Report No.: RO-279/77-17 A

Report Date: August 16, 1977

Occurrence Date: May 17, 1977

Facility: Oconee Unit 1, Seneca, South Carolina

Identification of Occurrence: Inadvertent isolation of emergency power source

Conditions Prior to Occurrence: Unit 1 in cold shutdown, Units 2 and 3 at 100% full power

Description of Occurrence:

On May 17, 1977 the periodic test PT/1/A/610/1G, 4160 volt Emergency Power Switching Logic (EPSL) Load Shed Test was performed on Oconee Unit 1. This test provides verification of the proper functional performance of the EPSL system and is performed basically as follows: The Unit 4160 volt buses are initially supplied from the main feeder buses through the startup transformer CT-1 (See FSAR Figure 8-2) and the standby buses are energized through transformer CT-5. The Keowee hydro emergency start circuitry is inhibited for Unit 1 during the test to prevent the starting of the Keowee hydro units. To initiate the test, a startup bus undervoltage condition is simulated which causes the EPSL system to transfer the main feeder buses to the standby buses. Continuing the test, CT-5 is separated from the standby bus by opening the breakers between CT-5 and the standby buses (SL_1 and SL_2). This causes the EPSL system to sense a loss of standby bus voltage and the Keowee underground feeder breakers to close onto the standby buses (SK_1 and SK_2). Since the Keowee units are not operating, the EPSL system senses a no voltage condition and separates the main feeder buses from the standby buses and energizes the main feeder buses from the startup transformer.

The test described above was successfully completed approximately 1816 on May 17, 1977. At the completion of the test, alarms existed indicating an undervoltage condition on the standby buses. Since these buses are normally de-energized an undervoltage condition was not an abnormal condition, however, the alarm indicating the condition was abnormal. Attempts to open Keowee standby breakers SK_1 and SK_2 failed due to improper personnel actions. It was believed from past experience that closing breakers SL_1 and SL_2 and then tripping them would clear the undervoltage alarms. When breaker SL-2 was closed at 2003 breaker ACB-3 tripped and Keowee Unit 1 received an emergency lockout. This resulted from connecting transformer CT-5 to the Keowee Unit 1 generator (not operating) through the standby bus, the Keowee standby bus breakers SK_1 and SK_2 (these breakers were closed from the EPSL test and had not been returned to their normal open position), transformer CT-4, the underground feeder and breaker ACB-3.

In recognizing the loss of Keowee Unit 1 from the underground feeder circuit personnel immediat'y tried to place Keowee Unit 2 in service on the underground feeder by c. sing breaker ACB-4. At this time, ACB-4 tripped and Keowee Unit 2 received an emergency lockout. This was the result of backcharging Keowee Unit 2 generator from the standby buses as described in the preceding paragraph.

Action was taken in accordance with Technical Specification 3.7.7 to start the Lee Combustion Turbine; however, the emergency lockout on both Keowee units was reset and the underground feeder circuit was returned to service within approximately 17 minutes thereby eliminating the need for the combustion turbine.

Designation of Apparent Cause of Occurrence:

A review has revealed several causes of this particular incident. The normal emergency power switching logic test is performed during refueling outages. The test performed on May 17, 1977 was an abbreviated version of the normal test and had been performed only once before on Oconee 2. A procedural inadequacy existed in that the procedure did not specify returning the Keowee standby breakers, SK_1 and SK_2 to their normally open position upon completion of the test. Since personnel did not properly return breakers SK_1 and SK_2 to their normal positions the closing of breaker SL_2 would backcharged the Keowee unit resulting in an emergency lockout of the Keowee units.

A procedural inadequacy also existed in that immediately upon the loss of the Keowee unit on the underground feeder the remaining Keowee unit was placed on the underground feeder. An investigation to determine the reason for the loss of the Keowee unit and the underground feeder should be performed prior to this operation.

The undervoltage alarm on the standby buses is a proper alarm when either the breakers SL_1, SL_2, SK_1 or SK_2 are closed and the standby bus is deenergized. The proper manner to clear these alarms after the test is to open the Keowee standby breakers SK_1 and SK_2 and then close and trip the CT-5 standby bus feeder breakers SL_1 and SL_2. That this was not performed was the result of procedural inadequacy and was largely responsible for this incident.

Analysis of Occurrence:

The Oconee Nuclear Station Technical Specification 3.7.7 makes provision for the continued operation of the reactors in the event both Keowee units are inoperable provided that a Lee Combustion Turbine is placed into operation and charges the standby buses through the isolated 100 kV transmission line within 30 minutes. In this incident, both hydro units and the underground feeder circuit were returned to an operable status within approximately 17 minutes. Considering the short period of time which transpired and the unlikely probability of the necessity for onsite emergency power, it is concluded that the health and safety of the public was not affected by this incident.

It should be pointed out that this incident occurred as a result of not returning the emergency power system to the correct lineup after a test.

However, even in the incorrect lineup with the Keowee standby bus breakers SK_1 and SK_2 closed the proper functioning of the emergency power system would not have been affected. Had the unit been in operation, the 4160 volt loads would have been supplied initially from the units auxiliary transformer. Upon an ES actuation and loss of the auxiliary transformer the 4160 volt loads would have transferred to the startup transformer CT-1 and both Keowee units would have started, energizing the overhead transmission path to CT-1 and the underground path to the standby bus through the Keowee standby breakers SK_1 and SK_2 (assumed to have been already closed as a result of an error in the test procedure). Should offsite power be lost the switchyard would isolate from the system grid and CT-1 would still be energized from one Keowee unit through the overhead transmission path. If this path were not to become inoperable, the main feeder bus would transfer to the standby bus and be energized from the remaining Keowee unit through the underground feeder. The closing of the Lee standby breakers SL_1 and SL_2 would be prohibited when CT-5 is energized since this would require a manual operation and sync check protection is provided. Thus, as can be seen, if breakers SK_1 and SK_2 had been left in the improper closed position the emergency power system would have functioned properly to assure a continued source of emergency power.

Protection is also provided in the case when the standby bus is energized through Lee standby breakers SL_1 and SL_2. The transformer CT-4 standby breakers SK_1 and SK_2 cannot be closed due to: a sync check interlock which would not be satisfied; an undervoltage interlock which prevents closing when the standby bus is energized; a redundant undervoltage interlock; auxiliary contacts from the SL_1 and SL_2 breakers preventing closure of breakers SK_1 and SK_2.

Corrective Action:

In order to prevent recurrence of this incident the following corrective actions have been taken: The periodic test procedure has been revised to provide requirements and guidance for restoring the emergency power system to a proper lineup by opening the Keowee standby bus breakers SK_1 and SK_2 and clearing the standby bus undervoltage alarm. The alarm response procedure has been revised to provide guidance to investigate the cause of the loss of a Keowee unit and the underground feeder prior to placing the remaining Keowee unit on the underground feeder.

Operations personnel have reviewed this incident and additional formal training will be provided on the operation and theory of the Oconee emergency power system.