TECHNICAL EVALUATION REPORT

AUXILIARY FEEDWATER SYSTEM AUTOMAT. INITIATION AND FLOW INDICATION (F-16, F-17

POWER AUTHORITY OF THE STATE OF NEW YORK

INDIAN POINT UNIT 3

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Prepared by

Franklin Research Center
20th and Race Street
Philadelphia, PA 19103

Author: J. E. Kaucher

FRC Group Leader: K. Fertn

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: R. Kenda
M. Wigdo

July 9, 1982

Reviewed by:

Group Leader

Approved by:

Project Manager

Department Director

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Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215)

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FOREWORD

Tnis Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

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1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to provide a technical evaluation of the auxiliary feedwater system design to verify that both safety-grade automatic initiation circuitry and flow indication are provided at Indian Point Unit 3. In addition, the steam generator level indication available at Indian Point Unit 3 is described to assist subsequent NRC staff review.

1.2 GENERIC ISSUE BACKGROUND

A post-accident design review by the Nuclear Regulatory Commission (NRC) after the March 28, 1979 incident at Three Mile Island (TMI) Unit 2 has established that the auxiliary feedwater (AFW) system should be treated as a safety system in a pressurized water reactor (PWR) plant. The designs of safety systems in a nuclear power plant are required to meet general design criteria (GDC) specified in Appendix A of the 10 CFR Part 50 [1].

The relevant design criteria for the AFW system design are GDC 13, GDC 20, and GDC 34. GDC 13 sets forth the requirement for instrumentation to monitor variables and systems (over their anticipated ranges of operation) that can affect reactor safety. GDC 20 requires that a protection system be designed to initiate automatically in order to assure that acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences. GDC 34 requires that the safety function of the designed system, that is, the residual heat removal by the AFW system, be accomplished even in the case of a single failure.

On September 13, 1979, the NRC issued a letter [2] to each PWR licensee that defined a set of requirements specified in NUREG-0578 [3]. It required that the AFW system have automatic initiation and single failure-proof design consistent with the requirements of GDC 20 and GDC 34. In addition, AFW flow indication in the control room should be provided to satisfy the requirements set forth in GDC 13.

During the week of September 24, 1979, seminars were held in four regions of the country to discuss the short-term requirements. On October 30, 1979, another letter was issued to each PWR licensee providing additional clarification of the NRC staff short-term requirements without altering their intent [4].

Post-TMI analyses of primary system response to feedwater transients and reliability of installed AFW systems also established that, in the long term, the AFW system should be upgraded in accordance with safety-grade requirements. These long-term requirements were clarified in the letter of September 5, 1980 [5]. This letter incorporated in one document, NUREG-0737 [6], all TMI-related items approved by the commission for implementation at this time. Section II.E.1.2 of NUREG-0737 clarifies the requirements for the AFW system automatic initiation and flow indication.

1.3 PLANT-SPECIFIC BACKGROUND

In a letter to the Power Authority of the State of New York (PASNY) dated November 7, 1979 [7], the NRC defined both generic and plant-specific requirements for the Indian Point Unit 3 AFW system. PASNY responded to Reference 7 in a letter dated December 7, 1979 [8]. In a letter dated December 30, 1980 [9], PASNY provided more detailed information relating to the AFW system design and implementation of system modifications.

The present review of the AFW system at Indian Point Unit 3 was begun in September 1981, based on the criteria described in Section 2 of this report.

2. REVIEW CRITERIA

To improve the reliability of the AFW system, the NRC required licensees to upgrade the system, where necessary, to ensure timely automatic initiation when required. The system upgrade was to proceed in two phases. In the short term, as a minimum, control-grade signals and circuits were to be used to automatically initiate the AFW system. This control-grade system was to meet the following requirements of NUREG-0578, Section 2.1.7.a [3]:

"1. The design shall provide for the automatic initiation of the auxiliary feedwater system.

2. The automatic initiation signals and circuits shall be designed so that a single failure will not result in the loss of auxiliary feedwater system function.

3. Testability of the initiating signals and circuits shall be a feature of the design.

4. The initiating signals and circuits shall be powered from the emergency buses.

5. Manual capability to initiate the auxiliary feedwater system from the control room shall be retained and shall 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 auxiliary feedwater system shall be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

7. The automatic initiating 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."

In the long term, these signals and circuits were to be upgraded in accordance with safety-grade requirements. Specifically, in addition to the above requirements, the automatic initiation signals and circuits must have independent channels, use environmentally qualified components, have system bypassed/inoperable status features, and conform to control system interaction criteria, as stipulated in IEEE Std 279-1971 [10].

The capability to ascertain the AFW system performance from the control room must also be provided. In the short term, steam generator level indication and flow measurement were to be used to assist the operator in maintaining the required steam generator level during AFW system operation. This system was to meet the following requirements from NUREG-0578, Section 2.1.7.b:

"1. Safety-grade indication of auxiliary feedwater flow to each steam generator shall be provided in the control room.

