Docket No. 50-313

DMB-016

Mr. John M. Griffin, Vice President
Nuclear Operations
Arkansas Power &Light Company
P. O. Box 551
Little Rock, Arkansas 72203

OCT 6 1983

Dear Mr. Griffin:

By letter dated July 18, 1982, we provided a status report of our evaluation of NUREG-0737, Item II.E.1.1, Emergency Feedwater (EFW) System for Arkansas Nuclear One, Unit 1, (ANO-1). In that report seven open items were identified. The enclosed Safety Evaluation Report (SER) provides our evaluation of Item II.E.1.1 for ANO-1 and closes all open items except two. The two issues which remain to be resolved relate to the staff positions concerning (1) redundant flow paths from the condensate storage tank to the EFW pumps or installation of a valve position indication in the control room for the single flow path and (2) tornado missile protection for the EFW system.

Upon your commitment to comply with the staff positions noted above and in the attached SER, we will consider Item II.E.1.1 resolved. Therefore, we request such a commitment within 30 days from receipt of this letter.

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

Sincerely,

Original signed by

John F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosure:
As Stated

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SAFETY EVALUATION REPORT

ARKANSAS NUCLEAR ONE, UNIT 1 (ANO-1)

IMPLEMENTATION OF RECOMMENDATIONS FOR

EMERGENCY FEEDWATER SYSTEMS

AUXILIARY SYSTEMS BRANCH

DOCKET NO. 50-313

I. INTRODUCTION AND BACKGROUND

The Three Mile Island Unit 2 (TMI-2) accident and subsequent investigations and studies highlighted the importance of the Emergency Feedwater System (EFWS) in the mitigation of severe transients and accidents. As part of our assessment of the TMI-2 accident and related implications for operating plants, we evaluated the EFW systems for all operating plants. Our evaluations for operating plants with Westinghouse and Combustion Engineering nuclear steam supply systems (NSSS) are contained in NUREG-0611 and NUREG-0635, respectively. These NUREGs also contain our recommendations for each plant and the concerns which led to each recommendation.

The objectives of the evaluation were to: (1) identify necessary changes in EFW system design or related procedures at the operating facilities in order to assure the continued safe operation of these plants, and (2) to identify other system characteristics of the EFW system which, on a long term basis, may require system modifications. To accomplish these objectives we:

(1) Reviewed plant specific EFW system designs in light of current regulatory requirements and,

(2) Assessed the relative reliability of the various EFW systems under various loss of feedwater transients (one of which was the initiating event of TMI-2) and other postulated failure conditions by determining the potential for EFW system failure due to common causes, single point vulnerabilities, and human error.

At our request, Babcock and Wilcox (B&W) performed reliability studies on operating plants with B&W reactors using failure rate data and fault tree methodology similar to that of NUREG-0611 and NUREG-0635 for both the existing design and the proposed upgraded designs. Based on that review and generic recommendations in NUREG-0611 and NUREG-0635 this Safety Evaluation Report was prepared.

We conclude that the implementation of the recommendations identified during this review, and listed below, will considerably and acceptably improve the reliability of the EFW system for ANO-1.

A. Short Term Recommendations

A1. Recommendation GS-1 - "The licensee should propose modifications to the Technical Specifications to limit the time that one AFW system pump and its associated flow train and

essential instrumentation can be inoperable. The outage time limit and subsequent action time should be as required in current Standard Technical Specifications; i.e., 72 hours and 12 hours, respectively."

The ANO-1 Technical Specifications require an inoperable emergency feedwater pump to be restored within 72 hours, or the unit shall be brought to hot shutdown within 36 hours or at the maximum safe rate. We conclude that this recommendation has been adequately met, and is, therefore, acceptable.

A2. Recommendation GS-2 - "The licensee should lock open single valves or multiple valves in series in the AFW system pump suction piping and lock open other single valves or multiple valves in series that could interrupt all AFW 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. See Recommendation GL-2 for the longer term resolution of this concern."

The licensee's response of March 12, 1981, indicated that manual valves in the EFW pump suction lines and other system valves that could interrupt EFW flow are locked in their correct positions. Also, an existing procedure verifies on a monthly basis that these valves are in their correct position. The plant Technical Specifications incorporate these surveillance requirements. We conclude that the licensee's response is acceptable and this recommendation has been satisfied.

A3. Recommendation GS-3 - "The licensee has stated that it throttles AFW system flow to avoid water hammer. The licensee should reexamine the practice of throttling AFW system flow to avoid water hammer.

