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

Report Nos.: 50-250/87-46 and 50-251/87-46

Licensee: Florida Power and Light Company
9250 West Flagler Street
Miami, FL 33102

Docket Nos.: 50-250 and 50-251 License Nos.: DPR-31 and DPR-41

Facility Name: Turkey Point 3 and 4

Inspection Conducted: November 4-6, 1987

Inspectors: T. O'Connor, Reactor Engineer, Team Leader — 12-17-87 Date Signed

R. Starkey, Reactor Engineer

Approved by: M. Shymlock, Chief, Operational Programs Section, Division of Reactor Safety — Dec 17, 1987 Date Signed

Summary

Scope: This special, announced reactive inspection was conducted in the area of void formations in the Unit 4 reactor vessel upper head region during cold shutdown conditions which occurred between October 21 and November 3, 1987. This inspection consisted of a review of the circumstances surrounding these events, reviews of associated procedures, logs, and charts, and interviews with operators, technical staff, and maintenance personnel.

The primary cause for the void formations was the intrusion of nitrogen and nitrogen saturated water from the 4C cold leg accumulator via the accumulator's leaking isolation valve. Additionally, it has been determined throughout all void instances that the fuel remained covered with water which ensured adequate decay heat removal.

Results: One violation was identified. (Failure to establish and implement procedures; see paragraph 5.b)

REPORT DETAILS

1. Licensee Employees Contacted

*J. Odom, Site Vice President
*F. Southworth, Acting Plant Manager
*J. Arias, Jr., Regulatory Compliance Supervisor
*J. Strong, Jr., Electrical Superintendent
*W. Bladow, Quality Assurance Superintendent
*G. Salamon, Compliance Engineer
*J. Labarraque, Technical Support Supervisor
*D. Haase, Site Engineering Group Chairman
*G. Marsh, Reactor Supervisor
*P. Higgins, Technical Licensing
*W. Miller, Senior Technical Advisor
*J. Kappes, Maintenance Superintendent
*J. Webb, Operations/ Maintenance Coordinator
*R. Earl, Quality Control Supervisor
M. Wayland, Electrical Department

Other licensee employees contacted included engineers, technicians, licensed operators, mechanics, and training staff personnel.

NRC Resident Inspectors

*T. McElhinney, Resident Inspector
R. Brewer, Senior Resident Inspector

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on November 6, 1987, with those persons indicated in paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee. The licensee did not identify as proprietary any of the materials provided to or received by the inspector during this inspection.

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. Void Formation in the Unit 4 Reactor Vessel Upper Head Region

a. Sequence of Events

This inspection reviewed the circumstances surrounding the recurrent void formations in the Unit 4 reactor vessel upper head region between October 21 and November 3, 1987. The primary cause for the void formations was the intrusion of nitrogen and nitrogen saturated water from the 4C cold leg accumulator via the accumulator's leaking isolation valve. Additionally, the licensee has determined throughout all void instances that the fuel remained covered with water which ensured adequate decay heat removal. The inspection centered on the licensee's response to the events and efforts directed at establishing the root cause of the void formations.

Cold leg accumulators provide a passive means of rapidly injecting borated water into the Reactor Coolant System (RCS) during certain accident conditions. When the reactor is critical, Technical Specifications require each accumulator to be pressurized with a nitrogen cover gas to a minimum of 600 psig and contain 875-891 cubic feet (6568-6642 gallons) of water with a boron concentration of at least 1959 ppm. The accumulators are required to be isolated from the RCS when the pressure in the RCS drops below 1,000 psig to prevent inadvertent discharge. Cold leg accumulators are isolated from the RCS by closing their respective MOV-4-865 isolation valve.

On October 21, 1987, Unit 4 was in cold shutdown and depressurized with preparations being made to draw a bubble in the pressurizer to degas the RCS of hydrogen. This effort would lower the hydrogen concentration from 25.29 cc/kg to less than 5 cc/kg. This reduced hydrogen level was needed so that maintenance could be performed on the power operated relief valves (PORVs). At approximately 1130 hours, the Reactor Control Operator (RCO) noted a void in the reactor head as indicated by the reactor vessel level indication system on the Qualified Safety Parameters Display System (QSPDS).

