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SEP 3 1980

Docket Nos: 50-269/270/287

MEMORANDUM FOR: Thomas M. Novak, Assistant Director for Operating Reactors, DL

FROM: Paul S. Check, Assistant Director for Plant Systems, DSI

SUBJECT: OCONEE UNITS 1, 2 & 3 AUXILIARY FEEDWATER SYSTEM RELIABILITY EVALUATION

In order for us to continue our evaluation of the Oconee Units 1, 2 & 3 Auxiliary Feedwater System we must complete the work outlined in NUREG-0660, "NRC Action Plan Developed as a Result of TMI-2 Accident," paragraphs II.E.1.1 and II.K.

II.E.1.1 of NUREG-0660 requires all PWR operating plant licensees to reevaluate their auxiliary feedwater systems to include:

(1) performing a simplified AFW system reliability analysis;

(2) performing a deterministic review of the AFW system using the acceptance criteria of Standard Review Plan Section 10.4.9 and Branch Technical Position 10-1 as principal guidance; and

(3) reevaluation of the AFW system flow rate design bases and criteria.

The licensee has provided the information requested by the staff regarding the simplified AFW system reliability analysis (Item 1 above). This information has been evaluated by the Probabilistic Analysis Staff (PAS) and the recommendations resulting from that evaluation which must be addressed by the licensee are included in Enclosure 1, questions 5 through 7 and 13 through 15. Questions 1 through 4, 8 through 12, and 16 through 20 address ASB concerns regarding the licensee's reliability study.

NUREG-0660 is not clear regarding performance of the determinstic review (item 2 above), licensee or staff; consequently ASB will undertake this work. However, for us to perform the evaluation, we will need additional information from the licensee. Our request for information is included in Enclosure 1 as questions 21 through 24.

Question 25 of Enclosure 1 concerns the reevaluation of the AFW system flow rate design bases and criteria (item 3 above).

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II.K.1 of NUREG-0660 indicates that some of the review of the I.E. Bulletins (79-05, 79-05A and 79-05B) issued after the TMI-2 accident were not completed. The licensee has responded to these bulletins. We understand that your project manager will complete that portion of the review.

II.K.2 of NUREG-0660 discusses the fact that all operating Babcock and Wilcox plants were ordered to shutdown shortly after the TMI-2 accident. The Orders included both short-term and long-term actions. The NRR Bulletins and Orders Task Force reviewed the licensee's responses to the short-term actions in the Orders and issued safety evaluation reports lifting the Orders. II.K.2.8 concerns completion of our review of the long-term actions of the Orders. Completion of this item will be performed under II.E.1.1.

The licensee may have previously responded to some of these items and, therefore, should be advised that a reference to a previous response (letter, FSAR amendment, etc.) would be acceptable. The licensee should be further advised that further clarification will be provided regarding questions 8 (GS-7), 11 (AS-3), and 18 (GL-5) when ICSB provides guidance. The licensee should not respond to these recommendations until it receives the further clarification.

We have prepared or are preparing similar enclosures to be forwarded to the other B&W operating plants (less Rancho Seco and TMI-1). We are prepared to meet with you to discuss any problems which you see in proceeding in this manner.

The licensee should be requested to provide responses by October 1, 1980.

Original signed by
Olan D. Parr
for
Paul S. Check, Assistant Director
for Plant Systems
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Enclosures:
As stated

cc: D. Eisenhut
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ENCLOSURE 1

Oconee Units 1, 2 & 3
Auxiliary Feedwater System Reliability Evaluation

1. Section 1.5 of the Oconee Units 1, 2 & 3 AFW System Reliability Analysis defines the AFW system mission success criterion as attainment of flow from at least one AFW pump to at least one steam generator. We consider this definition to be incomplete. The criterion should include the requirement to deliver the AFW flow to the steam generator <u>before</u> the steam generator boils dry since that is the primary function of the AFW system. The success criterion should be revised and resubmitted accordingly.