2. The auxiliary feedwater flow instrument channels shall be powered from the emergency buses consistent with satisfying the emergency power diversity requirements of the auxiliary feedwater system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9 [11]."

The NRC staff has determined that, in the long term, the overall flowrate indication system for Westinghouse plants must include either one AFW flowrate indicator with one wide-range steam generator level indicator for each steam generator, or two flowrate indicators. The flowrate indication system must be environmentally qualified, powered from a highly reliable, battery-backed, non-Class 1E power source, periodically testable, part of the plant's quality assurance program, and capable of display on demand.

The operator relies on both steam generator level instrumentation and AFW flow indication to monitor AFW system performance. The requirements for this steam generator level instrumentation are specified in Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident" [12].

3. TECHNICAL EVALUATION

3.1 GENERAL DESCRIPTION OF THE AUXILIARY FEEDWATER SYSTEM

The auxiliary feedwater (AFW) system at the Indian Point Unit 3 plant supplies water to the secondary side of the steam generator for reactor decay heat removal when normal feedwater sources are unavailable due to loss of offsite power or other malfunctions. The system consists of one steam turbine-driven pump (800 gpm at 1350 psig) and two motor-driven pumps (400 gpm at 1350 psig) capable of supplying feedwater to all four steam generators. Each motor-driven AFW pump supplies water to two of the four steam generators. The steam turbine-driven pump is to supply all four steam generators. Motive steam to the turbine-driven pump is from two steam generators, and the piping configuration is such that either one or both of these steam generators can provide steam to the turbine-driven pump. An additional remote manual isolation valve is being added to each of the steam supply lines to the turbine-driven pump in order to meet single failure requirements for all postulated accidents. The AFW system is automatically activated, but the operator must control flow rate to the steam generator remote-manually.

3.2 AUTOMATIC INITIATION

3.2.1 Evaluation

Auxiliary feedwater flow to the steam generators is automatically initiated when preset levels of any of the following parameters are exceeded:

A. Motor-Driven Pumps

1. 2 of 3 low-low water level in any one steam generator
2. Loss of either main feed pump
3. Safety injection trip signal
4. Loss of offsite power concurrent with a main turbine-generator trip (blackout)

B. Turbine-Driven Pump

1. 2 of 3 low-low water level in any 2 of 4 steam generator

2. Loss of offsite power concurrent with a main turbine-generator trip (blackout).

Tne normal valve configuration for the AFW system is all AFW pump suct valves open, discharge flow control valves 35% open, and the steam admissio valves to the turbine-driven pump closed. The discharge flow control valve associated with one motor-driven pump (31) and the turbine-driven pump rece power from independent safety-grade, 118 volt ac instrument buses with back battery inverters. The flow control valves for AFW pump 33 receive power f safety-grade instrument bus. However, the Licensee has stated that a desig modification is in progress to supply this bus with a battery inverter syst The steam admission valves (SOV-1310 and 1311) for the turbine-driven pump powered from 125 volt, dc distribution panels 31 and 34, respectively. Eac the motor-driven AFW pumps is powered from 480 volt ac diesel-generator-bac emergency buses (3A and 6A). Both motor-driven AFW pumps are included in t automatic load sequencing scheme of the diesel generators.

The capability to monitor system operation is provided by direct posit indication for all automatically operated and remote manual, power-operated valves.

The operation of any one AFW pump feeding water to any two steam generators will provide the necessary capacity for removing decay heat to prevent overpressurization of the reactor coolant system and to maintain st generator levels. All three AFW pumps start upon automatic system actuati and automatic isolation of a leaking steam generator is a design feature o the system. However, there is no system-level manual initiation function, only component-level manual initiation.

The primary source of water for the AFW system is the 600,000-gal, Seismic Category 1, condensate storage tank (CST). Sufficient water inven (360,000 gal) is maintained in the tank to bring the plant to hot standby hold there for 24 hours. Indication of CST level is provided in the main control room, and annunciation and alarm of CST low water level and low-lo water level are provided. The backup water supply for the AFW system is t

1,500,000-gal city water storage tank, which is shared by Indian Point Units 2 and 3. The backup water supply can be initiated from the control room.

A review of initiation logic and wiring diagrams revealed no credible single malfunction that would prevent proper protective action at the system level when required. In addition, the Licensee has stated in Reference 9 that the design of the AFW system initiation logic meets IEEE Std 279-1971 in that no single component failure will prevent the automatic start signal from being initiated, and the initiating signals and circuits are powered from safety-grade power supplies.

Manual operation of the AFW system components is provided in the control room and at the local station. Each control circuit is independent so that a single failure in one train will not affect the redundant train. In addition, the automatic initiating circuits are designed to be electrically independent from the control room manual start circuit so that the failure of the automatic initiating signals does not affect the control room manual capability of AFW pumps.

