NRC FORM 366 (4-95)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMD NO. 3150-0104
EXPIRES: 04/30/98
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit Two	05000 270	1 OF 10

TITLE (4) Grid Disturbance Results In Reactor Trip Due To Manufacturing Deficiency

EVENT DATE (5)			LER NUMBER (6)					REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR		SEQUENTIAL NUMBER		REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER(S)
												05000
07	06	97	97	-	02	-	00	08	05	97		05000

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)			
POWER LEVEL (10)	100	20.402(b)	20.405(c)	x 50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER	
	AREA CODE	
R. T. Bond, Safety Review Manager	(864)	885-3043

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT *(Limit to 1400 spaces, i.e. approximately fifteen single-space typewritten lines)* (16)

On July 6, 1997 at 0652 hours, Oconee Unit 2 was operating at 100% full power when a system grid disturbance initiated a Generator protective relay actuation that resulted in all four reactor coolant pump/power monitor channels of the Reactor Protective System tripping. The operators placed the Unit in a stable, hot shutdown condition. The grid disturbance was created by a switching problem at Jocassee Hydro Station, located approximately 15 miles away from Oconee. The voltage regulator on Unit 2 did not respond as expected to the grid disturbance and maintain bus voltage within acceptable ranges. The root cause of this event is a manufacturing deficiency, inadequate installation instructions. Corrective action included calibration of the voltage regulator. This event is not considered to have an impact on the health and safety of the public.

NRC FORM 366

BACKGROUND

Jocassee Hydro Station is a four unit Hydro pump storage generating facility that services the Duke Power Distribution System and is owned and operated by Duke Power.

At Oconee, the electrical generator [EIIS:GEN] uses protective relaying to sense abnormal conditions that may adversely affect the generator. When such a condition is sensed, a lockout will open the main generator breakers and trip the turbine.

The Reactor Protective System (RPS) [EIIS:JC] monitors parameters related to the safe operation of the plant. It protects fuel against clad damage and the Reactor Coolant System against damage caused by high system pressure. There are four RPS channels, with two out-of-four logic to produce a reactor trip signal. The generated trip signal will open all Control Rod Drive breakers.

The Reactor Coolant Pump (RCP) to Power trip provides protection for changes in reactor coolant flow due to loss of multiple RCPs. Because the flow reduction lags loss of power indications due to the inertia of the RCPs, the trip initiates protective action earlier than a trip based on a measured flow signal. RCP status is monitored by power transducers on each pump. These relays indicate a loss of a RCP on underpower. The underpower setpoint is selected to reliably trip on loss of voltage to the RCPs.

EVENT DESCRIPTION

On July 6, 1997 at 0652 hours, Oconee Unit 2 Generator was operating at 100% full power, when a system grid disturbance occurred. Control Room Operators observed many alarms, and the Unit 1 and 2 combined control room lighting dimmed. After about five seconds, Unit 2 tripped when a voltage restraint overcurrent relay (51VRZ) tripped Unit 2's backup lockout relay(86H). Relay 86H applied a trip signal to the Unit 2 Generator breakers, PCB 23 and 24. In parallel, the Reactor Protective System (RPS) tripped the reactor on a pump/power trip at 06:52:17 hours, due to the Reactor Coolant Pump power monitors sensing a temporary power reduction. Units 1 and 3 remained on-line.

The Operators confirmed that the Reactor and Turbine had tripped and monitored for proper operation of other automatic equipment. The Operators entered the Emergency Operating Procedures, and as normally required after a Reactor trip, opened the High Pressure Injection (HPI) [EIIS:BG] 2A HPI train Emergency Make-up Valve to increase HPI flow to maintain Pressurizer level. They noted that an additional HPI pump (2B) had auto started.

The operators noticed that Pressurizer level had dropped to about 60 inches, and Reactor Coolant System (RCS) pressure was approximately 1800 psig, which is slightly lower than the nominal post trip pressurizer and pressure response. Therefore, the operator opened suction valves from the Borated Water Storage Tank, started the 2C HPI Pump, and injected makeup through the 2B HPI train to return Pressurizer level to 100 inches.

Except as noted above, all primary and secondary parameters responded as expected. Pressurizer level decreased from a pre-trip level of 221 inches to a minimum of 61 inches and later stabilized at approximately 140 inches. RCS Pressure was 2147 psig prior to the trip. It decreased to 1798 psig during the transient before stabilizing again at approximately 2155 psig. RCS Temperatures following the trip decreased to a minimum of 551 F before stabilizing at approximately 559 F.

Steam Generator (SG) 2A and 2B levels at the start of the transient were 168 inches and 160 inches respectively. Both SGs reached a minimum level of 22 inches and stabilized at 25 inches following the trip. SG Pressures were initially approximately 900 psig. The post-trip peak pressure was approximately 1141 psig for the 2A SG and 1135 psig for the 2B SG. Both SGs subsequently stabilized at approximately 1007 psig. These peak pressures exceeded 1115 psig which is the upper limit for the desired response. The pressures did not reach levels classified as abnormal (1155 psig).

