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SUBJECT: Responds to 980115 RAI re licensee 961031 response to open issues & recommendations from NRC draft repts on plant emergency power sys.

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February 12, 1998

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Response to Request for Additional Information
on the Oconee Emergency Power System

In a letter dated July 8, 1996, the NRC issued for comment draft reports from the Office of Nuclear Reactor Regulation (NRR) and the Office for Analysis and Evaluation of Operational Data (AEOD). These draft reports contained analyses and recommendations regarding the testing, operation, design and reliability of the Oconee emergency power system and Standby Shutdown Facility (SSF). As requested in the July 8, 1996, NRC letter, Duke Energy reviewed the NRR and AEOD draft reports for accuracy and to determine a disposition for each recommendation.

In a meeting with the NRC on September 19, 1996, Duke Energy presented its understanding of the open issues and recommendations from the NRC draft reports, along with Duke Energy's plan for disposition of the issues. During the meeting, the NRC clarified Duke Energy's understanding of several of the open issues. A written response to the open issues and recommendations was provided by Duke Energy in a letter dated October 31, 1996.

In a letter dated January 15, 1998, the NRC requested additional information concerning the response provided by Duke Energy on October 31, 1996. Attachment 1 contains the response to the NRC's request for additional information.

If there are any questions regarding this submittal, please contact Michael Bailey at (864) 885-4390.

Very truly yours,

W. R. McCollum, ~~Jr.~~, Site Vice President
Oconee Nuclear Station

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MEB

Attachment

cc:

L. A. Reyes, Regional Administrator
Region II

M. A. Scott, Senior Resident Inspector
Oconee Nuclear Site

D. E. LaBarge, Project Manager
NRR

ATTACHMENT 1

Question 1

In response to Open Issue 14, Duke responded that emergency start procedure (AP/O/A/2000/002) was written to address failures of the relays and breakers associated with the Keowee power supplies. Duke then stated that all Oconee operators (licensed and nonlicensed) have been trained in the use of this procedure. Is the roving watch operator also trained in this procedure?

Response 1

All Keowee operators and technical specialists are trained on the use of the emergency start procedure. The roving watch operator is a qualified Keowee operator. Thus, a qualified Keowee operator is always stationed at the Keowee Hydro Station.

Question 2

In response to Open Issue 17, Duke stated that a review of the various Keowee procedures that would take the underground path or both Keowee units out of service was conducted. Two procedures were identified that would take longer than one shift: the unwatering and watering-up Keowee units procedures (OP/O/A/2000/038) and the underground power path procedures (OP/O/A/2000/040). How long do these procedures take to complete? How often are they performed? When are they performed (i.e., during refueling outages)? Maintenance unavailability from performing these two procedures was not included in Table C.1-6, Keowee Probabilistic Risk Assessment (PRA) Train and Component Maintenance/Testing Events.

Response 2

Operating procedures OP/0/A/2000/038 and OP/0/A/2000/040 are used in situations that require the removal of the underground power path from service and/or the unwatering of both Keowee units. Since the Oconee Technical Specifications allow outages of the emergency power paths and Keowee units during operation of Oconee, the use of OP/0/A/2000/038 and OP/0/A/2000/040 is not limited to Oconee refueling outages.

The amount of time that the underground power path is out of service per OP/0/A/2000/040 depends on the nature of the outage. The outage time could range from a few hours up to the Technical Specification allowance of 72 hours. The removal of the underground power path from service is minimized due to the risk significance of the underground power path. For example, the overhead power path is allowed more hours unavailability than the underground power path within the Maintenance Rule. Also, it is a standard practice to perform the single Keowee unit outages with the Keowee unit aligned to the overhead power path. Historically, the underground power path unavailability has been approximately 10 hours per year.

For the unwatering and watering-up of the Keowee units, the unwatering and watering-up process is performed once every two years for routine maintenance inspections. The unwatering and watering-up processes each take approximately 12 hours to perform. The total length of outage time for both Keowee units during the inspections is less than 60 hours which is within the Technical Specification allowed outage time. The unwatering and watering-up process can be used for other outages of both Keowee units which require that the Keowee units be unwatered. In this situation, the outage length of the dual Keowee unit outage will be determined by the cause of the outage.

PRA event SXFRCT4THM was intended to account for maintenance unavailability of the underground path only. A separate maintenance event is included for the time period when both Keowee units are unavailable.