Seismic requirements for the emergency feedwater system were not considered in the single failure analysis because the NRC will address this issue separately. A determination of whether components are qualified for accident and post-accident environments was not conducted. The environmental qualification of safety-related systems, including AFW system circuits and components, is being determined separately by the NRC and is not within the scope of this review. Review of the initiation circuit diagrams revealed no credible single malfunction that would prevent proper system action when required.

The electrical isolation and physical separation of elements of the AFW initiation system design comply with the requirements of NUREG-0578 [3] and IEEE Std 279-1971 [10]. The Licensee has stated that control-protection system interaction has been accomplished with appropriate separation and isolation, wherever required.

Concerning bypasses, the Licensee has stated the following:

Channel Bypasses

- The AFW channels associated with low-low steam generator level can be removed from service for maintenance, testing or calibration. This feature will not initiate a protective function and still meets single failure criterion and the minimum number of channels required by technicl specifications.

Operating Bypasses

- The Licensee has stated that the system contains no operating bypasses.

Each motor-driven AFW pump start circuit can be bypassed manually by placing the respective pump control switch in the pull-out position. This action effectively blocks any automatic initiation signal by opening contacts in series with the automatic initiation contacts. However, automatic annuciation is provided in the control room when this switch is placed in the pull-out position.

The Indian Point Unit 3 Technical Specifications require that each motor-driven AFW pump be started each month with full flow established to the steam generator once every refueling, and that the steam turbine-driven AFW pump is started each month with full flow established to the steam generator once every refueling. The safety injection signals are tested as part of the engineered safeguard system and the Technical Specifications which govern it. A timing test of the blackout initiation signal is performed each refueling outage. The loss of either main feed pump initiation signal is not safety-grade, and its testing scheme is not addressed in the plant Technical Specifications. The following testing scheme is followed, as specified in the Technical Specifications, for the steam generator water level instrumentation:

Channel Description	Check	Test	Calibrate
Steam generator level	Each shift	Monthly	Refueling

AFW system initiation logic is tested monthly.

3.2.2 Conclusion

It is concluded that the initiation signals, logic, and associated circuitry of the Indian Point Unit 3 AFW system comply with the long-term

safety-grade requirements of Section 2.1.7.a of NUREG-0578 [3] and the subsequent clarification issued by the NRC with the following exception:

- No system-level manual initiation capability exists for the AFW system at Indian Point Unit 3 as required by Reference 6, Section II.E.1.2; only component-level manual initiation is provided.

3.3 FLOW INDICATION

3.3.1 Evaluation

Each of the three AFW pump headers is equipped with a flow transmitter with output indicated on the control room and locally. In addition, wide-range, non-safety-grade steam generator level indication is provided. Both flow and level are continuously displayed in the control room.

The AFW flow indication system is powered from the vital instrument bus system, which is a Class 1E power source.

The Licensee has stated that the AFW flow indication system is part of the plant quality assurance program.

AFW flow indication system is testable as stated by the Licensee in Reference 8.

The environmental qualification of flow measurement and indication equipment is being reviewed separately by the NRC and is outside the scope of this review.

3.3.2 Conclusion

It is concluded that the sensors, transmitters, indicators, and recorders of the Indian Point Unit 3 AFW flow measurement system comply with the requirements of Section 2.1.7.b of NUREG-0578 and the subsequent clarification issued by the NRC.

3.4 DESCRIPTION OF STEAM GENERATOR LEVEL INDICATION

Steam generator level instrumentation at the Indian Point Unit 3 plant consists of both narrow- and wide-range, available to the operator in the control room. There are three separate and independent level instrument

channels per steam generator (two narrow-range and on wide-range) which are powered from instrument buses 31, 32, and 33. Although the wide-range level channel is not considered to be safety-related, it is powered from the vital ac instrument buses. The Indian Point Unit 3 Technical Specifications list testing frequencies for the steam generator level instrumentation as follows:

Channel Description	Surveillance Function	Frequency
Steam Generator Level	Check	S
	Calibrate	R
	Test	M

4. CONCLUSIONS

It is concluded that the initiation signals, logic, and associated circuitry of the Indian Point Unit 3 auxiliary feedwater (AFW) system comply with the long-term, safety-grade requirements of Section 2.1.7.a of NUREG-0578 [3] and subsequent clarification issued by the NRC with the following exceptions:

- No system-level manual initiation capability exists for the AFW system at Indian Point Unit 3 as required by Reference 6, Section II.E.1.2; only component level manual initiation is provided.

It is concluded that the sensors, transmitters, indicators, and recorders of the Indian Point Unit 3 AFW flow measurement system comply with the requirements of Section 2.1.7.b of NUREG-0578 and the subsequent clarification issued by the NRC.

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