UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

Report No.: 50-287/84-33

Licensee: Duke Power Company
422 South Church Street
Charlotte, NC 28242

Docket No.: 50-287 License No.: DPR-55

Facility Name: Oconee Unit 3

Inspection Conducted: November 15-16, 1984

Inspectors: H Chi for 12/21/84
D. Falconer Date Signed

H. Chi 12/21/84
H. Christensen Date Signed

Approved by: C. Julian 12/21/84
C. Julian, Section Chief Date Signed
Operations Branch
Division of Reactor Safety

SUMMARY

Scope: This special, announced inspection entailed 24 inspector-hours in the areas of Licensee Event Report followup concerning Oconee Unit 3 reactor trip of August 14, 1984.

Results: No violations or deviations were identified.

## REPORT DETAILS

1. Licensee Employees Contacted

 N. Pope, Superintendent, Operations
*T. Barr, Superintendent, Technical Services
*T. Coutu, Assistant Shift Operations Engineer
 P. Guill, Oconee Licensing Engineer
*T. Matthews, Compliance Technical Specialist
 S. Rose, Nuclear Engineer, Reactor Safety
*R. Sweigart, Project Operations Engineer

NRC Resident Inspectors

J. Bryant
K. Sasser
L. King

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on November 16, 1984, with those persons indicated in paragraph 1 above.

3. Licensee Action on Previous Enforcement Matters

This subject was not addressed in the inspection.

4. Unresolved Items

Unresolved items were not identified during this inspection.

5. Sequence of Events

On August 14, 1984, at 9:26 p.m., Unit 3 tripped from 100% Full Power when the instrument air line to the powdex demineralizer outlet valves was accidentally sheared by maintenance personnel. The loss of instrument air caused the powdex outlet valves to fail shut, which resulted in the condensate booster pumps tripping on low condensate suction pressure. The loss of the condensate booster pumps caused the Main Feedwater Pumps (MFP) to trip on low-suction pressure, which initiated an anticipatory reactor trip. The Motor Driven Emergency Feedwater Pumps (MDEFP) and the Turbine Driven Emergency Feedwater Pump (TDEFP) started in response to the loss of main feedwater and a stable 25-inch steam generator level was established by the Emergency Feedwater Level Control System (EFLCS).

Approximately fifteen minutes after the reactor trip, the '3A' MFP was reset and restarted. When main feedwater hydraulic control oil pressure and discharge pressure reached 75 psig and 750 psig, respectively, the Steam Generator (SG) level control automatically shifted from the EFLCS back to the normal Integrated Control System (ICS). This shift caused the Emergency Feedwater Control Valves (3FDW-315, 316) to switch to manual control. The manual controller position was set at its normal value of zero, causing the Emergency Feedwater Control Valves (EFCV) to close. The automatic closure of the EFCV stopped flow to the SG because the MFP was running at slow speed, and the discharge pressure from '3A' MFP was not high enough to allow flow to the SG (SG pressure ~ 1000 psig, MFP discharge pressure ~ 750 psig). The steam generator level decreased and pegged low at 12 inches and remained there for approximately nine minutes.

The operator observed the low levels in the SG's and manually reopened 3FDW-315/316 and increased the MFP speeds. SG levels returned to 25 inches. During the low SG levels, primary temperature increased from ~ 555°F to ~ 575°F; after feed flow was restored primary temperature returned to 555°F terminating the transient.

6. Emergency Feedwater System Description

The Emergency Feedwater System (EFWS) at Oconee consists of two Motor Driven Emergency Feedwater Pumps and one Turbine-Driven Emergency Feedwater Pump. Motor-driven emergency feedwater pumps A and B normally supply emergency feedwater to steam generators A and B, respectively. The Turbine-Driven Emergency Feedwater Pump supplies both steam generators. The primary emergency feedwater flow path to each steam generator contains a normally closed, air-operated flow control valve, FDW-315 and FDW-316.