The QSPDS interprets information from eight heated junction thermocouples (HJTC) to provide reactor vessel level indication. These eight HJTC are located in a vertical orientation spanning from the top of the reactor vessel through the upper plenum and stopping approximately one foot above the upper core plate. The uppermost thermocouple is approximately 166 inches above the upper core plate. The next thermocouple is located approximately 129 inches above the upper core plate.

The first void was subsequently compressed and eliminated by increasing RCS pressure via normal charging to approximately 30 psig from 0 psig. It was first believed that this void originated from hydrogen coming out of solution when the RCS was depressurized. Calculations later proved that the hydrogen concentration had not

reached its saturation level and therefore did not contribute to the formation of this void.

From October 21, 1987 through October 24, 1987, the operating staff continued performing evolutions designed to lower the hydrogen concentration of the RCS. These evolutions included filling and venting the RCS, increasing RCS pressure and degassing. Once the required level of hydrogen was reached, the plant was depressurized.

On October 25, 1987 at approximately 0200 hours, the RCO noted a second void in the reactor head as indicated by QSPDS. Additional indications of a void in the head, as observed by the RCO, included an increase in pressurizer cold calibration level from 86 percent to 97 percent. At approximately 0230 hours per the Plant Supervisor-Nuclear (PSN) direction, the RCO entered operating procedure 4-OP.041.8, RCS Fill and Vent, at step 5.1.2.10, and vented the reactor vessel head and pressurizer to the Pressurizer Relief Tank (PRT). At approximately 0300 hours, the QSPDS indicated that the reactor head was full. The pressurizer returned to its original level, and the PRT showed an increase in pressure also indicating the void had been vented.

The reactor head vent valve was then closed. The pressurizer was then realigned to vent to the containment atmosphere to facilitate pressurizer drain down and preparations for maintenance work on the PORV's.

The PSN requested the nuclear chemistry department to determine the composition of the gas vented from the RCS. Their analysis indicated that the gas consisted of approximately 96.3 percent nitrogen. The PSN called for an Event Response Team (ERT) to examine the occurrence of the reactor head voids. At approximately 0530 hours the RCO again observed indications on the QSPDS of a void in the reactor vessel head. This third void was also vented using step 5.1.2.10 of procedure 4-OP.041.8 and collapsed by 0600 hours. Venting of the reactor vessel head continued until 1240 hours.

At approximately 0750 hours, the ERT and the operating staff concluded that the primary source of nitrogen inleakage was from the 4C accumulator. The ERT and control room staff based their conclusions on the 4C accumulator pressure reading approximately 100 psig and narrow range water level reading off scale low (below 6000 gals). Additional evidence in the form of an increased RCS boron concentration pointed to the inleakage of 2100 ppm borated water from the 4C accumulator. The pressure on the A and B accumulators at this time was approximately 475 and 375 psig respectively. Accumulators are only required to be operable per Technical Specifications when the reactor is critical.

Based on the above information, the ERT recommended venting the 4C accumulator to containment atmosphere to stop the inleakage. At approximately 0850 hours, 4C Accumulator Vent valve, CV-4-853C, and Accumulator Header Vent valve, HIC-4-936, were opened to facilitate the venting of the 4C accumulator. At approximately 0900 hours, venting of the 4C accumulator was terminated due to the inability to reduce pressure in the accumulator. Operations personnel entered the containment to verify valve lineup and discovered the manual isolation vent valve 4-937 to be in the closed position. Valve 4-937 is located between the valve HIC-4-936 and the containment atmosphere. The identification tag attached to the valve 4-937 indicated that the valve should be normally closed (N/C). Operations Procedure 4-OP-064, entitled Safety Injection Accumulators, revision dated September 22, 1987, required this valve to be in the open position, and was last confirmed in its proper alignment on June 28, 1987. The licensee was unable to determine how or when the valve was repositioned.

