TECHNICAL EVALUATION REPORT

AUXILIARY FEEDWATER SYSTEM AUTOMATIC INITIATION AND FLOW INDICATION (F-16, F-17)

YANKEE ATOMIC ELECTRIC COMPANY
YANKEE ROWE NUCLEAR POWER PLANT

NRC DOCKET NO. 50-029
NRC TAC NO. 12440
NRC CONTRACT NO. NRC-03-79-118

FRC PROJECT C5257
FRC ASSIGNMENT 9
FRC TASK 289

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June 18, 1982

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FOREWORD

This 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.

Mr. J. E. Kaucher contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to provide a technical evaluation of the emergency feedwater system design to verify that both safety-grade automatic initiation circuitry and flow indication are provided at the Yankee Rowe plant. In addition, the steam generator level indication available at the Yankee Rowe plant 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, entitled emergency feedwater system (EFW) at the Yankee Rowe plant, 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

The Yankee Atomic Electric Company (YAEC) responded to the NRC requirements in a letter dated December 21, 1979 [7]. Additional information and clarification was provided by YAEC in letters dated March 31, 1981 [8] and June 30, 1981 [9].

The review of the EFW system at the Yankee Rowe plant began in November 1981, based on the criteria described in Section 2 of this report.

2. REVIEW CRITERIA

To improve the reliability of the EFW 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 EFW 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 EFW 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 EFW 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 EFW 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 EFW 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 EFW flow indication to monitor EFW 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 EMERGENCY FEEDWATER SYSTEM

The emergency feedwater (EFW) system at the Yankee Rowe 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 two motor-driven pumps and one steam turbine-driven (standby emergency boiler feed pump) pump. Both the suction and discharge valves on two of the pumps (one motor-driven pump and the turbine-driven pump) are normally open; thus, the system is aligned for operation and will provide EFW flow upon starting either pump. Water for the EFW system is normally supplied by the 135,000-gallon primary water storage tank (PWST). The secondary source is the 30,000-gallon demineralized water storage tank. The PWST is provided with redundant level indication and low level alarms. The EFW system can be manually initiated from the control room as stated by the Licensee [9].

The steam generators at the Yankee Rowe plant are large in comparison to other plants with the same or similar thermal ratings. The steam generators are large enough to give a dryout time of up to one hour. Consequently, the NRC has determined that the Yankee Rowe plant will not be required to implement an automatically initiated EFW system and no evaluation is required.

3.2 FLOW INDICATION

3.2.1 Evaluation

The performance of the EFW system at the Yankee Rowe plant can be assessed by the EFW flow indication, steam generator wide-range level indication, and system valve position indication. Each of the four EFW flow paths (one for each steam generator) has separate flow indication. The flowmeters receive electrical power from a battery-backed, vital ac bus. A continuous display of flow rate is available on the main control board as well as locally.

The implemented flow indicating systems have provisions for periodic testing and local fault alarm signaling. Surveillance testing will be

performed monthly. The Licensee has stated in Reference 8 that the implementation and purchase of this equipment was part of the plant's quality assurance program.

The environmental qualification of safety-related electrical and mechanical equipment including EFW system circuits and components is being reviewed separately by the NRC and is not within the scope of this review.

3.2.2 Conclusion

It is concluded that the sensors, transmitters, indicators, and recorders of the Yankee Rowe EFW flow measurement system comply with the requirements of Section 2.1.7.b of NUREG-0578 and the subsequent clarification issued by the NRC.

3.3 DESCRIPTION OF STEAM GENERATOR LEVEL INDICATION

Each of the four steam generators is equipped with two narrow-range and one wide-range level indicating devices. The first narrow-range channel is a safety-grade electronic system with indicators mounted on the inside as well as the front panel of the main control board. This channel is powered from the vital bus and provides digital input to the reactor protection system through bistables. The other narrow-range channel as well as the wide range channel are electro-pneumatic, using transmitters powered from emergency bus number 1 through a transformer, to measure level in the steam generator and send an electrical signal to electrical recorders in the switchgear room. These signals are connected to a two-pen recorder where they provide uncompensated indication and are retransmitted as a pneumatic signal. Both pneumatic signals are then pressure compensated and provide level indication on the feedwater flow rack on the mezzanine of the turbine room. In addition, the narrow-range and wide-range pneumatic channels provide indication on the main control board via a recorder and indicator, respectively.

4. CONCLUSIONS

It is concluded that the sensors, transmitters, indicators, and recorders of the Yankee Rowe EFW flow measurement system comply with the requirements of Section 2.1.7.b of NUREG-0578 and the subsequent clarification issued by the NRC.

5. REFERENCES

1. Code of Federal Regulations, Title 10, Part 50, particularly Appendix A
January 1, 1980

2. NRC
Generic letter to all PWR licensees
Subject: Short-term Requirements Resulting from Three Mile Island Accident
September 13, 1979

3. NRC
"TMI-2 Lessons Learned Task Force Status Report and Short-term Recommendations"
July 1979
NUREG-0578

4. NRC
Generic letter to all PWR licensees
Subject: Clarification of Lessons Learned Short-term Requirements
October 30, 1979

5. NRC
Generic letter to all PWR licensees
Subject: Short-term Requirements Resulting from Three Mile Island Accident
NRC, September 5, 1980

6. NRC
"Clarification of TMI Action Plan Requirements"
November 1980
NURFG-0737

7. D. E. Moody (YAEC)
Letter to D. G. Eisenhut (NRC)
Subject: NRC Requirements for Auxiliary Feedwater Systems
December 21, 1979

8. J. A. Kay (YAEC)
Letter to D. G. Eisenhut (NRC)
Subject: TMI Action Plan Items II.E.1.2 and II.E.4.2
March 31, 1981

9. J. A. Kay (YAEC)
Letter to D. M. Crutchfield (NRC)
Subject: Response to Action Items
June 30, 1981

10. Institute of Electrical and Electronics Engineers, Inc.
"Criteria for Protection Systems for Nuclear Power Generating Stations"
New York, N.Y.: 1971
IEEE Std 279-1971

11. NRC
Standard Review Plan
Section 10.4.9, Rev. 1
NUREG-75/087

12. NRC
"Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," Rev. 2
December 1980
Regulatory Guide 1.97 (Task RS 917-4)