UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-424/94-01 and 50-425/94-01

Licensee: Georgia Power Company
P. O. Box 1295
Birmingham, AL 35201

Docket Nos.: 50-424 and 50-425 License Nos.: NPF-68 and NPF-81

Facility Name: Vogtle 1 and 2

Inspection Conducted: January 11 - 14, 1994

Inspector: N. Merriweather 2/9/94
N. Merriweather Date Signed

Approved by: Candle Jackson for 2/8/94
M. Shymlock, Chief Date Signed
Plant Systems Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This special, announced inspection was conducted to investigate the 500 Kv switchyard problems that resulted in a turbine trip and subsequent reactor trip of Unit 2 on January 7, 1994.

Results:

Within the areas inspected, no violations or deviations were identified.

The licensee had developed an action plan to investigate the event and its causes. The results of the investigation will be reported to management in an Event Critique Report. The preliminary investigation results indicate the event was initiated by the operation of a differential relay in the 500 Kv switchyard. The root cause for the differential relay operation was still being investigated by the licensee. The most likely cause was a loose electrical connection that was found in the relay panel wiring. Another possible cause being investigated was a fault or problem with a current transformer (CT). The loose electrical connection and/or bad CT may have initiated the event by causing a mis-operation of the Scherer shunt reactor differential relay which initiated a trip signal to 500 Kv air circuit breakers 660 and 620. When the two referenced breakers opened, air pressure at each breaker receiver went below the breaker low pressure lockout setpoint of 1550 PSIG. This locked the breakers out of service and initiated a breaker

failure backup protection scheme which opened four other circuit breakers and resulted in a Unit 2 trip. The preliminary root causes for the event were the trip of the shunt reactor, the low breaker air pressure, and the backup failure scheme which caused other breakers to open in addition to the two breakers which were required to open due to actuation of the Scherer shunt reactor differential relay. The final results of the licensee's root cause evaluation will be reported to the NRC in Licensee Event Report (LER) No. 2-94-001.

REPORT DETAILS

1. PERSONS CONTACTED

Licensee Employees

*D. Adams, Plant Modifications and Maintenance Support Supervisor
*B. Beasley, General Manager
B. Burmeister, Engineering Support Manager
S. Chestnut, Technical Support Manager
*B. Dunn, Unit Superintendent
*G. Frederick, Maintenance Manager
*B. Gabbard, Nuclear Specialist I
M. Griffis, Plant Modifications Manager
*G. Hooper, Engineering Supervisor
*W. Kitchens, Assistant General Manager
*R. LeGrand, Health Physics/Chemistry Manager
*G. McCarley, Safety Engineering Group Supervisor
*R. Moye, Plant Engineering Supervisor
R. Sammons, Senior Engineer
*J. Sutphin, Instrumentation and Control Supervisor
*T. Webb, Nuclear Safety and Compliance Engineer

Other licensee employees contacted during this inspection included craftsmen, engineers, operators, security force members, technicians, and administrative personnel.

Other Organizations

*T. Mozingo, Site Representative, Oglethorpe Power Corporation

NRC Employees

B. Bonser, Senior Resident Inspector
*P. Balmain, Resident Inspector

*Attended exit interview

Acronyms and initialisms used throughout this report are listed in the last paragraph.

2. Unit 2 Automatic Trip Event Followup (92701)

This special, announced inspection was conducted to investigate the cause of the reactor trip that occurred on January 7, 1994, in which a fault condition in the 500 Kv switchyard resulted in a turbine trip and subsequent reactor trip of Unit 2 from 100 percent power. A region based inspector was dispatched to the site on January 11, 1994, to support the resident staff in evaluating the event causes and the licensee's corrective actions.

The licensee had developed an action plan to investigate the event and its causes. The investigation was assigned to an Event Review Team with the Engineering Support Manager as the Team Leader. The team consisted of representatives from Safety Engineering Group, Maintenance, Engineering Support, Operations, and the Augusta Transmissions, Operations and Maintenance department. The team held meetings on a daily basis to review the results of the investigation and to track and assign action items for resolution. The results of the investigation will be reported to management in an Event Critique Report. The preliminary investigation results including possible root causes, corrective actions, and action item status are discussed in the report details below. The final results will be reported to the NRC in Licensee Event Report (LER) No. 2-94-001.