The operating staff verified proper operation of the HIC-4-936 valve through actual field verification. Then with valve HIC-4-936 closed, manual isolation vent valve 4-937 was opened. At approximately 1030 hours, HIC-4-936 was opened allowing the 4C accumulator to depressurize. 4C accumulator venting was terminated at approximately 1220 hours with a 4C accumulator pressure of approximately 6 psig.

At approximately 1240 hours, the reactor head vent valve was closed. The pressurizer was then realigned to vent to the containment atmosphere to facilitate pressurizer drain down and preparations for maintenance work on the PORV's.

At approximately 1730 hours, per the recommendation of the ERT, the RCO began to drain the pressurizer from approximately 78 percent to 22 percent. Voids in the reactor vessel head had been characterized by increases in the pressurizer level. Increases in pressurizer level from 22 percent level would have caused a pressurizer level deviation alarm, thereby increasing the number of parameters providing warning of a void formation in the reactor vessel head. The draining of the pressurizer to the 22 percent level was performed according to operations procedure 4-OP-041.7, Draining the Reactor Coolant System, dated June 2, 1987. At approximately 1815 hours while draining the pressurizer, a void formed in the reactor vessel head. This fourth void was vented by utilizing step 5.2.2.5 of the Draining the Reactor Coolant System procedure which allows the RCO to open the reactor head vent to containment atmosphere. At approximately 1830, the void was vented and pressurizer drain down continued. Pressurizer level reached the 22 percent level at approximately 1936 hours. Operating procedure 4-OP-041.7 was then signed off as complete with the reactor vessel head vent left in the open position as allowed by the procedure.

The ERT determined that the reactor vessel head vent should remain in the open position to prevent additional void formations. This determination, however, was not communicated to the control room staff, even though the head vent was left in the open position.

Due to insufficient detail in both the RCO's log book and during shift turnover, subsequent operators were not aware of the particular procedure step which left the reactor vessel head vent in the open position. On the evening of October 26, the RCO could not locate a procedure or clearance justifying the reactor vessel head vent valve being in the open position, and closed the valve.

On October 26, 1987, at approximately 2040 hours, 4A and 4B accumulators were vented in accordance with section 7.5 of procedure 4-OP-041.7. Venting was completed at approximately 2230 with the closure of the accumulator vent valves.

On the morning of October 28, 1987, the 4A and 4B isolation valves were analyzed for correct actuation using Motor Operator Valve Actuation Test System (MOVATS). The operating staff and members of the ERT were cognizant that during the course of this testing nitrogen saturated water from the 4A and 4B accumulators would drain into the RCS. The ERT did not believe this testing would contribute to additional void formations in the reactor vessel head. This assumption, however, was based on the belief that the reactor vessel head was vented to the containment atmosphere.

At approximately 1430 hours, the RCO observed indications on the QSPDS of a fifth void in the reactor vessel head. This void was vented via the reactor vessel head vent using step 5.1.2.10 of operating procedure 4-OP.041.8, RCS Fill and Vent, and collapsed by 1445 hours. The reactor vessel head vent was closed at approximately 1451 hours.

In order to impose additional administrative control over the position of the reactor vessel head vent and comply with the recommendations of the ERT, equipment clearance 4-87-10-146 was issued at approximately 1640 hours. This equipment clearance placed the reactor vessel head vent valve SV-4-6318A in the open position thereby continually venting the reactor vessel head to the containment atmosphere.

On November 1, 1987, at approximately 2000 hours, the RCO observed indications on the QSPDS of a sixth void in the reactor vessel head with the reactor vessel head vented to containment atmosphere. Under the direction of the PSN, the RCO started the 4A charging pump to raise pressurizer level. When level reached approximately 25 percent, the void cleared. The 4A charging pump was stopped at approximately 2050 hours after reaching a pressurizer level of 42 percent.