   However, we do accept the discussion that proposes supplemental criteria; namely, maintaining adequate core cooling by use of an HPI pump. This supplemental criteria would then make AFW system reliability based on 15 and 30 minute operator action time applicable. However, it is not applicable for Case 3: LOAC, i.e. total ac power blackout since the HPI pumps require ac power. The AFW system reliability comparison for the 15 and 30 minute operator action time should be deleted for Case 3 in Figure 7 and in the figure in the Executive Summary section and submitted in a report supplement. It is noted that the staff AFW system reliability review of W and CE operating plants did not rely on this supplemental criteria.

2. Regarding the availability of steam for the auxiliary turbine-driven pump for the 15 and 30 minute cases, if the steam supply for the AFWS turbine is the steam remaining in the steam lines after generator dryout, verify the adequacy of this steam supply to drive the turbine.

3. Discuss the design range of steam supply and exhaust conditions for the AFW turbine.

4. In order for the staff to be able to confirm the assumptions made for the reliability assessment, discuss the following:

   (1) protective trips associated with the AFW turbine

   (2) the detailed valve arrangements and interlocks for both the supply and exhaust of the turbine

   (3) the normal alignment for the turbine exhaust; to atmosphere or otherwise.

Items 5 through 20 relate to the recommendations resulting from the staff's evaluation of the information provided by you regarding the simplified AFW system reliability analysis. The recommendations are categorized as generic and additional; as well as short-term and long-term.

SHORT TERM

5. Emergency Procedures for Initiating Back-up Water Supplies (GS-4)
   Emergency procedures for transferring to alternate sources of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operators when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

   (1) The case in which the primary water supply is not initially available. The procedures for this should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated, and

(2) The case in which the primary water supply is being depleted. The procedure for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply.

6. Emergency Procedures for Initiating AFW Flow Following a Complete Loss of Alternating Current Power (GS-5)

In the licensee's proposed plan to improve reliability of the AFW system at Oconee Units 1, 2 and 3 (December 21, 1979 letter), Duke Power Company indicated it was working to eliminate the AC power dependency of the turbine-driven pump. The following recommendation should be met in the interim.

The as-built plant should be capable of providing the required AFW flow for at least two hours from one AFW pump train, independent of any ac power source. If manual AFW system initiation or flow control is required following a complete loss of ac power, emergency procedures should be established for manually initiating and controlling the system under these conditions. Since the water for cooling of the lube oil for the turbine-driven pump bearings may be dependent on ac power, design or procedural changes shall be made to eliminate this dependency as soon as practicable. Until this is done, the emergency procedures should provide for an individual to be stationed at the turbine-driven pump in the event of the loss of all ac power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in an on-off mode until ac power is restored. Adequate lighting powered by direct current (dc) power sources and communications at local stations should also be provided if manual initiation and control of the AFW system is needed. (See Recommendation GL-3 for the longer term resolution of this concern.)

7. AFW System Flow Path Verification (GS-6)

The licensee should confirm flow path availability of an AFW system flow train that has been out of service to perform periodic testing or maintenance as follows:

(1) Procedures should be implemented to require an operator to determine that the AFW system valves are properly aligned and a second operator to independently verify that the valves are properly aligned.

(2) The licensee should propose Technical Specifications to assure that, prior to plant startup following a refueling shutdown or any cold shutdown of longer than 30 days duration, a flow test would be performed to verify the normal flow path from the primary AFW system water source to the steam generators. The flow test should be conducted with AFW system valves in their normal alignment.

8. Non-Safety Grade, Non-Redundant AFW System Automatic Initiation Systems (GS-7)

The licensee should verify that the automatic start AFW system signals and associated circuitry are safety-grade. If this cannot be verified, the AFW system automatic initiation system should be modified in the

short-term to meet the functional requirements listed below. For the longer-term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements, as indicated in Recommendation GL-5.

(1) The design should provide for the automatic initiation of the AFW system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of AFW system function.

(3) Testability of the initiation signals and circuits shall be a feature of the design.

(4) The initiation signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the AFW system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.

(6) The ac motor-driven pumps and valves in the AFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) The automatic intiation signals and circuits shall be designed so that their failure will not result in the loss of manual capability to initiate the AFW system from the control room.

ADDITIONAL SHORT TERM

9. Primary AFW Water Source Low Level Alarm (AS-1)

The licensee should provide redundant level indication and low level alarms in the control room for the AFW system primary water supply, to allow the operator to anticipate the need to make up water or transfer to an alternate water supply and prevent a low pump suction pressure condition from occurring. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating. For the long term the instrumentation and power supplies should be safety grade with at least one channel backed by a battery source.