Sequence of Events: A Georgia Power Transmission Department Preliminary Analysis Report P94-001 evaluated the event and provided the following sequence of events. The event began at 22:53:15 eastern standard time and lasted for a duration of about 500 milliseconds.

- Event initiated when Scherer shunt reactor differential lockout relay detected a fault condition and operated
- Vogtle switchyard air operated 500 Kv Power Circuit Breakers (PCBs) 620 and 660 trip
- A transfer trip simultaneously sent to Plant Scherer to trip PCBs 640 and 740
- A major alarm is indicated on PCB 660
- A major alarm is indicated on PCB 620
- Low air lockout relay operates on PCB 660
- Breaker failure lockout relay operates on PCB 660
- PCBs 640, 830 and 930 trip (PCBs 830 and 930 are 230 Kv breakers)
- Low air lockout relay operates on PCB 620
- Breaker failure lockout relay operates on PCB 620
- Vogtle Unit 2 and PCB 520 trip

Preliminary Event Analysis: To understand the arrangement of the electrical distribution system at Plant Vogtle see Figure 1 below.

Vogtle Unit 2 connects to the Georgia Power Company (GPC) transmission grid system through 500 and 230 Kv switchyards. Unit 2 output power is connected to the 500 Kv switchyard via a step-up transformer through 500 Kv power circuit breakers (PCBs) 520 and 620. Unit 1 is connected to the 230 Kv switchyard via a step-up transformer and 230 Kv breakers.

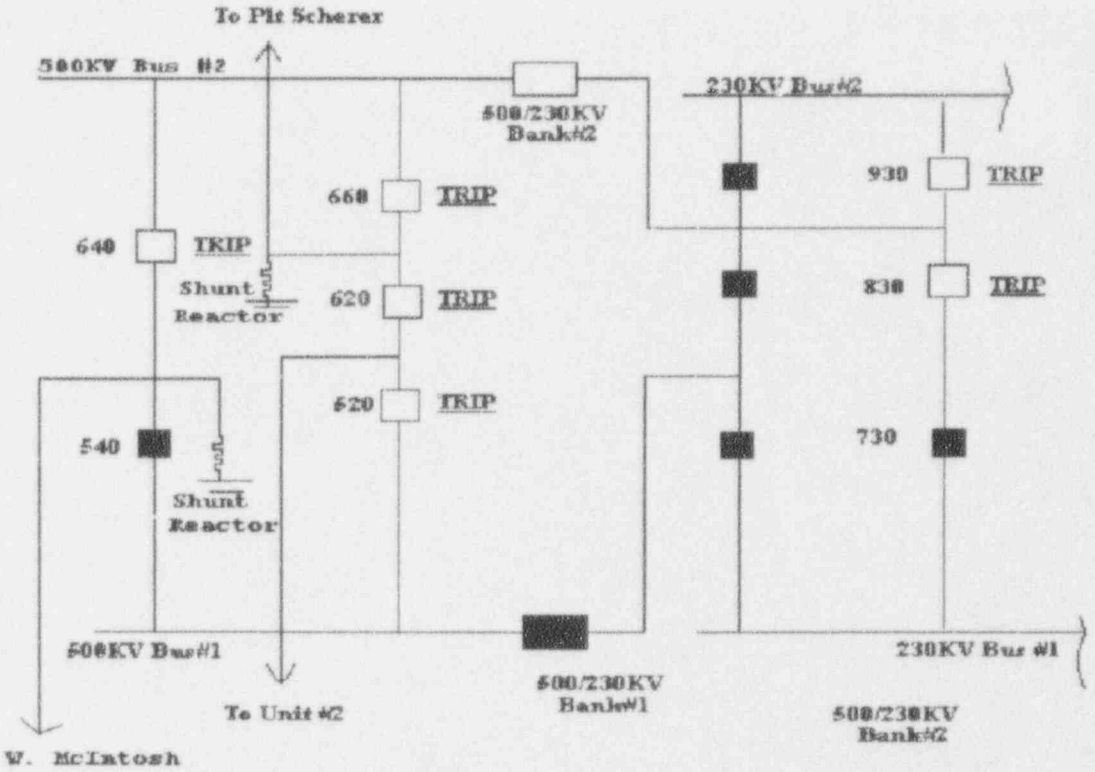

Figure 1

500/230Kv Switchyard Configuration

The 500 and 230 Kv switchyards are tied together through two autotransformers shown in Figure 1 as 500/230 Kv Banks 1 and 2. Preferred offsite power for safe shutdown of both plants is provided via the 230 Kv switchyard.