Following the collapse of the sixth void, a plant work order was written to determine if the reactor vessel head vent was blocked, which would have allowed the void to form. Root valve 4-500 for the reactor vessel head vent was closed under clearance 4-87-11-008 to facilitate the inspection of the vent line. Maintenance workers were unable to detect blockage in the vent line. The ERT suspected that the blockage occurred in the vent line orifice and was cleared when the pressurizer level increased.

On November 3, 1987, at approximately 0145 hours, the RCO observed indications on the QSPDS of a seventh void in the reactor vessel head. The RCO was unable to vent the reactor vessel head to containment atmosphere due to root valve 4-500 being isolated for the inspection of the vent line. Venting of the seventh void began at approximately 0946 hours after the root valve 4-500 was opened and the determination was made that a sample of the void gas was not required. To assist in the venting of the reactor vessel head, an additional reactor vessel head vent valve, SV-4-6318B, was opened.

On November 6, 1987, at approximately 0300 hours, clearance 4-87-10-146 which opened the reactor vessel head vent valves was lifted and the reactor vessel head vents were closed. The licensee then entered operating procedure 4-OP.041.8, RCS Fill and Vent, to begin pressurizing, heating up and drawing a bubble.

b. Event Response Team (ERT)/ Management Attention

Upon the occurrence of the second void in the reactor vessel head, the PSN notified the Operations Supervisor of the situation and requested the formation of an ERT. The ERT is a licensee team of expert personnel chartered with investigating significant plant events and trips, determining root causes, and recommending corrective actions. The Duty Call Supervisor was then contacted and the ERT activated. Activation of the ERT ensured that proper management, maintenance and engineering attention would be provided to identify and correct the cause of the voids. The ERT appeared to be thorough in its investigation, pursuing multiple paths of nitrogen intrusion even after the primary contributor had been identified. Safety evaluations were performed to examine the effect of the nitrogen on the fuel and plant operations with the manual isolation vent valve 4-937 closed. The inspectors concur with the licensee's conclusion that the closed 4-937 valve would not have prevented the operation of the cold leg accumulators under accident conditions.

Additional areas of examination by the ERT included: 1) examination of daily repressurizations of the accumulators with nitrogen, 2) MOVATS testing of the accumulator isolation valves, 3) performance of thermography on the accumulators in order to determine current level (accumulators do not have wide range level indication), 4) examination of the expected increase in boron concentration on the

RCS from the 4C accumulator inleakage and inleakage occurring during MOVATS testing, 5) potential for similar events occurring on Unit 3, and 6) additional sources of nitrogen intrusion.

The Volume Control Tank (VCT) was identified as an additional source of nitrogen intrusion. The plant configuration being utilized during a portion of the scenario involved the residual heat removal system and makeup via nitrogen pressurization on the VCT. Calculations by the licensee have determined that with the VCT nitrogen pressure being higher than the depressurized RCS, that enough nitrogen would come out of solution in approximately 28 hours to form a void in the reactor vessel head.

The ERT review of items relating to the 4C accumulator identified an open plant work order approximately eighteen months old requesting the accumulator isolation valve 865-C be repaired for suspected leakage. Because the 865-C valve is required to be open while the reactor is critical, a safety evaluation was not performed to analyze the effect of the valve leaking while in the closed position. Maintenance was not performed on the valve due to the piping elevations, which would require the fuel core to be unloaded from the reactor vessel. Additionally, operational history shows that on June 26, 1987, while under similar depressurized plant conditions, the 4C accumulator was determined to be empty.

During the course of the ERT's examination of the reactor vessel head voids, a problem of communication existed between the ERT and the operating staff. The problem was identified when the determination that the reactor vessel head vent should remain in the open position was not communicated to the control room staff. The licensee has taken steps to assist in this area by formalizing the method in which ERT information is disseminated to the operating staff. The NRC has a concern pertaining to the need for the adequate documentation of unusual alignments by the operating staff. Adequate documentation may have provided additional background information and guidance to the operator in his manipulation of the reactor vessel head vent. The lack of communication and adequate documentation may have contributed to the formation of the fifth void.