Emergency feedwater automatic initiation signals are generated upon complete loss of main feedwater and are sent to the controllers of the motor-driven emergency feedwater pumps, a solenoid controlling the steam admission valve MS-93 for the turbine-driven emergency feedwater pump and the automatic emergency feedwater steam generator level control system that controls emergency feedwater flow control valves FDW-315 and FDW-316.

A loss of main feedwater signal is generated by normally closed contacts located in each emergency feedwater pump initiation circuitry. These contacts are normally closed to energize a loss of main feedwater relay. Four contacts are provided. Two of the contacts (one per main feedwater pump) change state on low main feedwater pump discharge pressure of less than 750 psig and the other two contacts (one per main feedwater pump) change state on low main feedwater pump turbine hydraulic control oil pressure of less than 75 psig.

Each steam generator is provided with a safety-grade automatic level control system, EFLCS, which controls emergency feedwater flow control valves FDW-315 and FDW-316 to maintain a 25 inch level in the steam generators if the reactor coolant pumps are not tripped. The source of controlling the emergency feedwater flow control valves is determined by a control room selector switch with positions for manual or automatic control. In the automatic mode, the emergency feedwater flow control valves remain in manual with closed demand unless a loss of main feedwater initiation signal is received. Upon receipt of a loss of main feedwater initiation signal, control for the position of these valves is transferred from the manual controller to automatic steam generator level control. The valves then open to admit emergency feedwater.

7. Causes of Feedwater Event

Approximately fifteen minutes after the reactor trip, operators reset and restarted the '3A' main feedwater pump. Prior to restarting the pump, the main feedwater control valves were observed by operators to be open when they should have been closed. The valves were placed in manual and closed. Subsequent investigation revealed that emergency feedwater automatic level control was controlling steam generator levels at slightly less than 25 inches, causing the integrated control system (set to control level at 25 inches) to open the main feedwater flow control valves due to controller wind up in response to the mismatch between the ICS low-level limit and the emergency feedwater level control setpoint. The licensee was requested to provide the last calibration of the emergency feedwater steam generator level channels. This item will be identified as inspector followup item (287/84-33-01).

Upon starting the '3A' main feedwater pump, hydraulic control oil pressure and discharge pressure increased above 75 psig and 750 psig, respectively, resulting in control of emergency feedwater control valves FDW-315 and FDW-316 to automatically transfer back to the normal manual control mode. The manual controller was set for the normal full closed standby configuration of the emergency feedwater flow control valves causing FDW-315 and FDW-316 to close. Although the '3A' main feedwater pump was operating, discharge pressure was less than the 1000 psig steam generator pressure psig resulting in termination of all feedwater flow to the steam generators. The resulting increase in primary temperature alerted operators that flow had been terminated to the steam generators. Operator response was prompt and appropriate. Emergency feedwater flow control valves were opened and the '3A' main feedwater pump speed was increased to establish feedwater flow to the steam generators. Approximately one minute after initiating corrective actions, the operators succeeded in returning steam generator levels to the required 25 inches. Once main feedwater flow was verified to have been reestablished, the emergency feedwater pumps were removed from service.

The licensee had previously identified this potential problem with steam generator emergency feedwater level control and incorporated a procedural caution statement in the emergency procedure for loss of steam generator feedwater (EP/0/A/1800/14) to place FDW-315 and FDW-316 in manual control to prevent their closure prior to resetting a main feedwater pump during recovery operations from a loss of main feedwater. On August 14, 1984, operators failed to heed this caution step resulting in FDW-315 and FDW-316 closing when the '3A' main feedwater pump was restarted as detailed above.

The licensee's apparent failure to follow emergency procedure EP/0/A/1800/14 was previously addressed by the NRC resident inspection staff in inspection report 50/287/84-24, paragraph 7.

Contributing factors to the operators' failure to follow the procedural caution were the distraction caused by the main feedwater flow control valves opening and the fact that the caution step was located after the action step in the procedure instructing the restart of a main feedwater pump.