The Vogtle 500 Kv switchyard connects to the Georgia Power Company (GPC) 500 Kv transmission system through two transmission lines identified as Plant Scherer and W. McIntosh. The 500 Kv switchyard has five power circuit breakers (PCBs) and two shunt reactors. One shunt reactor is on the Scherer line and the other reactor is on the W. McIntosh line. The shunt reactors are remotely switched by the transmission department and are not controlled by the plant. Each shunt reactor is protected by two 500 Kv power circuit breakers.

The 500 Kv switchyard breakers are air blast type breakers. These breakers utilize compressed air to operate the breaker and to extinguish the arc. Each of the five switchyard breakers are supplied compressed air through a common header which is tied to two low pressure air receivers. Each receiver is filled by a separate refill valve which is connected to a high pressure receiver tank that can be filled by either of two air compressors or both. The high pressure receivers are normally aligned such that they are tied together and not isolated. The breakers are isolated via check valves in each of the air supply lines.

The event was initiated by the operation of the Scherer shunt reactor differential relay. The relay is located in the 500 Kv switchyard and is used to detect faults internal to the shunt reactor. The relay uses two sets of current transformers to monitor current through the shunt reactor. The relay operated and initiated trip signals to breakers 660 and 620 to isolate the shunt reactor. Breaker 620 is one of two generator output breakers. The other generator output breaker is 520.

When breakers 660 and 620 opened, air pressure in the receivers at each breaker went below the low pressure lockout setting of 1550 psi. This locked the breakers out of service and initiated a breaker failure backup protection scheme which sent trip signals to 4 other breakers. The breakers which opened were 640, 520 (the other Unit 2 generator output breaker), 830 (230 Kv) and 930 (230 Kv). The last two breakers isolated the Bank #2 autotransformer connecting the 230 Kv and 500 Kv switchyards together. The opening of breaker 520 resulted in the Unit 2 generator trip followed by a turbine trip and reactor trip.

The root causes of the event were the trip of the shunt reactor, the air pressure drifting low, and the breaker failure backup protection scheme which caused breakers to open in addition to the two breakers which were required to open due to actuation of the differential relay.

The root cause for the differential relay operation was still being investigated by the licensee. The most likely cause was a loose electrical connection that was found in the relay panel wiring. Another possible cause being investigated was a fault or problem with a current transformer (CT). The loose electrical connection and/or bad CT may have initiated the event by causing a mis-operation of the Scherer shunt reactor differential relay.

The control air supply for the 500 Kv breakers was discovered after the event to be low. The as-found control air pressure was approximately 1950 PSIG which was above the low pressure alarm setpoint of 1800 PSIG, but below the normal operating pressure setpoint of 2175 PSIG. The Georgia Power Transmission Department tested the breakers at the as-found pressure of 1950 PSIG and verified upon tripping the breakers that the pressure would fall below the low air pressure lockout setting of 1550 PSIG and actuate the low air lockout relay on the breaker.

The design of the Vogtle 500 Kv breaker control logic was such that if a 500 Kv breaker were called on to operate by a protective relay scheme, and the breaker lacks sufficient air pressure to operate properly, a breaker failure operation will occur with no time delay. This occurs as a result of a breaker failure relay bypass circuit. This bypass circuit is armed when the breaker has a low air lockout relay operation and the associated breaker motor operated disconnects (MODs) are closed.

As shown in the sequence of events above, PCBs 620 and 660 each had an existing trip request from the reactor differential lockout relay. The bypass circuit was armed because of low air pressure on the breaker and the MODs were closed. The low air pressure condition on the breakers

(i.e., PCBs 620 and 660) in conjunction with the operation of the reactor differential relay caused the breaker failure lockout relay to operate and trip all but one 500 Kv breaker in the Vogtle switchyard. The three conditions needed to arm the circuit and cause a direct trip of the breaker failure lockout relay were satisfied. The Unit 2 generator lockout relay then tripped causing a turbine trip and subsequent reactor trip.

The low control air pressure condition on the breakers was corrected prior to plant restart by readjusting the pressure regulating sensors to maintain breaker control air pressure at approximately 2200 PSIG. The breakers were tested at this pressure to verify that the pressure would not fall below the low pressure lockout relay setting when the breakers were closed and opened. The root cause of the low air pressure condition had not been fully determined so compensatory measures were also implemented to monitor the control air pressure hourly.

