April 6, 1998

Mr. W. R. McCollum
Vice President, Oconee Site
Duke Energy Corporation
P. O. Box 1439
Seneca, SC 29679

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION - EMERGENCY POWER INTEGRATED TESTS AND CYME MODEL EVALUATION - OCONEE NUCLEAR STATION UNITS 1, 2, AND 3 (TAC NOS. MA0886, MA0887, AND MA0888)

Dear Mr. McCollum:

As part of our ongoing examination of the Oconee Emergency Electrical Distribution System, the staff has reviewed the Oconee Nuclear Station Emergency Power and Engineered Safeguards Functional Test Report submittal dated April 30, 1997, the December 18, 1997, report entitled, "Oconee Nuclear Station CYME Modeling of Emergency Power and Engineered Safeguards Functional Tests 2, 5, and 6," and your letter dated February 25, 1998, that responded to an earlier request for additional information. As a result, we have determined that additional information is needed, as described in the enclosure.

Sincerely,

ORIGINAL SIGNED BY:

David E. LaBarge, Senior Project Manager
Project Directorate II-2
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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Docket Nos. 50-269, 50-270, and 50-287

Enclosure: As stated

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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

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REQUEST FOR ADDITIONAL INFORMATION
OCONEE EMERGENCY ELECTRICAL POWER
DISTRIBUTION SYSTEM

A. Questions Relating to Emergency Power and Engineered Safeguards Functional Test Report dated April 30, 1997

1. Volume I, Section 1 of the Oconee Emergency Power and Engineered Safeguards Functional Test Report contains a very good overview of the Oconee emergency power system. It indicates that the Emergency Power Switching Logic will monitor the voltage available to the Normal Source and, if an undervoltage condition exists, will attempt to transfer to the Start-Up Source if voltage is available there. It states that for events such as a unit trip, this transfer provides power to station loads.

(a) Are there intentional delays incorporated into this transfer?

(b) What signals other than undervoltage on the Normal Source will cause a transfer from the Normal Source to the Start-Up Source?

(c) Are these transfers fast transfers (no intentional time delay) or do they incorporate intentional time delays?

(d) What are the delays and for what purpose?

(e) For the unit trip event, what signals other than undervoltage cause a transfer from the Normal Source to the Start-Up Source?

(f) Are there delays in the transfer?

(g) On a unit trip, is there a delay between the reactor/turbine trip and the main generator trip (opening of generator switchyard circuit breakers)?

(h) What signal (or signals) trips the main generator?

(i) Is the transfer from the Normal Source to the Start-Up Source tied in any way to the tripping of the main generator? If it is not tied to the trip of the main generator and will only transfer on undervoltage, what effect does the decreasing frequency from the coastdown of the generator have on the connected loads prior to transfer on undervoltage?

Enclosure

2. Table 4-5 in Volume I of the test report is a summary of the Keowee response during Test 3 (Keowee loads while accelerating). It indicates that there was only 0.3 second from the time the Keowee voltage regulator switched to automatic and the Oconee loads were energized by Keowee. Because there is no interlock that precludes loading the Oconee loads before the voltage regulator is brought online, it appears that the Oconee loads were dangerously close to being energized by Keowee before its voltage regulator was available.

    (a) Please explain how satisfactory loading of Keowee can be assured given such a slim margin.

    (b) Has this vulnerability been modeled in the Keowee Probabilistic Risk Assessment (PRA)? If so, please indicate the unreliability attributed to this feature.

    (c) Describe the operation and setpoints of the 53 relays that control energization of the Keowee voltage regulator and the SV relay that controls the Keowee field flash breaker.

3. Section 4.3.1 of the report identifies an anomaly that occurred during Test 3 with the Keowee output volts/hertz (V/Hz) ratio. The V/Hz ratio was not being maintained at a nominal 1.05 per unit (pu), but rather increased from 0.76 pu to 1.016 pu over the course of the load start transient.

    (a) Although the Oconee loads were successfully loaded during the test, explain how successful loading of the Keowee loads can be assured given such a low (76 percent) initial V/Hz ratio.

