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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 74 TO FACILITY OPERATING LICENSE NO. NPF-37, AMENDMENT NO. 74 TO FACILITY OPERATING LICENSE NO. NPF-66, AMENDMENT NO. 66 TO FACILITY OPERATING LICENSE NO. NPF-72, AND AMENDMENT NO. 66 TO FACILITY OPERATING LICENSE NO. NPF-77

COMMONWEALTH EDISON COMPANY

BYRON STATION, UNIT NOS. 1 AND 2

BRAIDWOOD STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-454, STN 50-455, STN 50-456 AND STN 50-457

1.0 INTRODUCTION

By letter dated February 21, 1995, the Commonwealth Edison Company (ComEd or the licensee) requested revisions in Table 2.2-1, Table 3.3-4, Table 4.3-1 and the Bases for Section 2.2 of the Technical Specifications (TS) for the Byron and Braidwood Stations. The proposed amendments would eliminate the use of the reactor coolant resistance temperature detector (RTD) bypass manifold system and replace it with fast response RTDs mounted in thermowells welded directly in the reactor coolant system (RCS) piping. These modifications are planned to be implemented starting with Braidwood, Unit 1, during the refueling outage currently scheduled for September 1995. Similar modifications have been approved for other Westinghouse reactors (e.g., Amendment Nos. 161 and 142 to Facility Operating License Nos. NPF-4 and NPF-7 issued May 15, 1992, for the North Anna Power Station, Units 1 and 2; and Amendment Nos. 84 and 83 to Facility Operating License Nos. DPR-80 and DPR-82 issued October 7, 1993, for the Diablo Canyon Nuclear Power Plant, Units 1 and 2).

2.0 DISCUSSION

Byron and Braidwood have four reactor coolant loops. In the current system design, the RTD bypass manifold system is used to obtain representative hot and cold leg temperatures. Separate bypass manifolds are used for each reactor coolant loop. A representative hot leg temperature is obtained by mixing flow from three scoop connections. These scoops extend into the flow stream (at locations 120 degrees apart in the cross-sectional plane) on each reactor coolant hot leg. Each scoop has five flow holes which sample hot leg flow. The hot leg bypass flow exits to a return line shared with the cold leg manifold flow from the corresponding reactor coolant loop. Flow for the cold leg bypass manifold is obtained downstream of the reactor coolant pump discharge. One connection is considered adequate to obtain a representative cold leg temperature due to the mixing action of the pump. The hot and cold bypass manifold piping join to form a common discharge line. The combined flow discharges to the suction side of the reactor coolant pump. Separate bypass loops are provided for each of the four reactor coolant loops. The individual T-hot and T-cold loop temperature signals are processed to provide input to the reactor protection and control systems. The typical existing RTD bypass manifold system consists of over 400 feet of reactor coolant pressure boundary piping, 52 associated valves, over 150 hangers (including, on the average, 64 snubbers), eight sets of flanges and eight RTD manifolds per unit.

The hot and cold leg RTD manifolds each contain an active RTD and a spare RTD. The RTDs extend directly (without thermowells) into the flow path of the coolant passing through the bypass manifold. This minimizes the response time of the RTDs. The RTD outputs are used to calculate the loop delta T (ΔT) and loop T average (T_{avg}) signals that are utilized by the reactor protection and control systems. The loop ΔT and loop T_{avg} signals are used in the Overtemperature Delta T (OTΔT) and Overpower Delta T (OPΔT) reactor protection signals. In addition, the RTD outputs are used for rod control, turbine runback, pressurizer level and other control systems.

The bypass manifold system was originally developed to resolve concerns with temperature streaming (temperature gradients) within the hot leg primary coolant. The temperature streaming experienced in the hot leg piping was a result of incomplete mixing of the coolant leaving various regions of the reactor core at different temperatures. The bypass manifold system compensates for the temperature streaming by sampling the primary coolant through scoop tubes and mixing the primary coolant within the bypass manifold to develop an average RCS temperature. The bypass manifold system also limits high velocity coolant flow to the RTDs and allows RTD replacement without the need to drain down the reactor coolant system.

