Florida Power
CORPORATION

February 10, 1987
3F0287-03

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
Updated Response to Generic Letter 83-28
Item 4.5.3 - Reactor Trip System Reliability

Dear Sir:

Florida Power Corporation's (FPC) July 31, 1984 letter to Mr. Darrell G. Eisenhut (3F0784-21) provided updated responses to Generic Letter 83-28 (Salem ATWS). Our response to the subject item stated the B&W Owners Group (BWOG) was performing an analysis to verify the current one month test interval for the reactor trip system (RTS) is consistent with high RTS availability in consideration of the items cited in Item 4.5.3. That analysis has been completed and is attached as an update to our July 31, 1984 letter.

Sincerely,

E C Simpson

E. C. Simpson
Director, Nuclear Operations
Engineering and Licensing

JWT/sdr

Attachment

xc: Dr. J. Nelson Grace
Regional Administrator, Region II

Mr. T. F. Stetka
Senior Resident Inspector

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4.5 REACTOR TRIP SYSTEM RELIABILITY (System Functional Testing)

Item 4.5.3

Position

Existing intervals for on-line functional testing required by Technical Specifications shall be reviewed to determine that the intervals are consistent with achieving high reactor trip system availability when accounting for considerations such as:

1. Uncertainties in component failure rates
2. Uncertainty in common mode failure rates
3. Reduced redundancy during testing
4. Operator errors during testing
5. Component "wear-out" caused by the testing

Licensees currently not performing periodic on-line testing shall determine appropriate test intervals as described above. Changes to existing required intervals for on-line testing as well as the intervals to be determined by licensees currently not performing on-line testing shall be justified by information on the sensitivity of reactor trip system availability to parameters such as the test intervals, component failure rates, and common mode failure rates.

Response

Our July 31, 1984 response indicated that the BWOG had an evaluation underway to address this item. That evaluation has been completed and the results demonstrate the current one month surveillance test interval for the Reactor Trip System (RTS) is consistent with high reliability.

The following is a summary of the evaluation and conclusions.

Configuration Features of Importance

The investigation performed is generic to all plants with B&W NSS equipment including 177 and 205 fuel assembly plants. Only two significant design configurations exist for these plants that must be accounted for by the reliability evaluation of the RTS at the one-month test interval (or for longer intervals). Consequently two separate models have been constructed. For this project all 177 fuel assembly plants except Davis Besse are represented by one configuration (Oconee group); Davis Besse and Bellefonte, a 205 Fuel Assembly plant, are the other configuration (Davis Besse group). The fundamental difference between the two configurations is:

Oconee group: Safety rods (groups 1-4) are tripped by the Control Rod Drive Control System (CRDCS) using the D.C. shunt and A.C. undervoltage trip devices of each A.C. or D.C. breaker. Regulating rods (groups 5-7) are tripped by the electronic or Silicon Controlled Rectifier (SCR) trip portion of the CRDCS and the CRDCS A.C. trip breakers using D.C. shunt and A.C. undervoltage trip devices.

Davis Besse group: All rods are tripped by either the CRDCS using A.C. breakers or the electronic (SCR) trip. Each breaker is tripped by D.C. shunt and A.C. undervoltage trip devices.

Both configurations offer similar diversity since the mechanical breakers are backed by the electronic (SCR) trip. The electronic trip reduces the possibility of common mode failures.

Trip actuation features of these two groups are very similar. The Reactor Protection System (RPS) and the sensor inputs are virtually the same. The evaluation also included the Anticipatory Reactor Trip System (ARTS) that senses loss of feedwater and signals reactor and turbine trip. Minor differences of the ARTS arrangement exist between the two groups of plants.

In addition to the diversity that has existed in the B&W RTS due to the electronic trip, two important equipment upgrades have been completed to reduce the potential for common mode failure of the breakers.

1. <u>Change of trip shaft bearing lubricant</u> to Mobil 28 from Lubriko, the original trip shaft bearing lubricant. Accelerated aging tests by General Electric indicate that Mobil 28 has an expected lifetime in excess of 1×10^6 hours (114 years) as compared to the Lubriko lifetime of 1×10^5 hours (11 years) at an expected operating temperature of 40°C. Thus the past aging problems associated with lubricant stiffening are expected to be diminished considerably for the remainder of plant life. In particular, the common mode failure contribution to RTS unavailability that has largely been attributed to breaker shaft bearing stiffness resulting in slow response when the undervoltage device is actuated is expected to be corrected by the lubricant change. The BWOG has recommended each utility change existing Reactor Trip Breaker (RTB) bearings to bearings lubricated with Mobil 28 lubricant. Mobil 28 is in use by FPC as part of our maintenance procedures.

2. <u>Addition of an RPS trip signal to the D.C. shunt trip device</u>. This device operates on a different principle than the A.C. undervoltage trip device. Whereas the A.C. device is released by removal of power to the coil and uses the power stored in its spring to rotate the

trip shaft, the D.C.shunt device uses the power obtained by energizing a coil to rotate the trip shaft to the "breaker open" position. The undervoltage device can apply about 30 oz.-in. of torque, but the shunt device can apply approximately 200 oz.-in. of torque. Thus the D.C. shunt trip provides a diverse mechanism from the A.C. undervoltage device and would be expected to cause shaft rotation even with frozen bearings.