4. In the June 20, 1997, event that resulted in the failure of a Keowee unit to come up to voltage it was determined that the field flash breaker was cycling due to the setting of the 53-31T relay. That same setting was apparently in place on the Keowee unit being tested during the January 1997 tests. It is likely, therefore, that cycling of the field flash breaker was occurring during those tests that were performed with the Keowee unit started from standby.

    (a) Discuss the effect of the breaker cycling on the test results, including the effect on the V/HZ ratio and regulator timing issue described in question 2 above.

    (b) Describe what effect, if any, the resetting of the 53-31T relay to its original setpoint will have on the V/Hz ratio and regulator timing issue.

    (c) To our knowledge, the SV relay that controls Keowee voltage regulator energization will still cycle during a standby start of Keowee. Does Duke have any new thoughts following the June 20, 1997, event regarding any detrimental effects this might have on Keowee emergency operation? Do these relays cycle during normal starts of the Keowee units? Please discuss.

5. Figure 4.3.1-5 shows quite a large frequency overshoot when Keowee is emergency started from standby in Test 3. In this test, the loaded Keowee unit accelerates to 67.5 Hz before it turns downward.

   (a) Are there any potential detrimental effects to the Keowee or Oconee loads Keowee is powering when it accelerates to these frequency levels following an emergency start?

   (b) We note that the maximum frequency loading permissive on an emergency start from generation to the grid is 110 percent, which is lower than the level seen in Test 3. If the load were less during this test (e.g., no failure resulting in starting a large unscheduled load), would the larger frequency excursion have a detrimental effect on the loads?

   (c) For the non-loss-of-coolant accident (LOCA) scenario where a single Oconee unit is picked up by a standby Keowee overhead unit following actuation of the external grid trouble protection system, would the large frequency excursion have a detrimental effect on the Oconee or Keowee loads?

6. In all the tests that involve stroking of Engineered Safeguards (ES) valves, a motor contactor transient is observed on the contactors associated with some of the valves. The transient occurs following contactor pickup when the voltage across the contactor recovers to a value sufficient to pull the contactor in. Section 4 of the report indicates that, although the transient has negligible impact on the valves' performance, it explains the current increases and decreases seen during the applicable motor-operated valve's (MOV's) inrush period. Although very short, these current decreases are quite substantial; in many cases going to, or very near to, zero amperes. This indicates that although the contactor is not fully dropping out, the contacts may be parting sufficiently to cause some contact arcing during these periods of high current inrush.

   (a) Please discuss what effects this potential arcing could have on contact life and MOV reliability during an emergency event.

7. Section 5.2.4 of the report states that MOV 3LP-17, which is a gate valve, briefly stalled while starting following contactor pickup during Tests 4, 5, and 6. The stall times were 1.0, 1.0, and 0.4 seconds, respectively, for the three tests. The report indicates that the valve recovered in each case and completed its stroke to its proper ES position; and following inrush, valve stroke was normal and normal hammer-blow and unwedging was observed. We note that in all the LOCA tests where the MOVs are actuated, this particular valve's motor contactor

picks up at a voltage value that is quite often one of the largest values seen on the group of valves that are monitored. On that basis, not considering any other variables, it would be expected that this valve would be the least likely to stall.

(a) What variables make this particular valve so prone to stall?

(b) Was this expected prior to the test?

(c) Prior to the test, was this valve considered to be the most limiting of the group of valves monitored?

(d) Please provide plots of the valve motor's thermal capability and overload protection, overlaid on the starting inrush current figures shown for this valve during the tests.

8. During the tests a good deal of data was taken on a select group of MOVs.

(a) What insights were gained relative to MOV operability as a result of the observed data?

(b) Were any of the insights used in the Oconee Generic Letter (GL) 89-10 MOV program?

(c) The motor control center voltage at contactor pickup, as well as the time for voltage to reach 100 percent, was identified in the test report for each monitored MOV. Was this data used to help establish the voltage profile across the MOVs for the analyses done under the GL 89-10 program? If it was used in the program, how was it used? If it was not used in the program, how well does it correlate to the voltage profile assumptions that were used?