Incorporation of the bypass manifold system, however, created its own set of operational problems. The RTD bypass piping system has historically required a significant amount of maintenance. A primary reason for maintenance is valve leakage from valve packing or mechanical joints. Maintenance of the RTD bypass piping has resulted in plant shutdowns at some utilities, including two at Commonwealth Edison's Byron Station, for a combined 31 days of outage time. Additionally, the RTD bypass piping system become traps for radioactive particulates that contribute to high exposure levels during routine maintenance. Contact doses as high as eight rem/hr currently exist on some portions of the system. Radiation exposure is accumulated not only in maintaining the RTD bypass manifold system, but in performing any work near the RTD bypass manifold system. Removal of the RTD bypass manifold system is expected to result in a radiation dose savings of approximately 52 person-rem per refueling cycle per unit. Replacement of the RTD bypass manifold system with the thermowell-mounted fast response RTD system will eliminate forced outages associated with maintenance of the RTD bypass manifold system, resulting in a significant cost savings while maintaining the same required level of plant protection.

The proposed plant modification will remove the RTD bypass piping on all four reactor coolant loops. The existing RTD bypass return line will be cut and capped at the reactor coolant crossover header. In place of the direct immersion single-element RTDs mounted in the manifolds, thermowell-mounted dual element fast response RTDs will be used. A major benefit in using thermowell-mounted RTDs is that a faulty RTD may be replaced without breaching the RCS pressure boundary. The hot leg scoops will be modified to accept new thermowells. The thermowell will be positioned to provide an average temperature reading for each scoop (the thermowell tip will be located at the third flow hole). A hole will be drilled through the end of each hot leg scoop to facilitate flow past the RTD. Water will enter through the existing flow holes, flow past the thermowell-mounted RTD, and exit through the new hole. The current cold leg RTD bypass penetration nozzle will also be modified to accept a thermowell-mounted fast response RTD. The thermowell will extend approximately 3.3" into the flow steam.

The new thermowell-mounted dual element fast response RTDs, manufactured by Weed Instrument Company, Inc. (model N9004E), will be placed in each of the three existing hot leg scoops and in the cold leg penetration of each loop. One element of each RTD will be active; the other will serve as an installed spare. The three hot leg temperature signals will be electronically averaged in the reactor protection system (RPS) to produce a representative hot leg temperature. This will necessitate the addition of a number of new cards to the 7300 Process Protection Cabinets, resulting in the removal of a two-tier card frame and the addition of a three tier card frame for each protection cabinet. The spare RTD element will be wired to the 7300 cabinets to facilitate switching to the spare element at the racks in the event of a failure of the active element. The added 7300 hardware is compatible with the existing 7300 electronic hardware now used.

3.0 EVALUATION

The OTΔT reactor trip function provides primary protection against departure from nucleate boiling (DNB) during postulated transients. The indicated ΔT is used as a measure of reactor power and is compared with a setpoint that is automatically varied depending on T_{avg}, pressurizer pressure, and axial flux difference. If the OTΔT signal exceeds the calculated setpoint in two or more channels, the reactor is tripped.

The OPΔT reactor trip function is designed to protect against a high fuel rod power density and subsequent fuel rod cladding failure and fuel melt. The indicated ΔT is used as a measure of reactor power and is compared with a setpoint that is automatically varied depending on T_{avg}. If the OPΔT signal exceeds the calculated setpoint in two or more channels the reactor is tripped.

The ΔT that is compared to the OTΔT and OPΔT setpoints is calculated from the RTDs which measure the hot and cold leg temperature. The indicated T_{avg}, which is also calculated based on the hot and cold leg temperature measured by the RTDs, is also an input to the OTΔT and OPΔT setpoint equations. Therefore, the response of these trip functions is dependent on the measurement system of the hot and cold leg temperatures.