Manual isolation vent valve 4-937 is required to be in the open position to facilitate depressurization of the accumulators in cold shutdown. Additionally, during accident conditions under which the cold leg accumulators inject their contents into the RCS, Emergency Operating Procedures 4-EOP-ES-1.2, Post LOCA Cooldown and Depressurization, and 4-EOP-ECA-3.2, SGTR With Loss Of Reactor Coolant - Saturated Recovery Desired, direct the RCO to vent the accumulators to the containment atmosphere if the accumulator isolation valves cannot be closed. The intent behind closing the accumulator isolation valves is to prevent the introduction of

nitrogen into the RCS which may affect the ability of the safety systems to maintain adequate core cooling. Venting of the accumulators is an alternative method of preventing the introduction of nitrogen into the RCS.

The ERT performed a safety evaluation on the potential impact of the manual isolation vent valve 4-937 being in the closed position. Westinghouse has concurred with the licensee's evaluation. The safety evaluation states that under accident conditions, the accumulators would provide water required for core cooling prior to the delivery of flow from the safety injection pumps. If nitrogen gas is discharged into the RCS, it may accumulate in the steam generator U-tubes, possibly, inhibiting natural circulation flow through the steam generators and removal of decay heat. However, nitrogen would not discharge into the RCS until the RCS pressure had fallen below 250 psig, at which time the residual heat removal system can be operated providing the necessary decay heat removal capabilities. Additionally, below 250 psig, the steam generators are not required for decay heat removal.

In order to prevent the inadvertent closure of the manual isolation valve 4-937 in conjunction with the results of the safety analysis, the licensee has removed valve 4-937 from Unit 4 and will remove this valve from Unit 3.

The NRC has an additional concern pertaining to proper valve identification. Improper valve identification as it pertained to the valve position was noted on the tag attached to the the manual isolation valve 4-937 for the accumulator header vent. The incorrect operator aid may have contributed to the manual isolation valve incorrectly being in the closed position. The licensee should review the administrative controls over operator aids. Additionally, the licensee should review the administrative control of valves, locks and switches for the proper inclusion and configuration control of safety related components, in light of the fact that a closed manual isolation valve was required to be in the open position to facilitate actions required under emergency operating procedures.

Technical Specification 6.8.1 requires that written procedures shall be established and implemented for activities recommended in Appendix A of Regulatory Guide 1.33. Appendix A, recommends, in part, that procedures for the operation of safety related systems should be established.

Operations Procedure 4-OP-64, entitled Safety Injection Accumulators, revision dated September 22, 1987, requires, in Attachment 2 that the manual isolation vent valve 4-937 be in the open position.

Contrary to the above, on October 25, 1987, valve 4-937 was found not to be in the open position. This example of a failure to implement approved procedures to control the configuration of a safety-related system is a violation (50-251/87-46-01).

Although, the licensee has determined that the closed 4-937 valve would not have prevented the operation of the cold leg accumulators under accident conditions, inadequate configuration control on safety-related systems was the subject of recent escalated enforcement action. The escalated enforcement action issued civil penalties for inadequate configuration control in conjuction with the loss of boric acid flow paths, reference NRC Inspection Report Nos. 50-250/87-28 and 50-251/87-28, and with the isolation of backup nitrogen for the auxiliary feedwater system, reference NRC Inspection Report Nos. 50-250/87-33 and 50-251/87-33.

The licensee has identified nitrogen saturated water from the 4C accumulator as being the void source for the void which occurred on October 21, 1987. The licensee has determined that the remaining voids resulted from approximately 1500 cubic feet of nitrogen gas from the 4C accumulator, nitrogen saturated water from the 4A and 4B isolation valves during MOVATS testing and VCT pressurization with nitrogen. Additionally, the licensee has determined throughout all void instances, that the fuel remained covered with water and that proper decay heat removal was maintained.