The licensee should verify that the AFW system will supply on demand sufficient initial flow to the necessary steam generators to assure adequate decay heat removal following loss of main feedwater flow and a reactor trip from 100% power. In cases where this reevaluation results in an increase in initial AFW system flow, the licensee should provide sufficient information to demonstrate that the required initial AFW system flow will not result in plant damage due to water hammer."

The emergency feedwater (EFW) is not throttled to avoid waterhammer, as ANO-1 has Once Through Steam Generators (OTSG) which are equipped with external headers. However a waterhammer test was performed in accordance with Branch Technical Position ASB 10-2 and no waterhammer was detected. Thus, we find the ANO-1 EFWS design is acceptable with respect to this recommendation.

A4. Recommendation 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 operator 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 case should include 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 procedures for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply."

The licensee's response indicated that procedures are available for these cases. In the event feedwater suction from the primary source (Condensate Storage Tank) is lost or depleted after initiation of EFW these procedures instruct the operator to open the service water supply to the EFW suction upon receipt of low suction pressure alarm.

We conclude that this recommendation is adequately met, and is, therefore, acceptable. The long term resolution of this item is discussed in Item C4, Recommendation GL-4.

A5. Recommendation GS-5 - "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."

For the short term, the licensee's initial response indicated that an emergency procedure is available which specifies action required for manually initiating and controlling the EFW system in the event of loss of all AC power, and that the cooling water supply for EFW pump lube oil cooling is not dependent upon AC power and that there are no safety-related EFW pump room coolers at ANO-1. In response to our request for further information regarding this recommendation, the licensee in their submittal dated July 22, 1982, stated that one train of the EFW system is capable of operating for two hours without A.C. power under manual controls. Emergency lighting is available at the local station which meets the requirements of Appendix R, Section III.J. The licensee further stated that the plant communication system for ANO-1

is powered by a battery backed power supply and by the dedicated diesel generator installed for the security system. We conclude that this recommendation is adequately met, and is, therefore, acceptable. Refer to Recommendation GL-3 for discussion of the long term resolution of this concern.

A6. Recommendation 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 an extended cold shutdown, 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 EFW system valves in their normal alignment."

The licensee's response to the first part of this recommendation indicated that ANO-1 procedures require flow path availability verification following testing or maintenance, and that valve position is verified by two individuals. We conclude that this part of the recommendation is adequately met.

The licensee's response to the second part of this recommendation indicated that the ANO-1 Technical Specifications have the requirement to demonstrate EFW operability at least once every 18 months by functionally testing each EFW train and verifying that feedwater is delivered to each steam generator using the motor driven EFW pump.

By letter dated May 31, 1983, the licensee further stated that plant Technical Specifications have been revised to include a flow test verifying the flow path of one EFW train from the primary EFW source to the steam generators following any extended cold shutdown of 30 days or more. We find the changes in the Technical Specifications acceptable with respect to this recommendation.

A7. Recommendation 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 EFW 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 EFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) The automatic initiation 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."

The present EFW automatic initiation system at ANO-1 was reviewed by the Bulletins and Orders Task Force which concluded it was acceptable as indicated in the B&O Task Force Report, NUREG-0645. Refer to Recommendation GL-5 for discussion on the long term (safety grade) resolution of this concern.

A8. Recommendation GS-8 - "The licensee should install a system to automatically initiate AFW system flow. This system need not be safety grade; however, in the short-term, it should meet the criteria listed below, which are similar to Item 2.1.7 of a NUREG-0578. 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 initiating signals and circuits should be a feature of the design.

(4) The initiating 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 abd 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 initiation signals and circuits should be designed so that their failure will not result in the loss of the manual capability to initiate the EFW system from the control room."

This recommendation does not apply to ANO-1 as automatic EFW initiation was always part of the system design.

A9. Recommendation (Plant Specific) - The licensee's letter of December 30, 1979, "Emergency Feedwater System Reliability Study" stated that the atmospheric dump valves fail 50% open on loss of control signals. The licensee should verify

that control ppwer will not be lost in the event of a loss of offsite power (LOOP) or in the event of a complete loss of AC power (LOAC). If control power is not available for either of the above two events, then modifications should be made to prevent an uncontrolled cooldown in the event of a LOOP or a LOAC.

The licensee's response indicated that modifications have been made to leave the atmospheric dump valves normally closed on loss o control signal rather than 50% open. Safety grade power is available to allow opening the valves when needed. We conclude that this recommendation has been adequately met, and is, therefore, acceptable.

A10. Recommendation - "The licensee should assure that there are no temporary strainers in place in the EFW flow path that may cause flow blockage if plugged. Operating experience at several plants has shown this to be a potential common cause failure mechanism which could fail the entire EFWS. The suction strainers between the condensate storage tank and the pumps are an example."

