August 29, 1984

Docket No. 50-302

Mr. Walter S. Wilgus
Vice President, Nuclear Operations
Florida Power Corporation
ATTN: Manager, Nuclear Licensing
& Fuel Management
P. O. Box 14042; M.A.C. H-2
St. Petersburg, Florida 33733

Dear Mr. Wilgus:

SUBJECT: NUREG-0737 Item II.K.2.16 Reactor Coolant Pump Seal Integrity Following Loss of Offsite Power

Re: Crystal River, Unit No. 3

Following the Three Mile Island accident of 1979, the Commission generically questioned the potential for a serious accident involving the failure of the reactor coolant pump seals upon a loss of offsite power event. This led to the establishment of the proposed TMI Action Plan requirements II.K.2.16 and II.K.3.25 in NUREG-0737. TMI Action Plan Items II.K.2.16 (for B&W plants) and II.K.3.25 (for CE, GE and W plants) require licensees to evaluate the integrity of their reactor coolant pump seals for a period of two (2) hours following a loss of offsite power event. All PWRs, but eight (including Crystal River, Unit No. 3 (CR-3)), have limited the potential for seal failure by automatically loading the seal coolant injection pumps onto the emergency power bus and automatically starting the seal coolant injection pumps. This design was found acceptable.

The licensees, including Florida Power Corporation, of the remaining plants have primarily based their resolution of this issue on the acceptability of operator action to reinstate Reactor Coolant Pump seal cooling upon loss of offsite power. Also, the licensees maintain that sufficient time and procedures are available to the operator to reinstate seal cooling prior to seal failures occurring. Our review of your responses submitted for CR-3 concludes that you have not submitted sufficient information to determine the acceptability of operator action to reinstate seal cooling in time to assure integrity of your reactor coolant pump seals during an event caused by or consequentially resulting in a loss of offsite power. You have not provided adequate justification or validation that sufficient time and procedures are available to the operator to reinstate seal cooling prior to failures of these seals. There is insufficient information to assure that General Design Criterion 44 has been satisfied. Our Safety Evaluation supporting these conclusions is enclosed.

On the basis of the enclosed Safety Evaluation, we find your responses to the TMI Action Items II.K.2.16 for CR-3 unacceptable.

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Therefore, pursuant to 10 CFR 50.54(f) of the Commission's regulations, you are requested to provide the information identified in the Safety Evaluation as lacking which would demonstrate that the reactor coolant pump seal cooling system designs satisfy General Design Criterion 44 and which would show why your license should not be modified to require automatic initiation of seal cooling upon loss of offsite power. Your response shall be submitted under oath or affirmation, within 30 days from receipt of this letter.

The reporting and/or recordkeeping requirements of this letter affect fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511.

Sincerely,

for / Darrell G. Eisenhut, Director
Division of Licensing

Enclosure:
Safety Evaluation

cc w/enclosure:
See next page

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cc w/enclosure(s):

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

CONCERNING

NUREG-0737 ITEM II.K.2.16 AND II.K.3.25

REACTOR COOLANT PUMP SEAL INTEGRITY FOLLOWING LOSS OF OFFSITE POWER

FOR

CALVERT CLIFFS, UNITS NOS. 1 & 2, ARKANSAS NUCLEAR ONE, UNITS NOS. 1 & 2, CRYSTAL RIVER 3, RANCHO SECO, HADDAM NECK AND PALISADES

Background

Following the Three Mile Island accident of 1979, the Commission generically questioned the potential for a serious accident involving the failure of the reactor coolant pump seals upon a loss of offsite power event. This led to the establishment of TMI Action Items II.K.2.16 and II.K.3.25 in NUREG-0737. TMI Action Items II.K.2.16 (for Babcock and Wilcox plants) and II.K.3.25 (for Combustion Engineering, General Electric and Westinghouse plants) require licensees to evaluate the integrity of their reactor coolant pump seals for a period of two (2) hours following a loss of offsite power event. All but eight plants have limited the potential for seal failure by automatically loading the seal coolant injection pumps onto the emergency power bus and automatically starting the seal coolant injection pumps. This design was found acceptable.

The six licensees who have not automated seal injection upon a loss of offsite power condition have elected to rely upon operator action to reinstate coolant to their RCP seals. The eight plants affected are: Calvert Cliffs 1 & 2, Arkansas Nuclear One, Units Nos. 1 & 2 (ANO-1 & 2), Rancho Seco, Crystal River 3, Haddam Neck and Palisades.