Question 3

Concerning the response to Open Issue 34, is the probability distribution provided in Attachment 6 an uncertainty distribution for KEOWTOP substituting generic data except for the 50 out of 1135 events where generic data is not available?

Response 3

Yes, the probability distribution is for the case where the generic data has been substituted. This is confirmed by comparing the mean value from the figure (1.05E-02) to the value given in the table (1.0E-02) in the response to Open Issue 34 for the Keowee failure probability for the generic data case.

Question 4

In Open Issue 35, the staff raised concerns regarding the applicability of grid generation experience for components that operate differently during an emergency start compared to a normal start. In Open Issue 9, Duke identified eight components that operate differently during an emergency start than during a normal start: the field breaker, the field flashing breaker, the supply breaker, the voltage regulator, synchronizer operation, the compensating dashpot, the partial shutdown solenoid, and the gate limit. Many of these components are required to generate and maintain generator voltage (part of the generator excitation system modeled in Appendix A.6 of the Keowee PRA). It appears that the failure rates for these components were quantified with grid generation start demands and emergency start demands versus just emergency start demands. The staff also recognizes that there were approximately 6000 normal starts versus 113 emergency starts reported in the Keowee PRA. The staff also noted that many basic events involving these eight components were quantified as undeveloped events since no applicable generic data existed. The staff also reviewed Table C.1-1, "Keowee PRA Component Failures Sorted By Type Code" and noted that many of the emergency start failures listed in this table involve these eight components. From these concerns, the staff has the following questions.

a. The staff believes that only emergency start data is applicable to estimate the failure probabilities involving these eight components. Therefore, the staff believes that the Keowee PRA should be requantified using emergency start data for these eight components. The staff notes that these components perform similarly in a normal start compared to an emergency start. However, subtle differences in emergency operation of their subcomponents can yield unique failures that could be undetected during a normal start. As an example, the staff requests that Duke consider the failure of Keowee Unit 1 to achieve rated voltage following an emergency start signal on June 20, 1997, that resulted from a blown fuse in the field flash breaker control circuit. As described in the associated Augmented Inspection Team report, the field flash circuit breaker control circuitry is suspected to have failed from component interactions between the 53-31T overvoltage relay and the breaker close coil when it was in an energized state going to the "trip free" mode of operation. The staff notes that this overvoltage relay is not activated during normal starts.

b. As a continuation of question 4a, the staff also requests a list of all basic events that have the potential for failures that may be manifested only during an emergency start. To better understand the list, the staff also requests a comparison of how these component/subcomponents perform in a normal start sequence versus an emergency start sequence.

c. The staff requests that Duke explain how the June 20, 1997, event could be modeled using the Keowee PRA. This explanation should include all of the basic events that would be affected by the event failures and the component/subsystem interactions.

d. Duke stated that testing of the regulator in a manner that detects failure of the base adjust setting is a planned improvement. Has this test been incorporated in the monthly test start procedure? Has the base adjust setting been included in the monthly normal start test procedure?

Response 4a

Duke Energy believes that the most accurate representation of the failure rate is achieved by considering both the normal and emergency start data. The field flashing breaker is required to close on any start (normal or emergency) from the standby condition. For Keowee starts from the standby condition, the operation of the breaker is considered to be substantially the same. During the June 20, 1997, event which was a Keowee emergency start from the standby condition, the field flashing breaker cycled several times. This cycling is attributed to a setpoint change in late 1996 and was corrected after the June 20, 1997 event. Prior to the setpoint change in late 1996, both normal and emergency starts from the standby condition produced the same field flashing breaker response. This is true again now that the undervoltage relay setpoint has been restored to a higher setting. If the field flashing breaker was expected to cycle during emergency starts but not during normal starts, Duke agrees that pooling of the emergency start and normal start data would be inappropriate. However, where breaker operation is essentially the same for both normal and emergency starts, Duke does not see any reason to exclude the normal starts from the failure rate calculations.

If an attempt had been made to quantify the Keowee basic events based on the emergency start failures alone, the database would have been too small for the development of meaningful plant specific reliability data. The modeling would rely on using generic data for components such as breakers and performing a Bayesian update with the plant specific evidence. During the time period reviewed for the Keowee PRA database, 2 breaker failures occurred at Keowee during emergency starts (real or test). One breaker failure occurred during the October 1992 LOOP event on Oconee Unit 2. The second breaker failure occurred during an emergency start test on September 16, 1993.

