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SYSTEMATIC EVALUATION PROGRAM TOPIC VI-7.A.3, ECCS ACTUATION SYSTEM, PALISADES NUCLEAR POWER PLANT

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SYSTEMATIC EVALUATION PROGRAM

TOPIC VI-7.A.3
ECCS ACTUATION SYSTEM

PALISADES NUCLEAR POWER PLANT

Docket No. 50-255

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ABSTRACT

This SEP technical evaluation, for the Palisades Nuclear Power Plant, reviews the scope and frequency of periodic testing of the emergency core cooling system and compares the required testing against current licensing criteria.

FOREWORD

This report is supplied as part of the "Electrical, Instrumentation, and Control Systems Support for the Systematic Evaluation Program (II)" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing by EG&G Idaho, Inc., Reliability & Statisitics Branch.

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1.0 INTRODUCTION

The objective of this review is to determine if all Emergency Core Cooling System (ECCS) components, including pumps and valves, are included in component and system tests, if the scope and frequency of periodic testing are identified, and if the test program meets current licensing criteria. The systems included in the ECCS are the Safety Injection System and the Safety Injection Recirculation Actuation System.[1]

2.0 CRITERIA

General Design Criterion 37 (GDC 37), "Testing of Emergency Core Cooling Systems," requires that:

> The ECCS be designed to permit appropriate periodic pressure and functional testing to assure the operability of the system as a whole and to verify, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.[2]

Branch Technical Position ICSB 25, "Guidance for the Interpretation of GDC 37 for Testing the Operability of the Emergency Core Cooling System as a Whole," states that:

> All ECCS pumps should be included in the system test.[3]

Regulatory Guide 1.22, "Periodic Testing of the Protection System Actuation Functions," states, in Section D.1.a, that:

> The periodic tests should duplicate, as closely as practicable, the performance that is required of the actuation devices in the event of an accident.[4]

Standard Review Plan, Section 7.3, Appendix A, "Use of IEEE Standard 279 in the Review of the ESFAS and Instrumentation and Controls of Essential Auxiliary Supporting Systems," states, in Section 11.b, that:

> Periodic testing should duplicate, as closely as practical, the integrated performance from the ESFAS systems and their essential auxiliary supporting systems. If such a "system level" test can be performed only during shutdown, the testing done during power operation must be reviewed in detail. Check that "overlapping" tests do, in fact, overlap from one test segment to another. For example, closing a circuit

breaker with the manual breaker control switch may not be adequate to test the ability of the ESFAS to close the breaker.[5]

Regulatory Guide 1.22 states, in Section D.4, that:

Where actuated equipment is not tested during reactor operation, it should be shown that:

1. There is no practical system design that would permit operation of the actuated equipment without adversely affecting the safety or operability of the plant.

2. The probability that the protection system will fail to initiate the operation of the actuated equipment is, and can be maintained, acceptably low without testing the actuated equipment during reactor operation.

3. The actuated equipment can be routinely tested when the reactor is shut down.[4]

3.0 SAFETY INJECTION SYSTEM

3.1 Description. The Safety Injection System was originally designed to prevent fuel and cladding damage that could interfere with adequate emergency core cooling and to limit the cladding-water reaction to less than approximately one percent for all break sizes in the primary system piping, up to and including the double-ended rupture of the largest primary coolant pipe, for any break location, and for the applicable break time. The Safety Injection System when actuated, causes a rapid injection of large quantities of borated water into the primary coolant system, providing rapid cooldown and the added shutdown capability needed when a rupture of a main steam line occurs. The system also provides the function of removing heat from the primary coolant system for normal reactor cooldown and maintaining a suitable temperature for refueling and maintenance. The Safety Injection System consists of (a) Safety Injection and Refueling Water Tank; (b) Low-Pressure Safety Injection Pumps; (c) High-Pressure Safety Injection Pumps; and (d) Safety Injection Tanks. These components are described as follows.

(a) The Safety Injection and Refueling Water Tank. The Safety Injection and Refueling Water Tank contains approximately 250,000 gallons of water containing 1,720 ppm boron. This is sufficient boron concentration to provide a 5% shutdown margin with all control rods withdrawn and a new core at a temperature of 60°F. This is sufficient water to fill the refueling cavity. During safety injection with all injection pumps and containment spray pumps running, the tank will provide approximately 20 minutes of water supply before the pump suction must be switched to the containment sump. The tank is equipped with two separate full-capacity screened outlets which are arranged to prevent simultaneous plugging.

(b) Low-Pressure Safety Injection Pumps. The low-pressure safety injection pumps are used to inject large quantities of borated water into the primary coolant system. They are also used to circulate primary coolant during shutdown to remove residual and decay heat. There are two pumps, each of which can circulate sufficient water to keep the temperature rise through the core to less than the full power value with the reactor shut down at the end of core life.

(c) High-Pressure Safety Injection Pumps. Three high-pressure safety injection pumps inject borated water at high pressure into the primary coolant system during emergency conditions. The pumps are sized to ensure that, following the rapid depressurization of the primary coolant system and recovering of the core by the safety injection tanks, one high-pressure pump will keep the core covered with a 25% spillage allowance when the recirculation mode starts.

(d) Safety Injection Tanks. Four safety injection tanks are used to flood the core with borated water following a depressurization of the primary coolant system. The tanks are sized to ensure that three-out-of-four tanks will provide sufficient water to recover the core following a design basis accident.

