



UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30320

Report No.: 50-302/88-08

Licensee: Florida Power Corporation
3201 34th Street, South
St. Petersburg, FL 33733

Docket No.: 50-302

License No.: DPR-72

Facility Name: Crystal River 3

Inspection Conducted: March 8-11, 1988

Inspector: G. A. Hallstrom 4/4/88
G. A. Hallstrom Date Signed

Approved by: B. R. Crowley 4/5/88
J. J. Blake, Section Chief Date Signed
Materials and Processes Section
Division of Reactor Safety

SUMMARY

Scope: This routine, announced inspection was in the areas of license actions associated with LER 88-006 (Reactor Trip Due to Failure of Feedwater Block Valve FWV-29).

Results: No violations or deviations were identified.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

- *J. Alberdi, Assistant Director of Nuclear Plant Operations
- *P. D. Breedlove, Records Management Supervisor
- C. J. Carr, Nuclear Modifications Specialist
- *M. D. Clary, Nuclear Mechanical Engineer
- *J. E. Colby, Manager, Nuclear Mechanical/Steam Engineering Services
- *M. E. Collins, Nuclear Safety and Reliability Superintendent
- *G. R. Clyance, Nuclear Waste Manager
- *E. W. Ford, Licensing Specialist
- *R. E. Fuller, Senior Nuclear Licensing Engineer
- *D. Gulling, ISI Specialist
- *V. Hernandez, Senior Nuclear QA Specialist
- *S. G. Johnson, Manager of Site Nuclear Services
- *A. Kazemfar, Supervisor, Radiological Support Services
- *H. Koom, Assistant Nuclear Maintenance Superintendent
- *G. A. Longhouser, Security Superintendent
- *W. Marshall, Operations Superintendent
- *P. F. McKee, Director of Nuclear Plant Operations
- L. W. Moffet, Nuclear Safety Supervisor
- W. G. Newman, ISI Supervisor
- *S. L. Robinson, Chemistry/Radiation Superintendant
- *V. R. Roppel, Manager, Nuclear Operations Maintenance and Outages
- W. A. Stephenson, Nuclear Operations Technical Advisor
- R. Stevens, Reactor Operator
- K. O. Vogel, Operations Engineer
- *M. S. Williams, Nuclear Regulatory Specialist
- K. R. Wilson, Manager of Nuclear Licensing
- *W. D. Worley, Nuclear Chemistry Manger

NRC Resident Inspector

*J. E. Tedrow, Resident Inspector

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on March 11, 1988, 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 inspector indicated during the exit interview that no new items were identified during this inspection; however, new information regarding the potential for an inadequate replacement part was provided to the inspector by

telephone on March 16, 1988, and cognizant licensee personnel were informed that the following new item was now identified.

Unresolved item 50-302/88-08-01, Adequacy of Replacement Yoke Nut in Feedwater Block Valve.

The licensee did not identify as proprietary any of the material provided to or reviewed 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 are matters about which more information is required to determine whether they are acceptable or may involve violations or deviations. One unresolved item identified during this inspection is discussed in Paragraph 5.b.

5. LER 88-006

On February 28, 1988, Crystal River Unit 3, while reducing power for main generator problems, experienced a trip from 45% power due to a feedwater valve malfunction. Subsequently, the turbine would not trip automatically or manually from the control board.

a. Potential NRC Concerns

The inspector examined documentation and held discussions with cognizant licensee personnel in order to obtain information regarding:

- ° Root cause of the feedwater malfunction
- ° Potential generic implications at Crystal River
- ° Potential generic implications at other operating plants
- ° Contribution to the feedwater malfunction of potential inadequate maintenance activities
- ° Contribution to the feedwater malfunction of potential inadequate Inservice Testing (IST) activities.
- ° Root cause of the turbine trip failure
- ° Potential implications of turbine trip failure
- ° Potential adverse impact of turbine trip failure to ATWS considerations

- ° Adequacy of repair and attendant testing activities.

b. Related Documentation

The following documents were examined:

- ° Schematic of turbine trip systems together with FPC drawings.

<u>No</u>	<u>Title</u>
B-208-057 Rev. 3	Elementary Diagram, Turbine Trip Lockout Relays
B-208-040 Rev. 1	Elementary Diagram, Reactor Tripped Lockout Relay
B-208-057 Rev. B	Elementary Diagram Turb. 3 Auto stop Trip Sol. TB-321-SV

- ° Administrative Instruction AI-704, Rev. 1 dated July 3, 1987, Florida Power Corporation, Crystal River Unit 3 - Reactor Trip Review and Analysis

Post-Trip Review and Restart Justification; shutdown Rept. No. 88-1

- ° Preliminary B&W Transient Analysis Report of the February 28, 1988, Reactor Trip

- ° B&W Owners Group Safety and Performance Improvement Program (SPIP) Recommendations (From September 1987 Recommendation Tracking System Report). Nos.-

TR-044-MOV
TR-046-MOV
TR-047-MOV
TR-079-MFV
TR-107-ICS

- ° Surveillance Procedure SP-435, Rev. 22 dated December 20, 1987; Florida Power Corporation, Crystal River Unit 3 - Valve Testing During Cold Shutdown

Data Test Sheet III for valves tested December 29-30, 1987, during last refuel outage.