B. <u>Questions Relating to the CYME Modeling of Emergency Power and Engineered Safeguards Function Tests 2, 5, and 6 dated December 18, 1997</u>

1. The CYME modeling report identifies anomalies and differences between the operation of the reactor building cooling fan (RBCF) motors during the tests and what is modeled in the CYME analysis. It indicates that in Test 2 (loss of offsite power (LOOP) test) the model starts the RBCF on low speed from initially zero speed whereas in the actual test, the RBCF was initially running on high speed, started in low speed and later automatically shifted to high speed. For Tests 5 and 6 (LOCA/LOOP tests) the report indicates that RBCFs 3A and 3C were operated and modeled as described for Test 2, but RBCF 3B was started from standby (although rotating backwards) on low speed for both the test and the model.

(a) Describe how and why the RBCF motors will start during actual LOOP and LOCA/LOOP scenarios. Also describe why they operated differently during the tests.

2. In Figure 2-24 of the report, the staff notes that, if the OD-3 trip of the RBCF motor is drawn in as it is in Figure 3-24, the motor starting current is very close to tripping this device. The report attributes the excessively large and long starting current to the reverse rotation of the motor due to damper back leakage, which is scheduled for a modification to better seal the damper.

   (a) If the RBCF motor will be rotating backwards prior to an event before the modification is complete, discuss operability of the RBCF in this condition given the very slim margin to motor tripping.

3. The report states that the switching of the RBCF motors from low to high speed during the tests was not modeled by CYME because the model assumed the motors were starting in high speed from a zero speed condition. The report indicates that modeling of the safety system battery chargers at their current limit value, instead of the actual exponentially decaying current, adds a load equivalent to the RBCFs transferring to high speed. We note, however, that the battery current does not fully compensate for the RBCFs transferring to high speed. In Figures 1-1 and 1-8 for example, the current due to the RBCFs between 1980 cycles and 2340 cycles is substantially greater in the test results than in the model results.

   (a) Comment on the effect this nonconservatism will have on using the CYME program to analyze future plant modifications or scenarios.

4. With regard to the frequency response of the Keowee units, the report shows (Figures 1-5 and 2-5) that for Tests 2 and 5 the CYME model is nonconservative in estimating the maximum and minimum speed transients the machine experiences following load rejection from the grid. The report states that for both these tests the Oconee loads are placed onto the model at the time the loading actually occurred during the test. The frequency at loading during Test 2 is 59.6 Hz versus 60.9 Hz in the model. The frequency at loading during Test 5 is 64.7 Hz versus 62 Hz in the model. The report states that for Test 2, the frequency in the model at loading is slightly higher resulting in a slightly lower V/Hz ratio than in the test, which yields conservative model results. We note that for Test 5, just the opposite is the case. The frequency in the model is lower resulting in a higher V/Hz ratio than in the test, which yields nonconservative model results.

   (a) Comment on the use of nonconservative CYME model results for Test 5.

   (b) Comment on the nonconservative Keowee frequency response in the CYME model.

(c) For what purposes will the CYME transient response model of Keowee be used? Will it be used to analyze the effects on equipment that remain connected to Keowee over the full course of the transient (regulator controls, governor controls, protective devices, etc.) or just following connection of Oconee loads?

(d) Will a test be performed to validate the CYME Keowee frequency response model for a Keowee full load, two-unit load rejection, or has one already been done? If one has been done, please provide the comparison of the test to the model.

5. With regard to the frequency response question, as previously noted, the report indicates that the Oconee loads are placed onto the model at the time the loading actually occurred during the test.

(a) How will it be determined for future evaluations at what point the loads should be placed onto the Keowee unit relative to its frequency response curve, when no tests may be available for the modeled configuration on which to baseline the model?

(b) How can an accurate or conservative modeling be assured if the CYME frequency response model is nonconservative relative to the actual case?

6. The discussion in the report for Figure 3-5 indicates that the CYME program cannot begin its analysis at a frequency different from 60 Hz.

(a) When the frequency of the power source shifts from 60 Hz, such as following a load rejection or load application, does the CYME program calculate the connected system impedances and motor characteristics using the new non-60 Hz frequencies seen over the course of the transient? For example, in Figures 1-5 and 2-5, is CYME calculating the connected Oconee electrical system impedances and motor starting currents using the Keowee output frequencies shown in those figures?

7. The conclusion of the report states that although Test 3 (reduced voltage and frequency starting scenarios) is not included in this report, a comparison of the test data and CYME model predictions show the model to predict conservative results, except for the RBCF B motor.