Several electrical loads were lost as a result of the voltage fluctuation. These included the C Continuous Vacuum Priming pump, the Unit 2 Condensate Steam Air Ejector Off Gas Blower, 2B Electro Hydraulic pump, several Turbine Building Exhaust Fans, the Unit 2 Steam Packing Exhauster, and the Air Handling Unit 2-16. In addition, all the Unit 2 MOORE programmable controllers on the control room vertical board, that were in AUTO, swapped

to MANUAL. This affected valves 2RCW-52, 2RCW-62, 2RCW149, 2C-61, and 2C-58. The operators repositioned these valves and returned the controllers to AUTO. The other electrical loads were also restored to normal.

As a result of the transient, the 2A Condensate Booster Pump (CBP) inboard seal developed a large leak. 2A CBP seals were replaced.

Resolution of post-trip review issues was begun. Jocassee Hydro Station, located approximately 15 miles away from Oconee, was identified as the source of the grid disturbance.

An investigation was started to understand and resolve how the grid disturbance resulted in a trip of Oconee Unit 2.

The investigation of the causes for the grid disturbance and the response to it by Oconee Unit 2 was completed and at 2045 hours, the post trip review was completed and permission was granted for unit startup to 15% FP. It was decided not to place the Generator on line until calibration of the Generator voltage regulator was completed. The investigation had revealed that the voltage regulator had not responded properly to the grid disturbance. All protective relay setpoints applicable to this event were found to be acceptable. It was also determined that the relays performed as designed.

At 0002 hours on July 7, 1997, the operators began control rod withdrawal for approach to critical. At 0105 hours, Unit 2 reactor was critical. At 0316 hours, Unit 2 was at 15% FP with Generator off-line. At 2311 hours, after calibration of the voltage regulator, the Generator was placed on-line.

The investigation revealed the following:

A modification at Jocassee was planned to start on the morning of July 6, 1997, which involved rebuilding a seven mile section of the 100KV line that feeds the normal station auxiliaries. Jocassee was pumping with all (4) units and feeding the station auxiliaries from the 100KV line. While realigning to support this modification, two Jocassee units lost excitation while in the pumping mode. This initiated the grid disturbance.

At Oconee, Unit 1 and 2 are connected to the Duke Power grid through the 230 KV switchyard and Unit 3 is connected through the 525 KV switchyard. The line from Jocassee is connected to the 230 KV switchyard. At the time of the event, Unit 1 was at 70% power, Unit 2 was at 100% power and Unit 3 was at 95% power.

Units 1 and 3 responded to the grid disturbance properly, however, Unit 2 did not. The first indication of a problem at Oconee was a Unit 2 generator overcurrent alarm followed by a generator undervoltage alarm. These electrical conditions were detected by the Unit 2's voltage restraint overcurrent relay (51VRZ), which tripped Unit 2's backup lockout relay (86H). Relay 86H applied a trip signal to the Unit 2 Generator breakers, PCB 23 and 24. Tripping the generator breakers resulted in loss of load and subsequent Turbine/Generator trip and resulted in the temporary loss of power to the reactor coolant pump monitors.

Initial investigation revealed that the Oconee Unit 2 voltage regulator did not respond as expected. As a result of previous control problems, the AC AUTO Regulator circuit board was replaced in November 1994. When this circuit board was replaced, a Vendor Technical Representative was present to support the planned calibration of the voltage regulator (VR). Since the Duke Power VR Technicians were not familiar with the calibration of the AC AUTO Regulator circuit board, they relied on the expertise of the Vendor Technical Representative.

Subsequently, detailed instructions and training for calibrating the Auto Regulator circuit board gain controls were provided to Duke Power VR Technicians. Oconee Unit 2 voltage regulator gain controls were scheduled to be calibrated during the next outage in 1998. However, due to the Unit trip, calibration of the gain controls was completed on following the reactor trip on July 7, 1997.

The calibration revealed that the as found gains were improperly set, resulting in an overly sensitive voltage regulator which possibly would not react to a grid disturbance. This would account for the overcurrent condition and the generator bus voltage dipping to at least 80% of normal.

The problems at Oconee Unit 2 and Jocassee have been corrected. Oconee Units 1 and 3 will have their Auto-Regulator circuit board gain controls scheduled for calibration during their next scheduled refueling outages or at the next available shutdown.

A later review of the post trip results questioned the response to the Pressurizer level decrease to approximately 60 inches following the trip. The starting of a third HPI pump, although authorized by procedure, is not a normal post trip response. The initial post trip review had concluded that the low Pressurizer level occurred mainly from a procedure change to the Reactor Trip Emergency Operating Procedure that does not isolate RCS letdown immediately following a reactor trip as was the previous practice. This change was to prevent thermal shock to the coils of the Letdown coolers. However, for this trip, the minimum Pressurizer level was reached at approximately 49 seconds. The Main Steam (MS) pressure rapidly decreased to a minimum pressure of 981 psig at 46 seconds. Following a reactor trip, the MS turbine bypass valves (TBV) should control MS pressure at approximately 1010 psig. There were no indications of a stuck open MS relief valve, but yet the MS pressure decreased below the TBV setpoint.

