



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 107 TO FACILITY OPERATING LICENSE NO. NPF-58

FIRSTENERGY NUCLEAR OPERATING COMPANY

PERRY NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-440

1.0 INTRODUCTION

By letter dated October 22, 1997, Centerior Energy (now FirstEnergy Nuclear Operating Company, the licensee) requested an amendment to Operating License No. NPF-58 for the Perry Nuclear Power Plant. Pursuant to 10 CFR 50.59 and 10 CFR 50.90, the licensee requested a change to the plant that would incorporate temperature control valves and bypass lines around the emergency closed cooling (ECC) system heat exchangers. The licensee states that the changes are designed to ensure operability of the control complex chilled water system under post-accident load conditions without needing compensatory measures.

The change was submitted as a result of a revised 10 CFR 50.59 evaluation which determined that the addition of the temperature control valves in the ECC system has resulted in a small increase in the "probability of occurrence...of a... malfunction of equipment important to safety previously evaluated in the safety analysis report."

2.0 BACKGROUND

The ECC system is a closed system that provides a safety-related source of cooling water for the emergency core cooling systems and their supporting components (e.g., residual heat removal (RHR) pump seals, RHR room coolers, and low pressure core spray room cooler), control complex chillers, reactor core isolation cooling room cooler, and post accident hydrogen analyzers for certain modes of normal operations, as well as during and following an accident and when a loss of normal auxiliary power occurs. The system's primary safety function is to support the emergency core cooling system and other safety-related equipment following an accident. During normal operation the cooling function of the chillers is from the normal closed cooling system and is automatically transferred to the ECC system following a loss-of-coolant accident or upon loss of offsite power.

The ECC system is comprised of two separate, redundant loops. Each loop consists of one pump, heat exchanger, surge tank, and associated piping and instrumentation. The ECC heat exchangers are cooled by the emergency service water (ESW) system, which uses water from Lake Erie as the ultimate heat sink. Downstream of the heat exchangers are the control complex chillers and other loads.

Licensee Event Report 94-005-001, dated October 28, 1994, reported that under winter conditions (ESW system temperature below 55 °F) with no or minimal heat loads, the ECC cooling water could overcool the control complex chillers below the minimum design temperature of 55 °F. The original design of the ECC system included a throttle valve on the outlet side of the control complex chiller. The licensee found that the throttle valve could not maintain the design temperatures during all conditions. To address the potential for overcooling, the licensee installed a bypass line around each of the ECC heat exchangers. In Inspection Report 50-440/97002, the NRC issued a notice of violation due to inadequate support for the 10 CFR 50.59 evaluation conclusion that the probability of malfunction was not increased or that the potential for a different malfunction was not introduced. The licensee revised its 10 CFR 50.59 evaluation and provided the October 22, 1997, submittal for NRC review and approval.

3.0 EVALUATION

The modification increases the overall reliability of the ECC by stabilizing the supply temperature and flow rate to the ECC components. The design change includes a separate bypass line around each ECC system heat exchanger. Each bypass line uses a three-way electro-hydraulic modulating temperature control valve that can distribute flow between the heat exchanger and the bypass line depending on the ECC heat exchanger outlet water temperature. Flow is controlled through the ECC heat exchangers using three-way temperature control valves installed on the inlet side of the heat exchangers. The temperature control valve will modulate the ECC system cooling water using the exit temperature of the heat exchanger. The temperature is alarmed in the control room.

The licensee performed an analysis of the modification to ensure compliance with the original design basis of the ECC system. The licensee's analysis included the following aspects.

Mechanical System Analysis

The ECC system is designed to satisfy General Design Criteria 2, 4, 5, 44, 45, and 46, in addition to Regulatory Guide (RG) 1.29, Positions C.1 and C.2. The licensee states that the system is designed as Safety Class 3 and Seismic Category 1. All pumps, piping, valves and the surge tank meet ASME Boiler and Pressure Vessel Code Section III-3, Nuclear Power Plant Components. Electrical redundancy is provided in the electrical power supply and equipment in the same manner as for the emergency core cooling system. It is designed such that the occurrence of any single active or passive failure would not contribute to the inability of the ECC system to perform its intended safety function. In the submittal, the licensee states that the modification was installed in compliance with the original design basis and has no effect on the analysis, qualifications, procedures and instruction evaluated or implied previously in the Updated Safety Analysis Report (USAR).

