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DUKE POWER

July 2, 1997

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

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Operability Evaluation for Keowee Units 1 and 2

On June 20, 1997, Oconee Unit 1 was performing a test of the 100 kV power supply from a Lee gas turbine via the 100 kV dedicated path. During this test, the Oconee Unit 1 main feeder buses were energized by the 100 kV switchyard at Lee Steam Station through transformer CT5. During the alignment of a Lee gas turbine to the Lee 100 kV switchyard, breakers were incorrectly manipulated at the Lee gas turbine which actuated protective relaying at Lee. The Lee protective relaying isolated the 100 kV line and deenergized the Oconee Unit 1 main feeder bus loads. The Oconee Unit 1 main feeder bus loads were automatically reenergized by the Oconee 230 kV switchyard.

In response to the loss of power on the Oconee Unit 1 main feeder buses, the Keowee Units received an emergency start signal 20 seconds after the loss of power, as designed. Keowee Unit 1 which was aligned to the underground emergency power path did not successfully emergency start. Duke Energy Corporation initiated a Failure Investigation Process (FIP) team to determine the root cause of the failure of Keowee Unit 1 to emergency start.

Duke Energy Corporation held conference calls with the staff on June 24, 1997, June 25, 1997, and June 26, 1997, to discuss the status of the investigation of the failure of Keowee Unit 1 to emergency start. Attachment 1 to this submittal provides the staff with the status of the FIP team

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investigation as of June 30, 1997. This investigation is still in progress and additional information will be provided to the NRC resident inspectors and Augmented Inspection Team. In addition, Attachment 1 documents our planned corrective action that will eliminate the need for the compensatory action of replacing the field flashing breaker control circuit fuses after each emergency start where the field flashing breaker cycles repeatedly.

On June 23, 1997, Oconee Unit 1 was in the process of completing the test of the 100 kV power supply from a Lee gas turbine. After completion of the test of the 100 kV power supply from a Lee gas turbine, the Oconee safety-related 4160 V switchgears (1TC, 1TD, and 1TE) were dead bus transferred to the Oconee 230 kV switchyard. During the deenergization of 4160 V switchgear 1TC, Keowee transformer CX, which was supplying the Keowee Unit 1 auxiliaries, momentarily lost power, as expected, since it was powered from 1TC. Shortly after the 4160 V switchgear 1TC was reenergized from the Oconee 230 kV switchyard, a lockout of the Keowee 600 V switchgear 1X occurred.

Upon receipt of the 600 V switchgear 1X lockout alarm, the Keowee operator initiated actions in accordance with the appropriate alarm response guide to restore the power to the Keowee Unit 1 auxiliaries. As described in the alarm response guide, the Keowee operator verified that no protective relay targets had been received and manually reset the lockout relay. Once the lockout relay was reset, ACB 5 and ACB 7 simultaneously attempted to close and tripped open. When ACB 5 and ACB 7 tripped open, 600 V switchgear 1X was deenergized. A review of ACB 5 and ACB 7 indicated that the close coil circuit fuses for the ACBs were open. A FIP team was initiated to review the cause of the 600 V switchgear 1X lockout and the subsequent sustained loss of auxiliary power to Keowee Unit 1.

Duke Energy Corporation discussed the status of the investigation of the 600 V switchgear 1X lockout and the subsequent sustained loss of auxiliary power to Keowee Unit 1 with the staff during the conference calls on June 24, 1997, June 25, 1997, and June 26, 1997. Attachment 2 to this submittal provides the staff with the status of the FIP team investigation of this event as of June 30, 1997.

Both Keowee units are currently considered operable based on the justifications which are provided as attachments to this

submittal. A 10 CFR 50.59 safety evaluation was performed on the operability evaluation for the failure of Keowee Unit 1 to attain rated voltage which resulted in compensatory action. The 10 CFR 50.59 safety evaluation indicated that no unreviewed safety questions exist for the compensatory action.

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

MEB

Attachments

cc w/attachment:

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Region II

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

D. E. LaBarge, Project Manager
NRR

Attachment 1

Failure of Keowee Unit 1 to Reach Rated Voltage

Operability Evaluation for
Keowee Units 1 and 2

Background

On June 20, 1997, Oconee Unit 1 was performing a test of the 100 kV power supply from a Lee gas turbine via the 100 kV dedicated path. During this test, the Oconee Unit 1 main feeder buses were energized by the 100 kV switchyard at Lee Steam Station through transformer CT5. The test of the 100 kV power supply parallels a Lee gas turbine to the 100 kV switchyard at Lee Steam Station. After a Lee gas turbine is paralleled to the Lee 100 kV switchyard, a live bus transfer of the main feeder buses to the 100 kV dedicated line which is powered by a Lee gas turbine is performed.

