- Nuclear Service Water
- Standby Shutdown Facility Standby Makeup Pump (SSF SMUP)
- Equipment Decontamination
- Drinking Water
- Makeup Demineralized Water
- Heated Water
- Reactor Building Ventilation Cooling Water

Dilution events considered include pipe breaks, misalignment of systems interfacing with Spent Fuel Pool (SFP) Cooling, and SSF events which require the SSF SMUP to take suction on the SFP for up to 72 hours to deliver seal injection flow to the reactor coolant pumps; after 72 hours of operation at 26 gpm, the SMUP is secured and the SFP could be refilled with unborated water. Worst case scenarios for each event are given below:

- Pipe breaks: the four-inch Fire Protection header in the vicinity of the SFP is the worst-case dilution event resulting from a pipe break. The Fire Protection system is pressurized to 150 psig, and since it is not seismically qualified, the largest pipe break postulated is one due to seismic or tornado activity; this break size is approximately 1.5 $in.^2$ and results in a flow rate into the SFP of approximately 701 gpm. The ultimate source of Fire Protection water is Lake Wylie, which is considered an "infinite" source; assuming a flow rate of 701 gpm indefinitely from a Fire Protection header break, an initial SFP boron concentration of 2700 ppmB (Core Operating Limits Report (COLR) minimum limit), and an initial SFP level of 23 feet above fuel racks (only water above the racks is considered in this calculation for added conservatism), the SFP would be expected to be diluted to below 200 ppmB (k_{eff} = 0.95 safety limit) in 32.36 hours. This would provide ample time for Control Room alarms and indications or observation via shift rounds to alert Operators to the dilution event in progress and properly mitigate it. The total volume of unborated water required to reach the 200 ppmB safety limit is 701 gpm x 32.36 hours x 60 minutes/hour, or over 1.36 million gallons.

- Misalignment of systems interfacing with SFP Cooling: a variety of misalignments of systems and tanks are evaluated in the calculation. The worst-case dilution from a finite-source misalignment results from aligning SFP Cooling to take suction on the RMWST, and allowing the RHTs to piggyback on the RMWST; this scenario would be expected to provide a total of just over 336,000 gallons of unborated water to the SFP, which is not capable of diluting the pool below the 200 ppmB safety limit. The worst-case dilution from an infinite-source misalignment results from aligning SFP Cooling to take suction from Nuclear Service Water; at a nominal flow rate of 140 gpm, the 200 ppmB safety limit would be reached in just under 83 hours, which is bounded by the Fire Protection pipe break analysis above.
- SSF event: the only credible scenario during an SSF event is for the SSF SMUP to take suction on the SFP for up to 72 hours for reactor coolant pump seal injection. After 72 hours this pump is secured, and the SFP makeup could occur using unborated water. In the worst-case refill, the SFP would be filled beyond normal operating conditions to the brink of overflow. The final concentration of SFP water is shown in the calculation to be 1324 ppmB in this scenario, which does not challenge the safety limit of 200 ppmB.

The expected alarm to prompt Operator action for an inadvertent dilution event is 1(2)AD-13 E/2, "Spent Fuel Pool Level Hi/Lo." Operations procedure, "Annunciator Response for Panel 1(2)AD-13," addresses the response for this particular annunciator, including diagnosing high or low level and the appropriate actions. This annunciator is expected to be received at a high level of 40.5 feet in the SFP (normal level is 39.9 feet).

- Given that one foot of level in the SFP is equal to 17,000 gallons of water per "Annunciator Response for Panel 1(2)AD-13," a total of approximately (40.5 - 39.9) feet x 17,000 gallons/foot or 10,200 gallons of unborated water would be expected to be added to the SFP prior to the annunciator actuation assuming an initial level of 39.9 feet (normal level).
- Assuming an initial SFP level of 37.4 feet (Technical Specification minimum allowed level to achieve 23 feet of water above fuel racks), a total of approximately

(40.5 - 37.4) feet x 17,000 gallons/foot or 52,700 gallons of unborated water would be expected to be added to the SFP prior to annunciator actuation.

In both examples, the alarm response procedure directs Operators to restore the SFP level to normal (39.9 feet) using the procedure, "Spent Fuel Cooling System." Enclosures in this procedure contain guidance for making up to the SFP from borated or unborated sources, instructions for barriers to preclude adding sufficient unborated water to dilute boron concentration below the COLR minimum allowed concentration, and guidance on system alignment for adding boric acid to the SFP, should it be needed.

Specific instructions for barriers to preclude adding sufficient unborated water to dilute boron concentration below the COLR minimum allowed concentration include the following:

- The procedure contains enclosures with directions for making up to the SFP from the following sources:

    - Refueling Water Storage Tank (borated > 2700 ppmB)
    - RHT (borated < 2700 ppmB)
    - RMWST (unborated)
    - Demineralized Water (unborated)
    - Nuclear Service Water (unborated)

- Steps are given in the enclosures for sources that have the potential to dilute the SFP, to calculate the change in boron concentration and ensure the final concentration is greater than the COLR minimum. The enclosures for sources which have the potential to dilute the SFP below the COLR limit specifically state that makeup shall not commence if calculated final boron concentration is less than the COLR minimum, unless directed by Abnormal procedure, "Loss of Refueling Canal or SFP Level."