The breaker failure during the October 1992 Oconee Unit 2 LOOP event was a failure of ACB-5 to close due to misactuation of the impact spring. This failure mechanism is not specific to emergency starts and could just as well have occurred during any breaker operation. In the September 16, 1993, breaker failure, the field flashing breaker failed due to a missing cotter pin. This failure mechanism is not specific to emergency starts and could just as well have occurred during a normal start. Since these failures are not specific to an emergency start, it seems that it is most appropriate to include all starts for the purpose of determining a failure rate (see response to 4b for demand information).

Even if these failures had been specific to the emergency start, a Bayesian update of a generic failure rate with the limited plant specific experience would produce only moderate changes in the failure rate estimate. The Keowee results are not sensitive to changes in the failure rates of one or two components and would be minimally impacted. Thus, the conclusions of the analysis would be unchanged. As an example, consider the sensitivity study presented in the October 31, 1996, submittal where the breaker models were replaced by a generic "breaker fails to close" event with a value of 3E-03/demand. The Keowee failure probability in this study was calculated to be 1E-02. Assuming one failure of a generator field flashing breaker in 113 demands as the plant specific evidence, a Bayesian update of the generic failure rate (assumed Error Factor=10) gives approximately 5E-03/demand as the field flashing breaker failure rate. Substituting this new field flashing breaker failure rate into the cut sets from the earlier study gives a new Keowee failure probability of approximately 1.02E-02 which is an insignificant increase in the failure probability.

A clarification on the operation of the 53-31T overvoltage relay is necessary. The 53-31T overvoltage relay does function to trip the field flashing breaker during normal starts.

Response 4b

Table C.1-3 of the Keowee PRA report lists all of the basic events with a "denominator code" for each component. Those components which function only in the emergency starts are indicated in Table C.1-3 with a denominator code of ES. The list of components with a denominator code of ES is contained below for your convenience.

- Time Delay Relay 52-1TD Fails To Pick-up
- Time Delay Relay 52-2TD Fails To Pick-up
- Keowee 1 Emergency Start Auxiliary Relay 1ESRX/1A Fails To Pick Up
- Keowee 1 Emergency Start Auxiliary Relay 1ESRX/1B Fails To Pick Up
- Keowee 1 Emergency Start Auxiliary Relay 1ESRX/2A Fails To Pick Up
- Keowee 1 Emergency Start Auxiliary Relay 1ESRX/2B Fails To Pick Up
- Keowee 2 Emergency Start Auxiliary Relay 2ESRX/1A Fails To Pick Up
- Keowee 2 Emergency Start Auxiliary Relay 2ESRX/1B Fails to Pick Up
- Keowee 2 Emergency Start Auxiliary Relay 2ESRX/2A Fails to Pick Up
- Keowee 2 Emergency Start Auxiliary Relay 2ESRX/2B Fails to Pick Up
- Oconee Unit 1 Channel A Keowee Emergency Start Relay KA Fails to Pick Up
- Oconee Unit 1 Channel B Keowee Emergency Start Relay KB Fails to Pick Up
- Oconee Unit 2 Channel A Keowee Emergency Start Relay CR2A Fails to Pick Up
- Oconee Unit 2 Channel B Keowee Emergency Start Relay CR2B Fails to Pick Up
- Oconee Unit 3 Channel A Keowee Emergency Start Relay CR3A Fails To Pick Up

- Oconee Unit 3 Channel B Keowee Emergency Start Relay CR3B Fails to Pick Up

From the model, the components that only function during emergency starts are the relays that form the emergency start controls for the Keowee units. These components are normally in a standby condition and remain that way through all normal starts. All other components in the model are expected to behave in substantially the same manner for the emergency starts as for the normal starts, with no change in the component reliability.

With regard to the eight components that were identified as responding differently between an emergency start and a normal start, some additional discussion is necessary. In particular, the generator breakers are listed as responding differently. This is merely a question of timing of the generation of the close signal. The close signal is generated immediately in the emergency starts instead of at a particular speed setpoint as in the normal starts. The breaker will respond in an identical manner regardless of which signal happens to energize the close coil. There is no reason to treat the normal and emergency starts differently for the purpose of estimating the generator breaker reliability. The impact of the controls on the breaker reliability is implicitly included when the detail of the modeling is limited to a "breaker fails to close" basic event. This was the case when Duke substituted the generic breaker data in the place of the generator breaker fault tree model in our sensitivity study. The generic breaker failure value used in the study was 3E-03/demand.