During the alignment of a Lee gas turbine to the Lee 100 kV switchyard, breakers were incorrectly manipulated at the Lee gas turbine which prevented the successful alignment. Protective relaying was actuated at the 100 kV switchyard at Lee Steam Station. The Lee protective relaying isolated the 100 kV line and deenergized the Oconee Unit 1 main feeder bus loads from the Lee 100 kV switchyard. This resulted in a loss of power to the Oconee Unit 1 main feeder buses.

Upon the loss of power to the Oconee Unit 1 main feeder buses, the main feeder bus monitor panel logic timer actuated. After a continuous loss of power to the Oconee Unit 1 main feeder buses for 20 seconds, the main feeder bus monitor panel logic timer actuated an emergency start of both Keowee units and the emergency power switching logic. The emergency power switching logic actuated the load shed of Oconee Unit 1 loads in order to prepare Oconee Unit 1 to receive power from the underground emergency power path.

With power unavailable to the Oconee Unit 1 main feeder buses and the S breakers closed, the emergency power switching logic retransfer circuitry actuated after the load shed signal was generated. The retransfer logic waited 5 seconds as designed before retransferring the Oconee Unit 1 main feeder buses to the startup source. The startup source was supplied by the 230 kV Oconee switchyard through the associated startup transformer. The Oconee Unit 1 main feeder buses were without power for approximately 26 seconds.

Keowee Unit 1 was aligned to the underground emergency power path and its auxiliary loads were being powered by the Oconee Unit 1 main feeder buses. Since the Oconee Unit 1 main feeder buses were deenergized, Keowee Unit 1 was required to emergency start without any power to its auxiliary loads. This is generally referred to as a black start of the associated Keowee unit. Keowee Unit 1 did not successfully start in response to the emergency start signal from the main feeder bus monitor logic. Keowee Unit 2 did successfully obtain rated speed and voltage following the emergency start signal.

Root Cause for Keowee Unit 1 Failure to Emergency Start

A Failure Investigation Process (FIP) team was initiated to determine the root cause of the event. During the emergency start of Keowee Unit 1, the Keowee unit accelerated to rated speed but did not have any excitation or voltage output. This condition was due to a failure of the field flashing breaker to remain closed for a sufficient enough period of time to allow the generator voltage to build.

Investigation of the Keowee Unit 1 field flashing breaker close controls revealed an open fuse in the close control circuit. During the subsequent review of the field flashing breaker, no problems were observed while electrically and mechanically testing the field flashing breaker. Also, no short circuits or grounds were discovered in the field flashing breaker. During the review of the field flashing control circuit, various components were isolated and checked for short circuits and open circuits. No problems were discovered as part of the review of the field flashing control circuit. In addition, the timing relay in the field flashing breaker, which provides a trip to the field flashing breaker, was isolated and verified to operate properly. The components which are associated with the field flashing breaker and its control circuit were inspected for wear or signs of a failure. This inspection did not identify any problems. Verification of the Keowee Unit 1 field and voltage regulator was performed and no problems were identified.

Since the investigation described above did not identify any problems, a series of Keowee unit starts were performed to determine the cause of the Keowee Unit 1 failure. The Keowee unit starts included a manual start of Keowee Unit 1 in an attempt to recreate the scenario while examining for any equipment failures or malfunctions. The manual start of Keowee Unit 1 was successful and no abnormal indications

were observed. Following the successful manual start of Keowee Unit 1, an automatic start of Keowee Unit 1 was performed in an attempt to recreate the scenario. The automatic start of Keowee Unit 1 was successful and no abnormal indications were observed.

On June 22, 1997, test equipment was temporarily installed to monitor various parameters on Keowee Unit 1 during a normal automatic start and an emergency black start. The parameters which were monitored included:

1. Voltage across the field flashing breaker control circuit,
2. Current in the negative leg control fuse,
3. Field voltage, and
4. Generator output voltage.

The automatic start of Keowee Unit 1 was successful and no abnormal indications were observed.

In order to duplicate the conditions that occurred when the field flashing breaker failed on June 20, 1997, a temporary test procedure was developed to emergency black start Keowee Unit 1 and emergency start Keowee Unit 2. Keowee Unit 1 was aligned to the underground emergency power path during the emergency black start test. Both Keowee Units were successfully started during the emergency start test.