Evaluation

The causes of pump seal failures experienced in operating plants are being investigated by the NRC under Generic Issue 23 (GI-23). Previous seal failures have not led to significant radiological releases. However, they have increased our awareness for seal failures to initiate a more serious transient or accident. In particular, newer estimates of the frequency of seal failures (which are small break LOCAs) show that seal failures have significantly increased the previous small LOCA frequency estimates.

Our review of the responses submitted by the licensees of Calvert Cliffs 1 & 2, ANO-1 & 2, Crystal River 3, Rancho Seco, Haddam Neck, and Palisades concludes that the licensees have not provided the necessary information we need to justify the acceptability of manual operator action to reinstate seal cooling. The specific deficiencies are as follows: The licensees have not demonstrated the acceptability of operator action to reinstate seal cooling in time to assure integrity of their reactor coolant pump seals during an event caused by or consequentially resulting in a loss of offsite power. The licensees did not provide adequate justification nor validation that sufficient time and procedures are available to the operator to reinstate seal cooling prior to failures of the seals.

The licensees did not describe the information required by the operators to determine that cooling water to the RCP seals was lost; to determine the need for, and effectiveness of, restoring cooling water to the RCP seal coolers; the details of how the current sources of information provide what the operators need to know; and how the information is presented (e.g., annunciated, displayed on the control panels or back panel, provided on a computer printout, etc.).

Further, the licensees did not address the control requirements, including the information necessary to perform and verify the proper control actions for restoring cooling water to the RCP seals. They did not address how the current controls and sources of information provide the operator with control requirements and associated information requirements. No information was submitted outlining the instructions to the operators as documented in the abnormal operating procedures and or the emergency operating procedures. The instructions for obtaining information contained in the operating procedures and those left to operator training and experience were not discussed.

The licensees did not address the general sequences of events that could include a loss of offsite power (and resultant loss of cooling water for the RCP seals) for which reliance on operators is proposed. Nor were there any discussions of the priority of the specific actions required to restore cooling water to the RCP seals relative to all the other actions needed to deal with the occurrence.

The maximum time required for the operators to accomplish all the actions they are expected to take before restoring cooling water to the RCP seals for all postulated events, and a comparison of the time with the minimum time for seal damage to occur were not addressed. The licensees did not consider the likelihood and consequences of operator errors associated with restoring cooling water to the RCP seals. In their responses, the licensees did not provide a description of the methods used to ensure that the various operator actions used to compensate for design deficiencies are given the necessary priority. Specifically, if restoration of cooling to the RCP seals is left to manual action, how will the operator ensure in the long term that his relative priority does not change in the non-conservative direction? The detailed reasoning for relying on operator action instead of automating these actions was not provided. As illustrated by the above concern, it is evident that the licensees submitted inadequate justification for not automating the restoration of pump seal cooling.

The licensees have not demonstrated that reliance on operator action to re-establish cooling to the RCP seals would not increase the probability of a small LOCA to the Anticipated Operational Occurrence frequency (one or more times during the life of the plant). When addressing the consequences of failed RCP seals, the licensees referenced their FSAR LOCA analyses as bounding the consequences resulting from the failed seals. We do not concur with the licensees' arguments since the design basis accidents analyzed in their FSAR did not assume multi-loop breaks. The licensees' assessments do not appear to be supported by any analyses submitted to the staff.

The licensees with B&W plants referenced hand calculations performed by the reactor vendor. The reactor vendor calculated a maximum leak rate of 10 gallons per minute after the first hour following a loss of cooling to the seals. Validation of these calculations has not been submitted. In addition, the consequences of reinstating seal cooling were not addressed. Reinstating cold cooling water to a hot seal assembly could lead to thermal stresses which exceed the pump seal design limits.

The licensees with B&W plants referenced pump tests performed for the San Onofre Nuclear Generating Station. These tests, as documented in ASME Technical Paper No. 80-C2/PVP-2, maintained the pumps operated for 30 minutes without component cooling water and showed no significant increase in leakage. In addition, the licensees stated that similar seals have operated 40 minutes with complete loss of cooling and showed no significant signs of damage.

The licensees' justification for relying upon operator action to maintain seal integrity following loss of offsite power (LOOP) did not address operating reactor experiences involving seal failures. These events do not support the licensees' conclusions. Examples of such events are contained in the enclosure.

The licensees' submittals only focused on data which supported acceptance of present operating designs and did not address data which conflict with a favorable conclusion. The referenced ASME paper presented data for only one test. The Westinghouse Owners Group seal integrity tests showed similar findings for the initial test, but seal failures in subsequent tests. Although the San Onofre test provided valuable data, the level of confidence for the one data point is low. We also point out that many of the seal tests performed were on new seals. No evidence was presented which supports that the probability of consequences, which would result from seal leakage from "old" or "worn" seals, was acceptable.