- ° Surveillance Procedure SP-332, Rev. 29 dated January 14, 1988; Florida Power Corporation Crystal River Unit 3 - monthly steam line and Feedwater Isolation Functional Test.

- May 29, 1987 correspondence from Mr. L. S. Rubenstein of NRC to Mr. W. S. Wilgus of Florida Power Corporation regarding IST of pumps and valves at Crystal River 3 together with the associated Safety Evaluation Report (SER).
- Vendor (Crane Co.) Dwg. No. PB 147518 Rev. B for failed Feedwater Block Valve FWV-29 (Train B) and its sister FWV-30 (Train A).
- Valve vendor Certificate of Compliance (COC) information dated March 10, 1988, for a replacement yoke nut for valve FWV-29 to ASTM Specification B505-C932 material.

Note - The vendor-supplied replacement part had incorrect threads and Florida Power Corporation (FPC) maintenance personnel fabricated and installed a replacement yoke nut from B505-C932 material. The inspector requested an additional cross check of the yoke nut material identified on the vendor drawing (B147-8C) versus vendor certification for B505-C932. The inspector was telephonically informed on March 16, 1988, by cognizant licensee personnel that the vendor had now responded that equivalent material for the original yoke nut was B505-C863 (62,000 psi minimum UTS) rather than B505-C932 (20,000 psi minimum UTS). However, the vendor had also stated that the C932 material was adequate on "an emergency, short term basis." FPC cognizant personnel further stated that design basis calculations would be completed regarding the continued adequacy of the replacement part. The inspector informed cognizant licensee personnel that need for further NRC review of this matter would be identified as Unresolved Item 50-302/88-08-01, Adequacy of Replacement Yoke Nut in Feedwater Block Valve.

- FPC interoffice correspondence providing a post job critique for FWV-29 Repair from mechanical (File MS88-0041) and electrical (File ES88-008) maintenance supervision.
- FWV-29 analysis and repair associated work request documentation

<u>No</u>	<u>Task</u>
100781	Check and adjust limit switches (Yoke nut failure identified during this activity)
101005	Preparation for Valve Stem Block Coupler (Valve Stem Restraint/Clamping device to allow Removal/Replacement of yoke nut under pressure conditions)

101061

Fabrication of yoke nut from B505 C932 Bar Stock (yoke nut is outside the valve pressure boundary; i.e., not within the scope of ASME Section XI)

- ° FPC photographs and video footage of FWV-29 action during stroke testing in the failed condition, the failed yoke nut, and replacement yoke nut which was installed.

c. Preliminary Conclusions

The examinations and discussions reported above support preliminary conclusions as follows:

- ° The root cause of the February 28, 1988 feedwater malfunction and subsequent reactor trip was the yoke (stem) nut failure in FWV-29.

FWV-29's Limitorque motor operator is an SMB-4T which does not include thrust bearings. Thrust bearings and bearing housings are incorporated in the valve yoke. The yoke (stem) nut includes a bottom flange which rotates between the upper and lower thrust bearings. The bearings maintain the nut's vertical position and transmit open/close stem loads to the yoke. The bottom flange portion of the yoke nut contains no threads. The top portion of the nut includes threads which mate with threads on the valve stem and translate clockwise/counter clockwise nut rotation into stem movement to open/close the valve. The bottom flange was completely severed from the top threaded portion in the failed yoke nut.

The yoke nut failure allowed approximately 2 1/4 inches of additional upward valve stem travel without nut rotation during the open cycle under pressurized conditions due to upward forces on the valve internals. The valve's open/close limit switch settings are based on operator (stem nut) rotations and could not recognize the additional stem movement. This mismatch caused the valve to remain approximately 17% open after completion of the close cycle which was required by power reduction below 45%; i.e., FWV-29 closed and feed regulated by pump speed to maintain an 80 psi differential pressure across the valve nest which includes FWV-29. The mismatch of valve position to that transmitted to the integrated control system caused a power-to-feed flow mismatch and an overfeed condition in the B Once Thru Steam Generator (OTSG).

The reactor operator identified the overfeed condition (signalled by several alarms - PZR level low, RC pressure low, delta Tc High) and completed an approved response by opening the main crosstie valve (FWV-28) to balance flow to the two OTSGs. FWV-28 is interlocked to send a closure signal to both Train B

(FWV-29) and Train A (FWV-30) mainfeed block valves to enable it to open. The resulting dramatic decrease in feedwater flow caused a rapid increase in RCS pressure which could not be offset by operator action to implement manual spray in the pressurizer. The reactor tripped due to high RC pressure on "B" and "C" RPS channels.