During the emergency black start, it was noted that the field flashing breaker for Keowee Unit 1 cycled three times. A review of the events recorder data confirmed that the field flashing breaker cycling occurred on previous emergency start actuations on both Keowee units. One of the emergency starts when the field flashing breaker cycled was in 1995. The remaining incidents of the field flashing breaker cycling occurred after the setpoint on the generator voltage relay was revised. The generator voltage relay setpoint was revised on Keowee Unit 1 in March 1997 and on Keowee Unit 2 in November 1996. The cycling of the field flashing breaker does not impact the ability of the Keowee units to perform their intended safety function during emergency starts. The ability of the Keowee units to operate properly with the cycling of the field flashing breaker is evident by the results of the test on June 22, 1997 and the previous successful emergency start tests.

In addition, the current monitoring on the Keowee Unit 1 field flashing breaker control circuit fuse indicated that the peak inrush current for the control circuit was approximately 38 amps. The control fuses in the field

flashing breaker are designed to withstand a current of 38 amps for a period in excess of 9 seconds. The total time duration between the initial closure of the field flashing breaker and the last time that the breaker opened was 8 seconds. During the cycling of the field flashing breaker, the inrush current did not stay at approximately 38 amps for the entire 8 seconds. The 38 amps was the instantaneous peak inrush value. Therefore, the inrush current for the field flashing breaker control circuit is within the rating of the fuse.

A review of the fuse by a Duke metallurgist indicated that the fuse blew due to an overcurrent condition. As stated above, the fuse was properly rated for use in the field flashing breaker control circuit. In addition, the replacement fuse, which was the same type and amperage, withstood the inrush current during the emergency black start test. However, the end of life for the fuse can be accelerated due to the exposure to the inrush current experienced during Keowee emergency starts. Based on the review of the data, test results, and an evaluation of the fuse by the vendor, the root cause of the failure of the Keowee Unit 1 field flashing breaker control fuse was determined to be age related.

Compensatory Action

Once the failure was determined to be age related, the work history on the fuse was reviewed to determine the age of the fuse. The Keowee Unit 2 field flashing breaker control fuse was last replaced in 1993. No evidence was found to indicate when the Keowee Unit 1 field flashing breaker control fuse had been replaced. Since the end of life for the field flashing breaker control fuses is unknown, a conservative decision was made to replace the field flashing breaker control fuses after each Keowee emergency start where the field flashing breaker cycles repeatedly. This compensatory action is considered conservative since it has been proven by previous tests that the field flashing breaker control fuses can withstand multiple emergency start actuations. A 10 CFR 50.59 safety evaluation was performed on the compensatory action and no unreviewed safety questions were identified.

Additional Corrective Actions

A review continues to determine a method to alleviate the concern of the end of life for the field flashing breaker control fuses. This could result in a modification to the control logic in order to prevent the cycling of the field

flashing breaker. As additional information becomes available from the continuing review, Oconee will update the NRC resident inspectors and Augmented Inspection Team.

Conclusion

The Keowee units are operable based on the compensatory action to replace the field flashing breaker control fuses following each Keowee emergency start where the field flashing breaker cycles repeatedly.

Attachment 2

Switchgear 1X Lockout and Subsequent Loss of
600 V Auxiliary Power to Keowee Unit 1

Operability Evaluation for
Keowee Units 1 and 2

Background

On June 23, 1997, Oconee Unit 1 was in the process of completing the test of the 100 kV power supply from a Lee gas turbine. A Lee gas turbine had been successfully connected to the 100 kV dedicated path and loaded to at least the equivalent of an Oconee units maximum safeguards loads (4.8MVA). After the test of the 100 kV dedicated line was completed, the Oconee safety related 4160 V switchgear (1TC, 1TD, and 1TE) were dead-bus transferred to the Oconee 230 kV switchyard. The transfer was accomplished by momentarily deenergizing each 4160 V switchgear (1TC, 1TD, and 1TE). Power was restored to the 4160 V switchgear from the Oconee 230 kV switchyard through manual actions to close the associated startup source breakers (E breakers).

During the deenergization of 4160 V switchgear 1TC, transformer CX, which was supplying the Keowee Unit 1 auxiliaries, momentarily lost power, as expected, since it is powered from 1TC. After transformer CX had been deenergized for 4 seconds, the 600 V switchgear 1X incoming breaker (ACB 7) automatically tripped due to the undervoltage condition, as designed. Once the 4160 V switchgear 1TC was reenergized from the Oconee 230 kV switchyard, the undervoltage relays which tripped ACB 7 open were automatically reset. This provided a signal to automatically close ACB 7. However, ACB 7 failed to close and a lockout of the 600 V switchgear 1X occurred.