A staff review of the Interim Reliability Program (IREP) Analysis of ANO-1 (NUREG/CR-2787) has concluded that a dominant sequence which contributes to both core melt frequency and risk is a small loss of coolant accident initiated by reactor coolant pump seal ruptures. This also was not addressed by the licensees.

Finally, as previously described, no evidence was presented to support or justify the licensees' claim that operator action can be relied upon to re-establish seal cooling in time to prevent seal failures.

In summary, based on the staff's evaluation noted above, the licensees have not supplied sufficient information and justification which allow us to conclude that their pump seal cooling designs are in conformance with General Design Criterion 44. GDC-44 requires cooling water to transfer heat from structures, systems and components important to safety. It also requires that suitable redundancy in components and features shall be provided to assure that, for onsite electric power system operation (assuming offsite power is not available), the system safety function can be accomplished assuming a single failure.

As highlighted above, the licensees neglected data from operating plants which do not support their position. The licensees have not provided risk assessments nor cost benefit studies to support the acceptability of their proposed resolution to this issue. All but the 8 plants identified have their pump seal cooling systems automatically initiated during a loss of offsite power event.

Conclusion

Based on lack of supporting arguments, we find the licensees' responses to TMI Action ITEM II.K.2.16 (For ANO-1, Crystal River 3, and Rancho Seco) and II.K.3.25 (for Calvert Cliffs 1& 2, Haddam Neck, ANO-2, and Palisades) unacceptable. We have determined that the licensees should provide sufficient information and justification which would allow us to conclude that their pump seal cooling designs are in conformance with GDC-44 or the licensees should automate the loading and initiation of one of the seal coolant injection pumps (Seal Injection or CCW) to the emergency power bus.

Date: August , 1984

The following NRC personnel contributed to this Safety Evaluation: Jack Guttmann and Guy S. Vissing

ENCLOSURE

EXAMPLES OF SEAL FAILURES

IN OPERATING REACTORS

1. LER 79-103, "Reactor Coolant Pump Seal Fails At Davis-Besse 1"

   Seal failure was attributed to thermal shock which occurred during a loss of offsite power incident on 10/15/79.

2. Notification of An Incident of Occurrence No. 149, "Main Coolant Pump Seal Fails At Robinson 2"

   Approximately 200,000 gallons of primary coolant water was discharged into the containment structure. Leakage rate was estimated to be 500 gpm.

3. LER 81-022, "Two RCPs' Seals Fail At Davis-Besse"

   Seal staging was deteriorating.

4. LER 80-015 "Update On Reactor Coolant System Seal Failure At Arkansas Nuclear One, Unit No. 1"

   Approximately 60,000 gallons of reactor coolant was collected in the reactor building basement. The RCP "C" seal 3rd stage was severely damaged.

5. Letter to NRC, November 2, 1978, "Reactor Coolant Pump Seal Failure At Salem 1"

   All 3 RCP seals failed, causing about 15,000 gallons of primary water leakage to the containment sump.

6. Letter to NRC, December 27, 1977, "Reactor Coolant Pump Seal Failed At Arkansas Nuclear One, Unit No. 1"

   Cause - Natural end-of-life seal failure attributed to plant startups and shutdowns.

7. Letter to NRC, July 15, 1977, "Reactor Coolant Pump Seal Fails At Indian Point 2"

   Total leakage to containment was about 90,000 gallons with a maximum leak rate of 75 gpm.

8. Letter To NRC, August 27, 1976, "Reactor Coolant Pump Seal Fails At Arkansas Nuclear One, Unit No. 1"

   Seal cartridge was damaged.

9. Letter to AEC, April 30, 1974, "Additional Information on Coolant Pump Seal Failure At Oconee 2"

   Rotating seal ring failed due to thermal shock caused by excess upper seal leakage.

10. Letter to AEC, January 25, 1974, "Failure of Reactor Coolant Pump Seal At Oconee 2"

    After a small leak was observed in a 1¼ inch water supply line to the RCP seal, the seal water was stopped. Subsequently the seal failed, allowing primary water to flow to the containment floor at a rate of 90 gpm. Total leakage was about 50,000 gallons.

11. LER 82-094, "RCP Seal Failure At LaSalle Unit 1"

    Operator action to increase CCW flow from 13 gpm to 25 gpm resulted in excess thermal stress in the RCP seals. Seal failure occurred.