10. AFW Pump Endurance Test (AS-2)

The licensee should perform a 48-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Details for the test are outlined in Enclosure 2 titled, "Revision to Recommendation No. 2 of 'Additional Short Term Recommendation' Regarding Auxiliary Feedwater Pump Endurance Test."

For those pumps that have already been tested you should respond to this recommendation to the extent practicable with the data available. For those pumps not yet tested you should apply this recommendation in full.

11. Indication of AFW Flow to the Steam Generators (AS-3)

The licensee should implement the following requirements as specified by Item 2.1.7.b on page A-32 of NUREG-0578:

(1) Safety-grade indication of AFW flow to each steam generator should be provided in the control room.

(2) The AFW flow instrument channels should be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the AFW system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9.

12. Technical Specification Administrative Controls on Manual Valves - Lock and Verify Position (AS-4)

The licensee should lock open single valves or multiple valves in series in the AFW pump suction piping and lock open other single valves or multiple valves in series that could interrupt all cooling water flow. Monthly inspections should be performed to verify that these valves are locked and in the open position. These inspections should be proposed for incorporation into the surveillance requirements of the plant Technical Specifications.

13. Human Error During Test and Maintenance

The licensee should assure that plant procedures are written to reduce human induced common mode failures of all AFW system trains. For example, the licensee should implement

staggered testing of AFW system trains, i.e., for planned testing, not more than one AFW train (or pump) should be tested by the same shift ever. As another example, consideration should be given to locking open valves C-575 and C-576 since closure of either valve may result in a non-recoverable failure of the electric pump train due to pump cavitation.

14. Flow Blockage by Plugged Strainers

The licensee should assure that there are no temporary strainers in place in the AFW piping system that may cause flow blockages if plugged. Operating experience at several plants has shown this to be a potential common cause failure mechanism which could fail the entire AFWS. The suction strainers between the condensate storage tank and the pumps are an example.

15. Proposed Utility Changes

Recommendation 1 in the letter from W. O. Parker, Jr. to H. R. Denton, dated December 21, 1979, calls for a "second independent cooling water supply to the EFWS turbine lube oil cooler" from the "elevated water storage tank via the HPSW system." To provide the maximum increase in system reliability, this second source should require no manual actions to succeed and have no ac dependencies (e.g., valves requiring ac power to open). This philosophy is consistent with generic short term recommendation (GS) 5 and long term recommendation (GL) 3(a). A schedule should be established to assure implementation of this recommendation.

The commitment to implement recommendations (2) and (3) as described in the Parker to Denton letter of December 21, 1979, and the Duke response to IE Bulletin 79-05 as related to FDW-88 will increase system reliability.

LONG TERM

16. Elimination of AFW System Dependency on Alternating Current Power Following A Complete Loss of Alternating Current Power (GL-3)

At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any ac power source for at least two hours (including available water supplies). Conversion of dc power to ac power is acceptable. Duke should consider the two hours requirement when designing the backup to the control air system for MS-87 and MS-129 (steam pressure regulating valves) proposed in the December 21, 1979 letter.

17. Prevention of Multiple Pump Damage Due to Loss of Suction Resulting From Natural Phenomena (GL-4)

Licensees having plants with unprotected normal AFW system water supplies should evaluate the design of their AFW systems to determine if automatic protection of the pumps is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available to the control room operator, and the time necessary for assessing the problem and taking action should be considered in determining whether operator action can be relied on to prevent pump damage. Consideration should be given to providing pump protection by means such as automatic switchover of the pump suctions to the alternate safety-grade source of water, automatic pump trips on low suction pressure, or upgrading the normal source of water to meet seismic Category I and tornado protection requirements.

18. Non-Safety Grade, Non-Redundant AFW System Automatic Initiation Signals (GL-5)

The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety-grade requirements.

19. Eliminate Common Cooling Water Supply to AFS Pumps (plant specific)

In Duke Power Company's proposed plan to improve reliability of the AFW system at Oconee Units 1, 2 & 3, the licensee indicated he was working on modifications to eliminate the turbine-driven AFW pump's AC dependency and to provide for diverse cooling supplies for the auxiliary feedwater pumps. Design and installation details should be submitted for review.