There were 4 loads off the MS lines immediately following the trip:

(1) The Condensate Steam Air Ejector's remain aligned from MS until the operator manually swaps the supply to Auxiliary Steam (AS). This load is relatively small.

(2) The Main Feedwater (FDW) Pump Turbines (FDWPTs). This load can typically be 20,000 to 30,000 lbm/hr with both FDW pumps operating at min flow conditions. Eventually AS-98 will respond to supply the FDWPTs from the AS header.

(3) The Turbine Bypass Valves. This varies on the amount of decay heat. The valves are supposed to control MS pressure at 1010 psig following a reactor trip.

(4) The Second Stage Reheat (SSRH) tube supply. This flow path is automatically isolated following a turbine trip via two air operated valves and four electrically operated valves.

2MS-77, 2MS-78, 2MS-80 and 2MS-81 did not indicate closed until approximately 42 seconds following the trip. These valves provide isolation of the SSRH steam supply which is main steam. This stroke time appears to be consistent with past closure times for the valves, but the long stroke time may be contributing to the low steam pressure response seen on this and some of the previous reactor trips.

In addition, two of the four TBVs still indicated "not closed" while the steam pressure was at its minimum. A review of the transient monitor showed that the demand to the TBVs never went to "0" even with MS pressure below the control setpoint.

The combined effect of three loads (FDWPT, TBV, SSRH) may have caused the main steam pressure to drop below the nominal post trip value of 1010 psig.

An item was added to the Unit 2 control room turnover sheets to be aware that, on a Unit trip, the turbine bypass valves may not operate properly based on data from this unit trip.

It should be noted that the MS pressure response did not create an overcooling event, but it did result in enough Reactor Coolant contraction to combine with not isolating letdown to cause the Operator to start the third HPI pump to recover Pressurizer level. A Problem Investigation Process (PIP) report was generated to address these issues. This PIP was written to request additional review/modification of the identified MS components above to improve system response following a reactor trip.

CONCLUSIONS

This event was initiated by a grid disturbance that was created by conditions at the Jocassee Hydro Station. Two Jocassee Hydro units lost excitation while they were pumping and this abrupt loss caused an electrical transient to the grid. It was concluded that the Oconee Unit 2 voltage regulator was not calibrated properly and therefore it was incapable of responding to the grid disturbance of this magnitude. This initiated a trip of the generator breakers that resulted in a reactor trip.

When the voltage regulator component was changed out in 1994, it was installed per the technical guidance and instructions provided by the vendor representative. These instructions and guidance were determined to be incorrect. Therefore, the root cause of this event is a manufacturing deficiency, inadequate installation instructions.

A review of LERs written within the previous two years revealed that one LER 270/95-02, "Incorrect Timer Setting Due To A Design Deficiency Results In A Reactor Trip", occurred on April 14, 1995. This was a reactor trip from a grid disturbance, however the root cause was a design Deficiency due to an incorrectly set timer for a protective relay and the corrective action from that event would not apply to this event. Therefore this event is considered to be non- recurring.

The event did not result in personnel injuries, radiation overexposures, or releases of radioactive materials.

CORRECTIVE ACTIONS

Immediate

1. Operators took appropriate actions to stabilize the unit at hot shutdown.

Subsequent

1. Voltage regulator was calibrated prior to Unit 2 being placed in service.
2. All relays applicable to this event were checked for proper operation.
3. The 2A Condensate Booster Pump seal was replaced.
4. Note added to Operation turnover sheet about possible problems with the Turbine Bypass valves on Unit 2.

Planned

1. Calibrate the voltage regulators on Units 1 and 3 at the next scheduled refueling outage or at the next available shutdown.

2. Evaluate the response to the turbine header pressure observed following this trip.

Planned corrective action 1 is considered an NRC commitment item and is the only commitment contained within this report.

SAFETY ANALYSIS

The reactor scram occurred automatically and all control rods fully inserted as designed. The 4KV Safeguard Buses, the Emergency Power Supply Generators (KEOWEE HYDRO), and the offsite electrical sources were operable throughout the event to provide power to assure safe shutdown capability.

A loss of generator load and the resulting turbine trip, while at power operation, leads to an imbalance between the amount of heat produced in the primary system and the amount of heat removed by the secondary system. The Reactor Protective System (RPS) prevents excessive Reactor Coolant System (RCS) overpressurization and heatup by the actuation of the turbine trip anticipatory reactor trip. In this event, the voltage transient initiated a pump/power trip fractions of a second prior to the anticipatory trip. The RPS operated as designed and tripped the reactor.

Oconee Operations personnel successfully controlled shutdown of the plant using the appropriate station procedures. The Operators took a conservative action in starting the 2C High Pressure Injection pump.

Steam Generators A and B post-trip pressures were considered slightly higher than normal, but Main Steam Relief valves adequately controlled pressure such that design pressure was not exceeded.

Oconee is designed to withstand the most limiting Loss of Load event and still mitigate consequences of a Design Basis Accident as described in the UFSAR. Therefore, the Loss of Load accident bounds this event.

No Engineered Safeguards System or Emergency Feedwater actuations were either required or received.

The health and safety of the public were not compromised by this event.