- ° No potential generic implications at Crystal River

Three valves of Crystal River are unique in using Limitorque SMB-4T operators with the potential for the type of stem nut failure experienced by FWV-29. Train A feedwater block valve FWV-30 and crosstie valve FWV-28 also use the SMB-4T operator. FWV-30 was retested for functional capability during post trip recovery and under the same pressurized conditions (booster pumps running) as were imposed when the FWV-29 failure was identified. The testing required several close-open-close cycles with FPC personnel observing stem movement at the valve locally. FWV-30 exhibited full functional capability. FWV-28 had been functionally tested during the December 1987 refuel outage and operated normally during this event.

- ° Potential generic implications at other operating plants.

Assessment of the potential generic implications at other operating plants is very dependant on results from the yoke nut failure analyses now in process. Valve internals were inspected by FPC personnel and no galling, scuffing or other indications of overstress were identified. Mechanical properties testing and chemical analysis of the failed yoke nut will be completed together with micro and macroscopic examination of the failed surfaces. However, considerable smearing of the fractured surfaces occurred during the valve cycling which identified the failure and conclusive micro/macro analyses may be precluded. Initial evidence favors a cyclical fatigue failure induced by casting defects. Further NRC assessment of the completed failure analyses will be required to reach a conclusion regarding the generic potential at other operating plants.

- ° No contribution from inadequate maintenance or IST activities

FWV-29 contained adequate grease within the bearing areas and did not have internal damage other than the failed stem nut. Limitorque operator limit and torque switch settings were accurate for the unfailed condition and no evidence of inadequate maintenance was identified. NRC had granted relief from ASME XI quarterly full-stroke IST requirements for FWV-29 and FWV-30 due to the impracticality of this type of testing during power operations. IST during cold shutdown is required

and was last completed during the December 1987 refueling outage. The full-stroke, close-open-close testing required FPC personnel to observe stem movement in coordination with control room indication. FWV-28 is a class 4 valve and not required to be within the IST program. However, maintenance activities were completed to rework the operator, examine and reinstall the stem nut, and functional test FWV-28 December 1987 and January 1988. No inadequate maintenance or IST activities were identified during this inspection.

- ° The root cause of the turbine trip failure after reactor trip was defective Solenoid Valve TB-321-SV

The voltage was measured at the solenoid and found to be between 90 and 128VDC. The voltage fluctuation was due to poor fuse continuity (corroded fuse holder). However, the solenoid was found to have a pulling force of only about 2 pounds even with the proper 128VDC applied. The pull-in force for a new replacement solenoid was approximately 15 pounds. The capability of the turbine to trip automatically and/or from the control board was retested and found as per design after installation of the new solenoid.

- ° Potential implication from turbine trip failure

The root cause of the 1987 failure of the turbine to trip after reactor trip (LER 8711) was a failed lockout relay which provides a reactor trip signal (i.e., provides one path to apply 128VDC) to Solenoid Valve TB-321-SV. On that occasion the turbine was manually tripped using the control board push button (another path to supply 128VDC) and TB-321-SV operated normally. The failure of TB-321-SV did not adversely effect other turbine protection circuits (i.e., low bearing oil pressure, thrust bearing vibration, low condensor vacuum, mechanical overspeed, etc.). Also the solenoid turbine trip circuit is not designed to single failure redundancy. The inspector concluded that the root causes of the two failures were diverse enough to consider each failure an isolated example.

- ° Adverse impact of TB-321-SV failure to ATWS considerations

A turbine trip is accomplished by relieving auto stop oil pressure which allows a pneumatic EH fluid check valve to open and high pressure emergency stop fluid to vent to the EH reservoir. EH fluid pressure relief allows all throttle/reheat-stop valves to trip closed and prevent continued supply of steam. A turbine trip signal is supplied to the RPS by four pressure transducers (one for each RPS channel) when auto-stop oil pressure falls below 45 psi. This circuitry is independent of all turbine trip circuitry with exception of auto-stop oil pressure and operated normally when the turbine was tripped from the turbine pedestal during this event. The inspector concluded that there was no adverse impact from failure of TB-321-SV to Crystal River ATWS considerations.

° Adequacy of repair and attendant testing activities

Repair and attendant testing activities appear adequate with exception of the question regarding the B505-C932 replacement yoke (stem) nut material as reported in Paragraph 5.b.

d. Summary

No violations or deviations from NRC requirements were identified during this inspection. Licensee actions associated with this event appeared adequate to resolve NRC concern with exception of Unresolved Item 50-302/88-08-01. This item will be further reviewed during a subsequent inspection.