8. Post Trip Plant Response

Plant response immediately following the reactor trip was normal. Average reactor coolant temperatures decreased to approximately 555°F and reactor coolant pressure decreased to 1800 psig and was eventually controlled at 2150 psig as expected. Secondary steam pressure peaked at approximately 1040 psig and stabilized at 1000 psig with the emergency feedwater system controlling steam generator levels at approximately 25 inches.

Plant response continued normally until reactor operators attempted to reset and restart the 3A MFP resulting in feedwater to the A and B steam generators being terminated for several minutes. Steam generator level indication on both steam generators dropped to a minimum reading of 12 inches causing a reduction in primary to secondary heat transfer and a primary system temperature increase of approximately 20°F. Steam outlet pressure in the '3B' steam generator dropped approximately 50 psig. Actual levels in the steam generators during the period of feedwater termination are suspected to have approached dry conditions. Upon reestablishing feedwater to the steam generators, level returned to 25 inches, steam outlet pressure in the 3B steam generator recovered, and primary system temperature decreased and stabilized at 555°F.

A steam generator tube leak of approximately 0.025 gpm was present at the time of the reactor trip. The transient did not appear to have an adverse affect on the tube leak.

Exact minimum levels in the steam generators cannot be determined. Indicated levels decreased to approximately 12 inches and stopped. The start up level that would have been indicated if the steam generators were filled with saturated steam (i.e. no liquid inventory) is approximately 12-15 inches due to the $\Delta P$ caused by the weight of the steam above the lower tap of the level indicator. Calculations indicate that sufficient primary heat was available to boil-off initial steam generator water inventory within the estimated time of feedwater unavailability.

Although the above indicates that the possibility existed for dry conditions in the steam generators, steam generator outlet pressure parameters do not support this conclusion. The 50 psig drop in the '3B' steam generator pressure can be attributed to the reduced steam production in the steam generator caused by the termination of feedwater and the seal steam that was supplied from the '3B' steam generator. Steam generator '3A' outlet pressure remained at approximately 1000 psig with the turbine by-pass valves opened during the entire period of diminished water inventories. These steam generator outlet pressure histories indicate that steam production never ceased and that the generator did not dry out completely.

9. Corrective Actions

Immediate corrective actions to the reactor trip were to stabilize the plant at hot shutdown, reestablish main feedwater flow and terminate emergency feedwater flow. The cause of the reactor trip was determined and the sheared instrument air line was repaired. Personnel involved in the shearing of the instrument line were counselled.

Emergency Procedure EP/O/A/1800/14 was revised to incorporate the intent of the caution step into the body of the procedure by adding direction to the operator to match the manual loader output to the automatic controller output prior to restarting the main feedwater pumps.

It has been the licensee's general procedure writing practice to locate the caution statement immediately following the appropriate action; however, plans to revise procedures to a symptom oriented format by October 1, 1985, should correct this deficiency.

The licensee provided shift training on EP/O/A/1800/14, the procedure changes incorporated to improve the restarting of a main feedwater pump following emergency feedwater actuation and the circumstances surrounding the reactor trip and post trip feedwater events.

Training was not specifically provided on the behavior of steam generator level indication at low steam generator levels. During the exit interview the licensee committed to provide training to operators and STA's on this behavior. This item will be identified as an inspector followup item (287/84-33-02).

Design changes to improve the current designs of the emergency feedwater initiation circuitry and to remove the undesirable interaction between the control grade ICS steam generator level control and the safety grade automatic emergency feedwater steam generator level control have been proposed by the licensee. The design change proposals would correct the automatic closure of FDW-315 and FDW-316 and automatic trip of the turbine driven emergency feedwater pump upon restart of the main feedwater pumps, and the drifting open of the main feedwater flow control valves when steam generator level is controlled by automatic emergency feedwater level control. Final implementation decisions and schedules have not been made for these proposed design changes. Implementation of the proposed design changes will be identified as an inspector followup item (287/84-33-03).