Upon receipt of the 600 V switchgear 1X lockout alarm, the Keowee operator initiated actions in accordance with the appropriate alarm response guide to restore the power to the Keowee Unit 1 auxiliaries. During the performance of the alarm response guide, the Keowee operator noted that no protective relay targets had been received. The lack of protective relay targets indicated that a fault had probably not occurred on the 600 V switchgear 1X to initiate the lockout. As described in the alarm response guide, the Keowee operator manually reset the lockout relay. Once the lockout relay was reset, ACB 5 and ACB 7 simultaneously attempted to close. Interlocks between ACB 5 and ACB 7,

which prevent closure of ACB 5 and ACB 7 at the same time, tripped both breakers open. ACB 5 and ACB 7 tripped open before the 600 V switchgear 1X was energized. A review of ACB 5 and ACB 7 indicated that the control circuit fuses for the ACBs were open.

A Failure Investigation Process (FIP) team was initiated to review the cause of the 600 V switchgear 1X lockout and the subsequent loss of 600 V auxiliary power to Keowee Unit 1.

Root Cause for the Lockout of Switchgear 1X

During the investigation of the 600 V switchgear 1X lockout, the root cause for the lockout was determined to be due to the failure of the 'Y' timer in the ACB 7 close control circuit. The 'Y' timer circuit is designed to assure that the ACB will close and latch before the 'Y' anti-pump relay deenergizes the ACB closing coil.

In this particular design application, the 'Y' timer was intended to provide a delay of approximately 0.325 seconds. This setpoint was developed based on test data, manufacturer data, and Oconee calculations. The 'Y' timer in ACB 7 was discovered to have failed such that it was not providing an adequate time delay. The 'Y' timer failure resulted in deenergization of the closing coil before allowing enough time for ACB 7 to fully close and latch in the closed position. As the breaker returned to the fully tripped position, the mechanical linkage was aligned such that it activated the micro-switch which initiated a lockout. The lockout relay provided a trip signal to ACB 7. In addition, the lockout relay prohibited ACB 5 and ACB 7 from being closed while the lockout relay was actuated.

Root Cause for Loss of 600 V Auxiliary Power to Keowee Unit 1

During the investigation of the loss of auxiliary power to Keowee Unit 1, the cause of the open fuses was determined to be that the 'X' relay and closing coils of ACB 5 and ACB 7 remained energized while each breaker was in a trip free condition. This resulted in the fuses opening on overcurrent conditions after approximately 6 seconds.

The automatic transfer logic for the Keowee auxiliaries functions to realign the auxiliary switchgear (1X or 2X) in order to reenergize the switchgear. Once the switchgear 1X lockout occurred, the automatic transfer logic initiated a time delay. After a time delay of 30 seconds, the automatic transfer logic actuated and provided a close permissive to

ACB 5. A close permissive already existed on ACB 7 due to ACB 7 being closed previously and in automatic.

After the switchgear 1X lockout alarm was received, the Keowee operators initiated actions under their alarm response guide to restore power to switchgear 1X. The Keowee operators reviewed the targets on the protective relays and determined that no fault existed on switchgear 1X. Once it was determined that no actual fault existed on switchgear 1X, the Keowee operators reset the lockout relay on switchgear 1X.

When the lockout relay was reset, both ACB 5 and ACB 7 had close signals present and attempted to close simultaneously. Interlocks exist between ACB 5 and ACB 7 to prevent closure of both ACBs simultaneously. These interlocks actuated and tripped both ACBs. However, the ACBs tripped before the 'Y' relay in each ACB could energize and drop out the 'X' relay and closing coil. With the 'X' relay and closing coil energized, the control circuit current was approximately 20 amps. This condition existed until the 10 amp Gould OT10 fuses opened as designed at approximately 6 seconds.

Compensatory Action

No compensatory action is required to make the Keowee units operable.

Corrective Action

In order to make ACB 7 operable, the failed 'Y' timer in ACB 7 was replaced. A spare breaker with a new 'Y' timer was installed in ACB 5. In addition, the 'Y' timers in ACB 6 and ACB 8 were verified to be operable.

The close coil circuit fuses in ACB 5 and ACB 7 have been replaced.

The alarm response guide has been revised to require placing the automatic swapover logic in manual prior to resetting the lockout relay. This will preclude both auxiliary breakers from having a close signal at the same time.

Conclusion

Following the determination of the root cause of the problems described above and the completion of the associated corrective actions, the Keowee units were declared operable.