- An enclosure is included to provide direction for boron addition to the SFP, should it be necessary.

2. **A summary of the results for boron dilution events involving system misalignment which results in unborated water being introduced to the spent fuel pool. Describe how the potential dilution from these events would be detected and mitigated. The response should include expected alarms and specific steps from alarm response or off-normal procedures that would lead to corrective actions.**

RESPONSE: The summary of boron dilution events involving system misalignments is given in the response to Question 1. The expected alarm to prompt Operator action for an inadvertent dilution event is 1(2) AD-13 E/2, "Spent Fuel Pool Level Hi/Lo." Operations procedure, Annunciator Response for Panel AD-13, addresses the response for this particular annunciator, including diagnosing high or low level and the appropriate actions. This annunciator is expected to be received at a level of 40.5 feet in the SFP (normal level is 39.9 feet).

- Given that one foot of level in the SFP is equal to 17,000 gallons of water per procedure, Annunciator Response for Panel 1(2) AD-13, a total of approximately (40.5 - 39.9) feet x 17,000 gallons/foot or 10,200 gallons of unborated water would be expected to be added to the SFP prior to annunciator actuation assuming an initial level of 39.9 feet (normal level).

- Assuming an initial SFP level of 37.4 feet (Technical Specification minimum allowed level to achieve 23 feet of water above fuel racks), a total of approximately (40.5 - 37.4) feet x 17,000 gallons/foot or 52,700 gallons of unborated water would be expected to be added to the SFP prior to annunciator actuation.

In both examples, the alarm response procedure directs Operators to restore SFP level to normal (39.9 feet) using the Spent Fuel Cooling System procedure. Enclosures in this procedure contain guidance for draining SFP contents to various locations, such as the Refueling Water Storage Tank or the RHT; guidance for making up to the SFP from borated or unborated sources, instructions for barriers to preclude adding sufficient unborated water to dilute boron concentration below the COLR minimum allowed concentration; and guidance on system alignment for adding boric acid to the SFP, should it be needed.

Specific instructions for barriers to preclude adding sufficient unborated water to dilute boron concentration below the COLR minimum allowed concentration include the following:

- The procedure contains enclosures with directions for making up to the SFP from the following sources:

  - Refueling Water Storage Tank (borated > 2700 ppmB)
  - RHT (borated < 2700 ppmB)
  - RMWST (unborated)
  - Demineralized Water (unborated)
  - Nuclear Service Water (unborated)

- Steps are given in the enclosures for sources that have the potential to dilute the SFP, to calculate the change in boron concentration and ensure the final concentration is greater than the COLR minimum. The enclosures for sources which have the potential to dilute the SFP below the COLR limit specifically state that makeup shall not commence if calculated final boron concentration is less than the COLR minimum, unless directed by Abnormal procedure, "Loss of Refueling Canal or Spent Fuel Pool Level."

- An enclosure is included to provide direction for boron addition to the SFP, should it be necessary.

3. **The fuel pool heat exchanger provides a boundary between unborated component cooling water on the shell side and borated pool water on the tube side. The operation of the heat exchanger is such that the shell side is at a higher pressure than the tube side. In the event of a tube rupture in the SFP heat exchanger, unborated water can be introduced into pool through the ruptured tube. Please describe how this event, and the potential dilution resulting from it, would be detected and mitigated. The response should include expected alarms and specific steps from alarm response or off-normal procedures that would lead to corrective actions.**

RESPONSE: Per calculation, "Evaluation of Potential Boron Dilution Accidents for the Catawba Spent Fuel Pools," leakage of unborated Component Cooling water into SFP

Cooling via a SFP Cooling heat exchanger tube leak is not expected, as Component Cooling system pressure is lower (150 psig design pressure) than SFP Cooling system pressure (175 psig design pressure). However, should unborated water leak into the SFP Cooling system from the Component Cooling system, a conservative estimate for the maximum expected leakage is the volume of both Component Cooling system surge tanks, given in the Design Basis Specification for the Component Cooling System as 3925 gallons each or 7850 gallons total. This volume estimate is based on the fact that low level alarms on the surge tank(s) affected would be received in the Control Room, and the header which feeds Component Cooling water to the SFP Cooling heat exchangers would automatically isolate on low level indications. The expected alarm to prompt Operator investigation and action for this particular event is 1(2) AD-10 A/1(2), "Component Cooling Surge Tank A(B) Lo-Lo Level," received at 34% level, decreasing. The response for this annunciator is found in the Abnormal Procedure, "Loss Of Component Cooling". Steps in this abnormal procedure are given to ensure surge tank levels are normal, if not, dispatch Operators to locate and isolate the source of the leak. Conservatively, it may be assumed that a volume equal to that of both surge tanks (one full surge tank and accompanying piping volume to the heat exchanger) completely empties through the break; using this total of 7850 gallons of unborated water to dilute the SFP from the COLR minimum limit of 2700 ppmB is not sufficient to dilute the SFP to the 200 ppmB safety limit (the 7850 gallons of unborated water is well below the required 1.36 million gallons required to perform the necessary dilution).