If a plant specific "field flashing breaker fails to close" failure rate is calculated from the Keowee data (as in the Keowee PRA), a value of 3.1E-4/demand (2/6488) is obtained. When the data is extended to include starts and failures through 6/97, one additional failure and 1647 additional starts are included. The resulting failure probability is calculated to be 3.7E-4/demand. The "field flashing breaker fails to close" probability from a solution of the breaker fault tree is approximately 5E-04/demand. The data obtained from the Keowee calculations give a fairly consistent value for the breaker reliability, regardless of the technique or time period of review.

It should be noted that two additional time delay relays which have only an emergency start function have been added to the Keowee units since the Keowee PRA was performed.

These two time delay relays were added by Nuclear Station Modification ON-52966. The following information lists a description of the two relays which have been added to the Keowee units.

- Time Delay Relay 2-1TD
- Time Delay Relay 2-2TD

Response 4c

At the highest level the June 20, 1997, event is a failure of the field flashing breaker to close. Any basic event or gate that results in the failure of the field flashing breaker to close could be used to simulate the event. If the level of detail in the Keowee PRA was limited to the level of detail in PRAs at other plants, the field flashing breaker modeling would likely have been limited to a "breaker fails to close" basic event. No consideration at all would have been given to modeling the controls for the breaker. The "breaker fails to close" event would be the candidate for modeling a failure such as was experienced by Keowee. However, because of the level of detail included in the Keowee PRA models, some specific events may be more appropriate than others as a representation of the actual failure of interest.

The breaker going to the "trip free" condition contributed to the breaker failure. In fact the AIT concluded that random breaker failure, going to the trip free condition, was the most probable root cause for the event. The PRA model includes an event for mechanical failure of the breaker. This event could be considered as the failed event in the PRA.

The function of the 53-31T overvoltage relay is to apply a trip signal to the field flashing breaker when the relay senses that the generator voltage is adequate for self excitation. During the June 20, 1997, event, the relay performed this function consistent with the setpoint to which the relay had been adjusted. The setpoint adjustment on the 53-31T overvoltage relay had the unexpected impact of causing some cycling to occur during field flashing breaker demands. In addition, the setpoint adjustment may have increased the probability of breaker failure above the expected normal random hardware failure rate. In effect, the system had been left in a condition following modification/maintenance that potentially increased the failure probability of the breaker. This situation is best represented by the latent human error event. A copy of the precursor analysis that was performed for the June 20, 1997 event is included in Attachment 2.

There is no event in the model that describes precisely the breaker cycling and the resulting "trip free" condition that was experienced. Either of the two basic events that are described above would represent reasonable events for characterizing the failure experienced on June 20, 1997.

Response 4d

The regulator base adjust setting is now checked during the monthly normal start testing. In addition, the regulator base adjust setting is calibrated on a 3 year frequency.

Question 5

In Open Issue 22, the staff was concerned about potential mechanisms for a single common cause grid degradation failing both Keowee power paths when generating to the grid. In Section 3.1.5.2 of the draft safety evaluation report on the Oconee AC power system, the staff discussed the potential for an electrical fault to simultaneously trip both Keowee units while generating to the grid due to loss of excitation protection. The staff also discussed the possibility that an operator may cause an unwanted actuation of a 40G relay by misadjusting generator field excitation.

Assuming a Keowee lockout occurred, is the Keowee operator or a roving watch operator (as opposed to the Technical Specialist) expected to be able to diagnose the problem and take proper recovery actions to restart the Keowee units? Are there alarms signaling that the 40G relays or other lockouts have been actuated? Are the recovery procedures readily accessible and easily retrieved?

Response 5

If a Keowee lockout is assumed to occur, an alarm would be received in the Keowee control room. The Keowee operator would utilize the appropriate alarm response guideline to restore the Keowee unit to service. The alarm response guideline outlines the steps necessary to diagnose the cause of the lockout and to restore the Keowee unit to service. In addition, the alarm response guideline instructs the Keowee operator to notify a Keowee technical specialist about the problem. The steps in the alarm response guideline were developed based on the potential failures which could result in a Keowee lockout. The alarm response guidelines are located in the Keowee control room and can be easily retrieved.

ATTACHMENT 2

Precursor Evaluation for the Keowee Failures of 6/20/97 and 6/23/97