Electrical System Analysis

The licensee verified that the additional temperature control valves would not adversely impact electrical loading. The licensee's evaluation concluded that the system short circuit and system

voltage analysis are not adversely affected, that the safety related buses can accept the additional electrical loads imposed by the new valves, and that the emergency diesel generators can accept the additional loading of the temperature control valves.

Fire Protection/Appendix R Safe Shutdown Analysis

The licensee evaluated the temperature control valves and the associated components against the Perry Safe Shutdown Capability Report for Appendix R/Fire Protection purposes as described in Section 9A of the Perry USAR. The licensee examined the impact of the modification on control room fires, the addition of combustibles in the fire area, separation of new conduits, and automatic fire detection and suppression in the area. The licensee concluded that the modification will not adversely impact the fire protection/Appendix R safe shutdown analysis.

Probabilistic Safety Assessment

The licensee performed an evaluation of the impact of this modification on the Perry Probabilistic Safety Assessment with respect to core damage due to failure of a temperature control valve. The licensee concluded that the addition of a bypass line around the ECC heat exchangers and the addition of the temperature control valves have a negligible impact upon the core damage frequency.

Post Modification Testing

The modification is designed to maintain the ECC temperature at the inlet to the control complex chillers above 55 °F during normal and accident conditions during all seasons. The most limiting configuration is during winter operation with minimal heat loads. Post modification infrared thermography testing revealed that under low or no heat load conditions at low ESW temperatures, heat loss from the ECC system still occurred at a low rate. This occurs due to flow currents from the bypass piping adjacent to the heat exchanger discharge nozzle which allows the exchange of the colder water from the heat exchanger with the warmer ECC system water. Unattended, this may cause the design temperature of the ECC system to drift below 55 °F. The licensee will maintain temperatures through administrative and procedural controls of the ESW system during periods when ESW temperatures are below 55 °F and there are little or no ECC system heat loads. The minimum ESW flow needed to remove accident heat loads will be maintained at all times.

The licensee performed the following failure modes and effects analysis to determine the potential failure mechanisms and the overall associated effects.

Common Mode Failure

The modification has been designed in accordance with the original ECC system design criteria. The licensee has concluded that on the basis of the original design specifications and criteria, common mode failure has not been introduced.

Pipe Rupture

As previously described, the piping and associated piping components have been designed, procured, and installed in accordance with the original design specifications of the ECC system. A postulated pipe rupture in the ECC system would result in failure of a single ECC loop. As described in the USAR, the ECC system would still perform its design function via the redundant loop. Therefore, the licensee has concluded that a pipe rupture in ECC piping (including any effects from flooding) would not prevent the ECC system from performing its safety related function.

Position Failure of the Temperature Control Valve

The temperature control valves and associated logic could result in a valve mispositioning such that the valves could fail in full flow bypass of the heat exchanger, full flow through the heat exchanger, or an intermediate flow position.

If the temperature control valve positions itself to direct full flow bypass of the ECC heat exchanger, the result will be that the ECC flow is not cooled by ESW. This failure mode, which would result in undercooling of the ECC water, is similar to the loss of ESW event as described in Section 9.2.1 of the USAR. In the other extreme, if the temperature control valve positions itself to direct full flow through the heat exchanger when the lake temperature is below 55 °F, this could result in overcooling of the ECC water and subsequent loss of a Control Complex Chiller train. Loss of a Control Complex Chiller train has previously been assumed in the present design. Therefore, failure of the temperature control valve to position itself correctly does not introduce failure modes that have not been previously assumed in the USAR.

The addition of the bypass line and the temperature control valves has introduced failure modes which could result in either undercooling or overcooling components served by the ECC. The staff agrees that the modification represents a slight increase in the probability of occurrence of the loss of the heat removal capability of the ECC system due to the addition of safety related active components which must function post accident. However, the staff considers the overall impact to be minimal because (1) a single active or passive failure would only disable a single train of ECC and the redundant system is fully capable of performing the ECC safety function, and (2) the resulting failure of a ECC subsystem has previously been addressed in the USAR. Therefore, based on our review of the licensee's evaluation, we find that the balance of plant aspects of the design change to add bypass lines around the ECC heat exchangers, temperature control elements and valves to modulate the temperature of the control complex chillers in the ECC system, to be acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Ohio State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

This amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 or changes a surveillance requirement. The staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluent that may be released offsite and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that this amendment involves no significant hazards consideration and there has been no public comment on such finding (62 FR 59922). Accordingly, this amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

6.0 CONCLUSION

The staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

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Date: October 29, 1999