3.2 Evaluation. Safety injection is automatically initiated upon receipt of a safety injection signal from the Engineered Safety Features (ESF) Systems.*

Since the ESF equipment being initiated varies according to whether power is available from the standby source or the diesel generator, a mode selector switch is provided so that either the normal shutdown or the design base accident portions of the circuit can be tested separately. Individual momentary type pushbuttons are provided to simulate the Safety Injection System in each of the redundant control circuits. The test is in progress only as long as the pushbutton is depressed. Releasing this pushbutton during a test will automatically reset the Safety Injection System or design base accident sequence relays.

Testing in the "without standby power" mode does not initiate bus load shedding with standby voltage available. After a test, the solenoid-operated valves will reset automatically. Other equipment that is initiated will continue until it is shut down manually.

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* Testing of major portions of the ESF control circuits can be accomplished while the plant is at power. More extensive circuit sequence and load testing may be done with the reactor shut down. The test circuits are designed to test the redundant circuits separately so that the correct operation of each circuit may be verified either by equipment operation or by sequence lights. The test circuit design is such that, should an accident occur while testing is in progress, the test will not interfere with initiation of the safeguards equipment required.

The system testing of the safety injection pumps and valves begins when the momentary pushbutton switches are depressed, which simulate the Safety Injection System. An alternate method of beginning the test is to trip the two-out-of-four pressurizer low-pressure devices in the initiating circuit matrix at power or shutdown. The bus shedding and the actual sequence loading of the emergency generators can be tested by simulating the loss of standby power.

The system test is considered satisfactory by the licensee if control board indication and visual observations indicate that all components have received the safety injection signal in the proper sequence and timing i.e., the appropriate pump breakers shall have opened and closed, and all valves shall have completed their travel.

The safety injection pumps are started at intervals not to exceed three months. Alternate manual starting between control room console and the C-33 panel are practiced in the test program. During reactor operation, the instrumentation which is necessary to initiate safety injection is checked daily; the initiating circuits are tested monthly. In addition, the active components (pumps and valves) are tested every three months to check the operation of the starting cirucits and to verify that the pumps are in satisfactory running order. The test interval of three months is based on the judgment of the licensee that more frequent testing would not significantly increase the reliability (i.e., the probability that the component would operate when required), and that more frequent testing would result in increased wear over a long period of time.

The safety injection tanks are a passive safety feature. In accordance with the specifications, the water volume and pressure in the safety injection tanks are checked periodically during operation. Each safety injection tank has two check valves in series between the tank nozzle and the primary coolant system. The pressure control system between the check valves is also used to test the check valves. The check valve nearest the tank may be tested by opening the pressure control valve. As the pressure between the check valves decreases, the valve will open under the influence of tank pressure.

Based on the evaluation of the final safety analysis report,[1] the technical specifications[6] and the existing test procedures for the Safety Injection System, the system testing does conform to the present criteria for reactor licensing.

4.0 SAFETY INJECTION RECIRCULATION ACTUATION SYSTEM.

4.1 Description. The Safety Injection Recirculation Actuation System is designed to automatically transfer the safety injection pump suction from the Safety Injection and Refueling Water tank to the containment sump water supply, establishing a recirculation flow from the containment sump via the high-pressure safety injection pumps.

When a safety injection signal is initiated by the engineered safeguards control system, borated water at a minimum concentration of 1720 ppm boron is initially pumped from the Safety Injection and Refueling Water

tank to the primary coolant system. When the Safety Injection and Refueling Water tank level drops below a preset level, the Safety Injection Recirculation Actuation System is actuated and pumps suction is then automatically transfered to the containment sump. At this time, the flow path from the containment sump is opened, the Safety Injection and Refueling Water tank flow path is closed, the low-pressure safety injection pumps are stopped, and water is recirculated from the sump by the high pressure pumps. Water from the containment sump is also circulated by the containment spray pumps and cooled by the shutdown cooling heat exchangers. A portion of the cooled water may be directed, by operator action, to the suction of the high-pressure safety injection pumps. This will provide cooling water to the core below the saturation conditions existing inside containment.

4.2 Evaluation. Review of the final safety analysis report and the technical specifications of Palisades indicates that no specific requirement for testing of the Safety Injection Recirculation Actuation System is required. With no testing requirements for the Safety Injection Recirculation Actuation System, the system does not meet the current licensing criteria.

5.0 SUMMARY

The review of the referenced material has determined the following in regard to the Palisades Emergency Core Cooling System testing and testability.

(1) The Safety Injection System meets the current criteria for testability during reactor operation.

(2) The Safety Injection Recirculation Actuation System does not meet the current criteria for testability during reactor opertation.

6.0 REFERENCES

1. Consumer Power Company, Palisades Final Safety Analysis Report (22 Jan 1974, Amendment No. 28).

2. General Design Criterion 37, "Testing of Emergency Core Cooling System," of Appendix A, "General Design Criteria for Nuclear Power Plants," 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

3. Branch Technical Position ICSB 25, "Guidance for the Interpretation of GDC 37 for Testing the Operability of the Emergency Core Cooling System as a Whole."

4. Regulatory Guide 1.22, "Periodic Testing of the Protection System Actuation Functions."

5. Nuclear Regulatory Commission Standard Review Plan, Section 7.3, Appendix A, "Use of IEEE Standard 279 in the Review of the ESFAS and Instrumentation and Controls of Essential Auxiliary Supporting Systems."

6. Consumer Power Company, Palisades Technical Specifications (June 20, 1978, Amendment No. 41).