20. Air Operated Valves

Flow control valves FDW 315 and 316 are air operated and fail open on a loss of air. This loss of air will probably occur within minutes following a loss of offsite power as you have indicated in your analysis. Considering the sensitivity of the B&W system to AFW flow, evaluate the need to install accumulators which would allow 30 minutes to 2 hours (loss of all AC) of valve operations. This would allow the operator ample time to manually connect the N_2 backup source.

The same should be considered for your proposed backup to the control air system for steam pressure regulating valves MS-87 and 129. Operator action should not be required for at least 30 minutes to connect any manual backup supply.

21. Postulated High Energy Pipe Breaks

(1) In the event of a postulated break in the main steam or main feed system inside or outside containment coupled with a single active failure, discuss how the Oconee AFW design limits or terminates AFW system flow to the depressurized steam generator and directs the minimum flow to the intact steam generator. If manual action is relied upon verify that sufficient flow to the intact steam generator will occur in sufficient time to provide adequate core cooling.

(SRP 10.4.9,I.14 and 10.4.9,II.5)

22. Missile Protection

Discuss the physical separation of your AFW system piping and components and evaluate the capability of your system or plant to withstand the effects of internally and externally generated (tornado) missiles. (SRP 10.4.9.II.1 and II.2)

23. Qualification Group and Seismic Category

Discuss the quality group and seismic classification of the AFW systems, components and piping and evaluate the overall plant design to bring the plant to safe cold shutdown following a seismic event (SRP 10.4.9.II.8 and II.9).

24. Long Term Source of AFW Supply

Branch Technical Position 5-1, attached to SRP 5.4.6, requires a seismic Category I water supply with sufficient inventory to permit operation at hot shutdown (as defined by the B&W Standard Technical Specifications) for at least 4 hours followed by cooldown to RHR operating temperature and pressure. The inventory needed shall be based on the longest cooldown time needed with either only onsite or only offsite power available with an assumed single failure (usually 24-36 hours).

Evaluate the capability of your AFW system to meet this position taking credit for water supplies with seismic capability equal to or greater than the overall AFW system. In your evaluation include any added capabilities that may occur as a result of design changes proposed as a result of fire protection requirements.

25. Design Basis For AFW System Flow Requirements

The licensee is required to provide the AFWS flow design basis information required in Enclosure 3 for the Oconee 1, 2 and 3 design basis transients and accident conditions.

The response should include the following:

(1) List of all events needing AFW to mitigate the consequences.

(2) Justification that the bounding non-LOCA calculation will serve as a conservative basis for sizing the AFW system for non-LOCA core cooling considerations. In other words, show that the calculation will bound all of the non-LOCA events requiring AFW.

(3) The non-LOCA analysis should include a loss of feedwater event using FSAR type assumptions to maximize heat removal requirements (1.2 ANS decay heat, 2% power level measurement uncertainty, RCP heat input). The calculation should not take credit for "anticipatory reactor trip" since it will not occur under all conditions. Lifting of the PORV is not precluded; however, credit for pressure relief through the valve should not be assumed.

(4) For the small LOCA events, reference may be made to the B&W Report, "Evaluation of Transient Behavior and Small Reactor Coolant System Breaks in the 177 Fuel Assembly Plants dated May 7, 1979.

The acceptance criteria for the event will be:

1. Reactor Coolant System pressure remains less than 110% of design pressure (2750 psig).

2. No fuel failure (DNBR >1.30).

Enclosure 2

Revision to Recommendation No. 2 of "Additional Short Term Recommendations" Regarding Auxiliary Feedwater Pump Endurance Test

The licensee should perform an endurance test on all AFW system pumps. The test should continue for at least 48 hours after achieving the following test conditions:

- Pump/driver operating at rated speed

  and

- Pump developing rated discharge pressure and flow or some higher pressure at a reduced flow but not exceeding the pump vendor's maximum permitted discharge pressure value for a 48-hour test
- For turbine drivers, steam temperature should be as close to normal operating steam temperature as practicable but in no case should the temperature be less than 400°F.