(a) If the CYME program cannot begin its analysis at a frequency different from 60 Hz, how was the program used to make this prediction?

(b) If the program cannot begin its analysis at a frequency different from 60 Hz how will it be used to predict the results for other Keowee start from standby scenarios, such as the LOOP with loading on the overhead path and Keowee initially in standby?

(c) If the CYME model will be used to analyze standby start scenarios how will it be validated for those scenarios?

8. Figure 1-1 in the report shows a substantially larger inrush for the Keowee main step-up transformers and Oconee startup transformers than what was predicted in the CYME model (3293 amperes versus 1900 amperes, respectively). The report attributes this difference primarily to the fact that the test data includes dc offset current and harmonic currents, whereas the model data includes only 60 Hz currents. It indicates that this is not a problem because the protective relaying for the transformers are designed to account for the dc offset and harmonic currents. Because the voltage depression associated with this inrush is conservative in the CYME model compared to the test results (12.1 kV versus 12.5 kV, respectively), this explanation appears reasonable provided the CYME results will not be used for any analytical work associated directly with the Keowee main step-up and Oconee startup transformers' inrush currents.

(a) Describe for what purposes this CYME transformer inrush modeling may be used.

9. Figures 2-1 and 3-1 in the report show approximately a O.7 second and 1.0 second delay, respectively, between the first LOOP unit loading and the second LOOP unit loading. The report states that these delays are modeled.

(a) Are these delays modeled only for this validation effort to show the correlation between the model and the test? A conservative assumption would assume that the units load simultaneously.

C. Previous Request For Additional Information Question

In the response to staff questions dated February 25, 1998, it is stated that there are presently no periodic tests, which include the black start of the Keowee units. It is indicated that the ability of the Keowee units to start and run with no ac power available has been demonstrated by several one-time tests and that the capability of the Keowee batteries to provide sufficient energy to start Keowee and flash its field is verified annually by a battery service test. The staff notes that the battery service test does not check the subtle interactions between the battery and the field flash circuits. The voltage to the generator field, the field flash circuits, and other dc circuits is lower during a black start than it is during a start with ac power available. The lower dc voltage can result in an extended Keowee voltage buildup time following a standby start. The lower dc voltage can also result in different operating characteristics or inoperability of dc powered components, particularly when a component has degraded. The battery service test will not detect these potential problems or the resulting interactions. The staff therefore believes that periodic tests of the Keowee black start and black run capabilities should both be performed. We note that diesel generator plants periodically demonstrate the black start capability as part of the refueling outage load sequencing test specified in the Improved Standard Technical Specifications.

(a) Please address the points raised in this question relative to the lack of a black start test.

D. Probabilistic Risk Assessment Questions

1. The Keowee PRA states that the process for collecting Keowee data includes a 10-year period from January 1, 1984, to December 31, 1993.

   (a) Since December 31, 1993, have additional Keowee component failures been found that would have made the system unavailable for an emergency start (excluding the Keowee failure to start on June 20, 1997)?

   (b) Were these failures identified through system generation starts, operability starts, or emergency starts?

   (c) If the failure was identified through emergency starts, would the failure have been manifested during a system generation start?

2. Regarding Air Circuit Breaker (ACB) operation, the staff noted several ACB failures in the Augmented Inspection Team (AIT) report dated July 31, 1997 (AIT report 50-269/97-11, 50-270/97-11, 50-287/97-11). The staff's review of the Keowee PRA also found that dominant contributors to the failure of a Keowee unit to provide power to CT3 or CT4 include failures of ACBs 5 - 8. The staff also notes that high reliability of ACBs 3 and 4 is important during dual-unit grid generation.

   (a) Given that these components are tracked under the Maintenance Rule, what is the performance criteria for ACBs 1 - 8?

   (b) Based on previous discussions, the staff understands that ACBs 1 - 4 are tracked under the Keowee Super System, and ACBs 5 - 8 are tracked by themselves as a separate group. Considering ACB group 1 - 4 and ACB group 5 - 8, how are the performance criteria established for components in these groups since they have different testing/demand frequencies?

   (c) What are the demand/test frequencies for each ACB (ACBs 1 - 8)?