The adequacy of the alarm and trip setpoints for the control air system were being investigated as part of the Event Critique. In addition, the air system capacity was being reviewed by engineering for adequacy. The licensee had also contacted the vendor and was pursuing a site visit to examine the as-built configurations of the switchyard breakers to determine if any installation problems might still exist.

The equipment that initiated the event is located in the switchyard and is not considered safety-related. The maintenance performed on the equipment appeared to be consistent with the vendor recommendations. The Scherer shunt reactor had been Doble tested in November 1993 as part of the routine annual preventative maintenance (PM) program. The shunt reactor was retested as part of the investigation and the test results were essentially unchanged. The oil in the shunt reactors is sampled every six months and analyzed for gassing. A oil sample was also taken for gas analysis as part of the event investigation. The results of the chemical analysis of the oil had not been reported to the licensee prior to the end of the inspection.

The primary differential relay on the Scherer shunt reactor was last calibrated in 1986. The Transmission Department representative indicated that this was not an unusually long period between calibrations because these relays have proven to be very reliable. The relay calibration was checked as part of the trip investigation and was found to be within calibration.

The 500 Kv and 230 Kv switchyard breakers in general receive annual preventative maintenance (PM) except the unit breakers (e.g. PCB 620 and 520) which receive preventative maintenance during a major plant outage or refueling. The most recent maintenance on the 500 Kv switchyard equipment of concern is as summarized below:

- PCB 620 - Last PM date was October 4, 1993
- PCB 520 - Last PM date was October 5, 1993

- PCB 660 - Last PM date was December 16, 1993

- Pressure sensors/microswitches were replaced and recalibrated in the main air supply valve cabinet on December 16, 1993. The sensors had failed as a result of excessive vibration of the compressor skid assembly.

- One of the two main air compressors had been disassembled and shipped off for repair about 3 to 5 weeks prior to the event. A spare compressor with temporary connections was now in service and was in service during the event.

- Each breaker receiver air pressure and header air pressure were checked periodically. The last check prior to the event was on January 6, 1994. The main header pressure was recorded as 2150 PSIG. The receiver pressures on PCBs 660 and 520 were recorded as 2000 PSIG and the pressure on PCB 640 was recorded as 2100 PSIG.

The pressure gauges at the breakers are not calibrated as part of the sensor calibration, therefore the readings are not directly a true indication of system pressure. The technician that performs maintenance on the switchyard equipment indicated that the main header pressure reading was used to verify system operability. As shown above this reading was 2150 PSIG. However, the temperature at which all these pressure readings were taken had not been recorded and the readings had not been compensated for temperature. In addition, the data sheet did not specify acceptance criteria. This lack of acceptance criteria for pressure readings may have also contributed to the low control air pressure condition.

The high pressure receiver air tanks are required to be drained periodically for moisture. The maintenance technician indicated that this was done on a weekly basis. No records are maintained to document completion of this task.

The Event Review Team action item list consisted of approximately 22 items for which action had been completed on eight. Some of the items open and still being reviewed by the team involved:

- Improving trip setpoints for breaker control air system

- Better air pressure warning (earlier) alarms

- Eliminating breaker failure bypass scheme

- Have engineering evaluate the design of the air system for proper capacity and capability

- Initiating a site visit by the breaker manufacturer to verify that breakers are installed properly

- Reviewing previous Vogtle plant trip reports for similar events
- Reviewing other industry event reports (e.g., Peach Bottom event)

As stated earlier the results of the Team review will be reported to management in a Critique Report with recommended corrective actions. The results of all these reviews will be reported to NRC in a LER. The inspector concluded that the licensee's corrective actions and the root cause investigation was being conducted in a prudent and safe manner.

Within the areas inspected, no violations or deviations were identified.

3. Exit Interview

The inspection scope and results were summarized on January 14, 1994, with those persons indicated in Paragraph 1. The inspector described the area inspected and discussed in detail the inspection results indicated above. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee.

4. Acronyms and Initialisms.

GPC	Georgia Power Company
Kv	Kilo-volt
LER	Licensee Event Report
PCB	Power Circuit Breaker
PM	Preventative Maintenance
MOD	Motor Operated Disconnects
NRC	U. S. Nuclear Regulatory Commission