Following the 48-hour pump run, the pumps should be shut down and allowed to cool down until pump temperatures reduce to within 20°F of their values at the start of the 48-hour test and at least 8 hours have elapsed. Following the cool down, the pumps should be restarted and run for one hour. Test acceptance criteria should include demonstrating that the pumps remain within design limits with respect to bearing/bearing oil temperatures and vibration and that ambient pump room conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room.

The licensee should provide a summary of the conditions and results of the tests. The summary should include the following: 1) A brief description of the test method (including flow schematic diagram) and how the test

was instrumented (i.e., where and how bearing temperatures were measured). 2) A discussion of how the test conditions (pump flow, head, speed and steam temperature) compare to design operating conditions. 3) Plots of bearing/bearing oil temperature vs. time for each bearing of each AFW pump/driver demonstrating that temperature design limits were not exceeded. 4) A plot of pump room ambient temperature and humidity vs. time demonstrating that the pump room ambient conditions do not exceed environmental qualification limits for safety-related equipment in the room. 5) A statement confirming that the pump vibration did not exceed allowable limits during tests.

Enclosure 3

Basis for Auxiliary Feedwater
System Flow Requirements

As a result of recent staff reviews of operating plant Auxiliary Feedwater Systems (AFWS), the staff concludes that the design bases and criteria provided by licensees for establishing AFWS requirements for flow to the steam generator(s) to assure adequate removal of reactor decay heat are not well defined or documented.

We require that you provide the following AFWS flow design basis information as applicable to the design basis transients and accident conditions for your plant.

1. a. Identify the plant transient and accident conditions considered in establishing AFWS flow requirements, including the following events:

   1) Loss of Main Feed (LMFW)
   2) LMFW w/loss of offsite AC power
   3) LMFW w/loss of onsite and offsite AC power
   4) Plant cooldown
   5) Turbine trip with and without bypass
   6) Main steam isolation valve closure
   7) Main feed line break
   8) Main steam line break
   9) Small break LOCA
   10) Other transient or accident conditions not listed above

   b. Describe the plant protection acceptance criteria and corresponding technical bases used for each initiating event identified above. The acceptance criteria should address plant limits such as:

- Maximum RCS pressure (PORV or safety valve actuation)
- Fuel temperature or damage limits (DNB, PCT, maximum fuel central temperature)
- RCS cooling rate limit to avoid excessive coolant shrinkage
- Minimum steam generator level to assure sufficient steam generator heat transfer surface to remove decay heat and/or cool down the primary system.

2. Describe the analyses and assumptions and corresponding technical justification used with plant condition considered in 1.a. above including:

   a. Maximum reactor power (including instrument error allowance) at the time of the initiating transient or accident.

   b. Time delay from initiating event to reactor trip.

   c. Plant parameter(s) which initiates AFWS flow and time delay between initiating event and introduction of AFWS flow into steam generator(s).

   d. Minimum steam generator water level when initiating event occurs.

   e. Initial steam generator water inventory and depletion rate before and after AFWS flow commences - identify reactor decay heat rate used.

f. Maximum pressure at which steam is released from steam generator(s) and against which the AFW pump must develop sufficient head.

g. Minimum number of steam generators that must receive AFW flow; e.g. 1 out of 2?, 2 out of 4?

h. RC flow condition - continued operation of RC pumps or natural circulation.

i. Maximum AFW inlet temperature.

j. Following a postulated steam or feed line break, time delay assumed to isolate break and direct AFW flow to intact steam generator(s). AFW pump flow capacity allowance to accommodate the time delay and maintain minimum steam generator water level. Also identify credit taken for primary system heat removal due to blowdown.

k. Volume and maximum temperature of water in main feed lines between steam generator(s) and AFWS connection to main feed line.

l. Operating condition of steam generator normal blowdown following initiating event.

m. Primary and secondary system water and metal sensible heat used for cooldown and AFW flow sizing.

n. Time at hot standby and time to cooldown RCS to RHR system cut-in temperature to size AFW water source inventory.

3. Verify that the AFW pumps in your plant will supply the necessary flow to the steam generator(s) as determined by items 1 and 2 above considering a single failure. Identify the margin in sizing the pump flow to allow for pump recirculation flow, seal leakage and pump wear.