The licensee's response indicated that suction strainers were installed for startup testing purposes and were removed several years ago. We conclude that this recommendation has been adequately met, and is, therefore, acceptable.

B. Additional Short Term Recommendations

B1. Recommendation - "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 makeup 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."

The licensee's response in their letter dated October 20, 1982, indicated that the EFW Upgrade consists of a non-class 1E condensate storage tank level transmitter that will send a signal to a control room level indicator. The level indicator also includes a low CST level alarm contact to the control room annunciator which provides an alarm when two hours of EFW supply remains. In addition, a Class 1E, seismic Category I pressure switch is provided for the EFW pump suction piping. This switch is intended to alarm on the control room annunciator when at maximum flow, two hours of EFW supply is available. Although the control room annunciators are non-Class 1E, they are backedup by DC power.

We conclude that this recommendation has been adequately met and is, therefore, accepable.

B2. Recommendation - "The licensee should perform a 72-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Following the 72-hour pump run, the pumps should be shut down and cooled down and then 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 pump room ambient conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room."

The licensee provided the pump endurance test procedure and the results of their EFW pumps. The test results indicate that the test parameters were not exceeded. We therefore conclude that this recommendation has been met and therefore acceptable.

B3. Recommendation - "The licensee should implement the following requirements as specified by Item 2.1.7.b of 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."

The Bulletins and Orders Task Force reported that safety grade EFW flow transmitters have been installed at ANO-1. Further, the Instrumentation and Control Systems Branch (ICSB) provided an evaluation of this recommendation, as part of NUREG-0737, Item II.E.1.2, on July 13, 1982, and found it acceptable.

B4. Recommendation - "Licensee with plants which require local manual realignment of valves to conduct periodic tests on an AFW system train which have only one remaining AFW train available for operation should proposed Technical Specifications to provide that a dedicated individual who is in communication with the control room be stationed at the manual valves. Upon instruction from the control room, this operator would align the valves in the AFW system from the test mode to its operational alignment."

The licensee responded that plant procedures for periodic tests of EFW system trains do not require local alignment of valves, nor do the tests cause a loss of EFW flow path to the steam generators due to selection of test flow path. We conclude that the licensee's response satisfies this concern and is therefore, acceptable.

C. Long Term Recommendations

C1. Recommendation GL-1 - "For plants with a manual starting AFW system, the licensee should install a system to automatically initiate the AFW system flow. This system and associated automatic initiation signals should be designed and installed to meet safety grade requirements. Manual AFW systems start and control capability should be retained with manual start serving as backup to automatic AFW system initiation."

This recommendation does not apply to ANO-1 since automatic initiation of EFW was always part of the plant design.

C2. Recommendation GL-2 - "Licensees with plant designs in which all (primary and alternate) water supplies to the AFW systems pass through valves in a single flow path should install redundant parallel flow paths (piping and valves).

Licensees with plant designs in which the primary AFW system water supply passes through valves in a single flow path, but the alternate AFW system water supplies connect to the AFW system pump suction piping downstream of the above valve(s), should install redundant valves parallel to the above valve(s) or provide automatic opening of the valve(s) from alternate water supply upon low pump suction pressure.

The licensee should propose Technical Specifications to incorporate appropriate periodic inspections to verify the valve positions into the surveillance requirements."

The licensee's initial response to this recommendation indicated that they do not intend to install an automatic switchover of the EFW pump to the service water system (alternate water supply) due to the consequences of an inadvertent actuation which could result in the introduction of low purity water into the steam generators. In our letter dated March 22, 1983, we stated that the licensee response does not address the basic concerns that resulted in long term Recommendations GL-2 and GL-4. These concerns are (1) no single failure of inadvertent closure of a single valve should interrupt all EFW system flow and (2) loss of EFW pump suction due to natural phenomena should not result in multiple pump damage. In order to address these concerns, we suggested that the licensee consider other solutions to the problem for meeting GL-2 and GL-4 recommendations, e.g., automatic pump trip, a two out of three logic low suction pressure automatic switchover or upgrade the water supply to withstand natural

phenomena (satisfies GL-4) and parallel suction valves or valve position indication in the control room of a single valve in the flow path (satisfies GL-2).