Methods and Approach

The modeling methods use Reliability Block Diagrams (RBD's) for the RTS and the CRDCS breaker subsystems involved in reactor trip. The PACRAT code (developed by B&W) was used to calculate the time dependent unavailability of equipment for the one-month on-line test intervals. It is similar to FRANTIC II and has been used for other evaluations of the RPS previously submitted to the NRC (see topical report BAW-10085P, "Reactor Protection System," Vol. 2, Rev. 6, April 1979). The RBD models constructed for the Oconee and Davis Besse groups include sensors and process equipment providing signals to the Reactor Protection System (RPS), the RPS trip module outputs, the sensors and processing equipment associated with the Anticipatory Reactor Trip System (ARTS), the ARTS outputs, the Control Rod Drive Control System (CRDCS) breakers, and the CRDCS Electronic Trip (SCR's). The analysis addressed automatic RTS operation and omitted credit for the additional advantages of operator action for manual trips and operator action to "power drive" the rods in using the CRDCS in manual.

All of the five issues raised by question 4.5.3 were addressed by the evaluation. Random and common mode equipment failure rates were accounted for and operating experience was used to support the evaluation wherever possible. Data from LER's was used for sensors and instrument strings and B&W operating experience data was relied upon to provide random and common mode breaker failure rates and was updated to show the effects of the lubricant changes. Historic operating experience for B&W and Combustion Engineering (CE) plants was evaluated to obtain failure modes and frequencies for the individual breaker components. CE operating experience was used to provide failure rates for the shunt trip device and both B&W and CE experience provided data to support the undervoltage device failure rates. Since the lubricant change will improve the reliability of the undervoltage device actuation, the expected future performance was accounted for by crediting the breaker data base operating experience for those past events for which failure would not have occurred had the new lubricant been installed.

Generic data sources were used to provide failure rates for quantification for electrical components of the RTS other than the breakers, sensors, and instrument strings.

Wearout caused by test cycling and aging was evaluated for all components and emphasis was placed on the breakers since they are most affected by testing. The breakers are designed for 12,500 cycles and the lubricant change will virtually eliminate aging concerns. It was concluded that wearout is a relatively unimportant concern, however possible effects were simulated by a sensitivity analysis using the RBD's.

The effects of testing on RTS availability included the influence of operator errors during testing and considered test and maintenance errors that could contribute to breaker failure to trip. The effect of reduced system redundancy due to channel bypass during testing was also evaluated. The tests of importance are the monthly single channel RPS and ARTS instrument string, the trip module, and breaker tests.

Time dependent point estimate values for the RTS unavailability were determined using best estimate data to establish a base line and the sensitivity analysis was performed to indicate the influence of uncertainties for the five issues of question 4.5.3. The sensitivity analysis was based on a 95% upper bound distribution.

SUMMARY OF RESULTS AND CONCLUSIONS

1. The results of the best estimate and sensitivity analyses are:

	Average System Unavailability Using Best-Estimate Data	
Base Case	Davis-Besse Class	Oconee Class
Best-estimate time-average system	6×10^{-7}/demand	6×10^{-7}/demand

	Average System Unavailability Using Best-Estimate Data	
Sensitivity to	Davis-Besse Class	Oconee Class
Uncertainties in random component failure rates	7×10^{-7}/demand (slightly sensitive)	2×10^{-6}/demand (moderately sensitive)
Uncertainties in common mode failure rates/operator errors	9×10^{-6}/demand (highly sensitive)	6×10^{-6}/demand (highly sensitive)
Reduced redundancy during test (channel bypass)	9×10^{-7}/demand (slightly sensitive)	6×10^{-7}/demand (slightly sensitive)
Breaker wearout caused by testing	(not sensitive)	(not sensitive)

2. The RTS configuration of both the Oconee and Davis Besse groups have several features that contribute to the high reliability such as:

   a) The Electronic (SCR) Trip provides a diverse method of trip actuation that is separate from the CRDCS mechanical breakers. Thus the potential for failure to trip due to common mode failure of the breakers is significantly reduced.

   b) The common mode failure potential of the breakers is considerably reduced by the addition of the shunt trip device which provides diversity from the undervoltage device. The reliability of trip actuation by the undervoltage device is improved by the lubricant change from Lubriko to Mobil 28.

   c) The RPS and ARTS are configured with four channels.

3. The wearout evaluation indicated that the RTS components are not susceptible to wearout caused by testing. The breakers are the major components affected by test cycling and the GE AK-2 breaker has a design cycle objective of 12,500 cycles. Aging of the trip shaft bearing lubricant is virtually eliminated as a concern when the Mobil 28 lubricant is installed. Therefore, for the breakers, common mode

failure due to wearout is not a significant source of RTS unavailability. Other components do not exhibit histories that indicate that wearout is a concern.

4. Reduced redundancy caused by testing does not significantly contribute to RTS unavailability. Reduced redundancy is primarily due to bypass testing of the RPS and ARTS sensor strings which has the effect of reducing the trip logic from 2/4 to 2/3 for the duration of the tests. Other on-line tests (breakers, electronic trip, trip modules) are performed with the channel tripped and therefore in a "fail-safe" condition that does not affect unavailability.

5. The evaluation of the RTS reliability and demonstration that high reliability is achieved with the current 1 month testing frequency addresses the concerns of Generic Letter 83-28 Item 4.5.3. The necessity of further evaluation to determine a different surveillance interval has been referred to the BWOG Tech Spec Committee to be incorporated in their overall evaluation of Tech Specs. The BWOG Committee has submitted B&W Topical Report BAW-10167, "Justification for Increasing the Reactor Trip System On-Line Test Intervals," to the NRC in a BWOG letter, dated June 18, 1986.