In response, by letter dated July 29, 1983, the licensee presented a conceptual design change which includes a new seismically qualified condensate storage tank (primary supply) large enough to provide minimum technical specification volumes of water for both ANO-1 and ANO-2. The EFW pumps for both the units would be aligned to take suction from this new condensate storage tank. Though the new tank is seismically qualified, it is not tornado missile protected. Further, the EFW system water supply passes through valves in a single flow path. As stated in a telephone conference call with the licensee on September 6, 1983, we will require the licensee to install redundant parallel flow paths (piping and valves) from the tank or install valve position indication in the control room for the single flow path, in order to fully comply with this recommendation. Pending receipt of a commitment to comply with this requirement, we consider this matter resolved. Discussion regarding the lack of tornado missile protection is provided under Item C4 (Recommendation GL-4).

C3. Recommendation GL-3 - "At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate flow and be capable of being operated independently of any AC power source for at least two hours. Conversion of DC power to AC power is acceptable."

The licensee responded that the ANO-1 long-term EFW upgrade would include DC operated valves for the turbine driven EFW pump flow train such that manual operator action would not be required in a loss of all AC power. However, the EFW turbine steam admission line isolation valves CV2617, 2666 and 2667 will remain AC powered. These valves will be normally open. By letter dated October 20, 1982, the licensee indicated that the surveillance requirements for verification of the proper position of the steam admission valves, both by remote indication and locally, during the monthly test are included in the plant Technical Specifications. Therefore, we find the ANO-1 design in conformance with the provision of this recommendation.

C4. Recommendation 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 suction 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."

To meet the above recommendation by letter dated July 29, 1983, the licensee proposed a new seismic Category I condensate storage tank which provides the primary supply path to the EFW pump suction. At present the new tank does not meet tornado missile protection requirements. The design incorporates a remote manual switch over to tornado missile

protected service water system. We have discussed with the licensee the concern that manual switchover following loss of the tank by tornado missiles may not occur soon enough before loss of EFW pump suction and subsequent pump damage occurs. The licensee is evaluating the possible installation of a partial tornado missile barrier around the tank which will provide sufficient time for remote manual action in the control room compatible with the EFW pump protection requirements. We find the proposed ANO-1 EFWS design acceptable for seismic protection. However, we will require that the licensee include tornado missile protection in the design of the EFW system. Pending receipt of a commitment to comply with this requirement, we consider this matter resolved.

C5. Recommendation GL-5 - "The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety grade requirements."

As described in the evaluation of GL-1, the ANO-1 emergency feedwater system has safety grade automatic initiation signals and circuits. The final evaluation of this recommendation was provided by the Instrumentation and Control Systems Branch on July 13, 1982, as part of NUREG-0737, Item II.E.1.2.

C6. Long Term Plant Specific Recommendation - "Evaluate the ANO-1 EFWS design with regards to applicable high energy pipe break criteria in Branch Technical Positions ASB 10-1, ASB 3-1 and MEB 3-1 including assumption of a concurrent single active failure. Provide the effects of pipe whip and jet impingements as well as the environmental effects of postulated pipe failures. The latter should include the resultant temperature, pressure and humidity. The results of this analysis should be compared with the environmental design criteria of vital EFWS electrical components. The effects of a main steam or feedwater line failure on the capability of the EFWS to provide safe shutdown should be included in this analysis.

The licensee should evaluate the postulated pipe breaks stated above and (1) determine any EFW system design changes or procedures necessary to detect and isolate the breaks and direct the required feedwater flow to the intact steam generator(s) before they boil dry or (2) describe how the plant can be brought to a safe shutdown condition by the use of other systems which would be available following such postulated events."

The licensee's response of May 31, 1983, indicated that the worst case environment in the EFW pump room could result from a postulated main feedwater line break. The environment could reach a maximum temperature of 136 F, maximum humidity of 100%, maximum pressure of 0.7 psig and a total integrated radiation dose of 1.1×10^3 rads. The safety-related equipment in the EFW pump room including the EFW pump motor is qualified to this environment. The licensee further stated that the closed D.C. powered steam admission valves to the EFW pump turbine were relocated outside the EFW pump room on elevation 404 feet. Since the steam piping is not pressurized downstream of these normally closed steam admission valves, the limiting high energy line break environment remains that due to the main feedwater line break. The licensee's response to this recommendation is therefore, acceptable.

D1. Basis for EFW System Flow Requirements

In Enclosure 3 of our letter dated June 18, 1982, we requested the licensee provide certain information regarding the design basis for EFWS flow requirements. By letters dated July 22, 1982, and October 20, 1982, the licensee provided this information. The licensee verified that the EFWS minimum flow rate requirements could be maintained for transient and accident conditions.

Based on our review of the licensee's submittals, we conclude that the licensee's design basis for EFW flow requirements is acceptable.

The following NRC personnel have contributed to this Safety Evaluation: Raj Anand.