The RTD response time is incorporated in the safety analyses. In particular, RTD response time is modeled in the OTΔT and OPΔT trip functions. The overall response time modeled in the safety analyses for the existing RTD bypass piping system is 8 seconds. The overall response time is the elapsed time from the time the temperature change in the RCS exceeds the trip setpoint until the rods are free to fall. More specifically, 6 seconds is modeled as a first order lag term and 2 seconds as pure delay on the reactor trip signal. The 6 second lag term includes such factors as: RTD bypass piping fluid transport delay, RTD bypass piping thermal lag, RTD response time, and RTD electronic filtering. The 2 second delay on reactor trip addresses such factors as electronics delay, trip breakers and gripper release. The proposed fast response RTD/thermowell system is also projected to have an overall response time of 8 seconds.

The time distribution for the parameters is different between the two designs. The existing design includes a transport time for RCS fluid to reach the RTD, located in the manifold. However, the new RTDs will be directly immersed into the coolant, providing a fast response. The proposed design no longer has the transport delay. Because the RTDs will be mounted in thermowells, the response time of the RTD/thermowell combination will increase over the existing system. In addition, a T_{hot} average summator card will be added to the 7300 cabinet to electronically average the T_{hot} signals. The change in electronics delay in adding the summator card is insignificant.

As discussed in the licensee's submittal, the RTD response time is calculated to increase from 4.0 seconds with the present system to 4.4 seconds, including a ten percent error allowance to account for loops current step response measurement tolerances.

The licensee and Westinghouse are projecting that the new RTD system may need a filter time constant of up to 2.0 seconds. Signal conditioning (filtering) of the individual loop ΔT and T_{avg} signals is represented by τ_3 and τ_6, respectively, in the OTΔT and OPΔT equations in TS Table 2.2-1. With the current bypass manifold system, the filter is not required since the existing RTDs do not respond rapidly to local temperature variances within the reactor coolant loop. The bypass piping and manifold provide adequate mixing of the coolant, eliminating any local temperature variances. Therefore, the values of τ_3 and τ_6 are currently specified as 0 seconds, effectively turning off the electronic filter. The new fast response RTDs may respond to temperature spikes which are not representative of actual RCS bulk fluid temperature. Signal conditioning may be required to eliminate these temperature spikes. Although the current TSs do not provide any signal conditioning, the 8 second total response time used in safety analyses has sufficient margin to account for a typical 2 second time constant for signal conditioning. In addition, Westinghouse has evaluated the effects of a redistribution of the time responses between the total lag term (currently modeled at 6 seconds) and electronics delay term (currently modeled at 2 seconds). Based on these evaluations, the actual distribution between the total lag and electronics delay terms is inconsequential. As long as the total response time remains ≤8 seconds, the safety analyses acceptance criteria continue to be met. Therefore, the current safety analyses remain bounding.

In summary, the nominal estimated response time parameters for the current bypass system and the proposed RTD/thermowell system are as follows:

	Bypass System	Proposed System
RTD Bypass Piping and Thermal Lag (sec)	2.0	0.0
RTD Response Time (sec)	4.0	4.4
RTD Filter Time Constant (sec)	0.0	2.0
	___	___
Total Lag (sec)	6.0	6.4
Electronics Delay (sec)	0.5	0.5
	___	___
Total Response Time (sec)	6.5	6.9

As shown above, with the proposed modification, actual measured total time response, including measurement uncertainty, is anticipated to be approximately 6.9 seconds, which is less than the 8 seconds used in the safety analysis.

To assess whether the new method of obtaining hot leg temperature yields results consistent with the RTD bypass manifold system, the ΔT readings of each loop will be compared before and after installation of the proposed modification. A comparison of ΔT values (normalized to full power) will be performed. Any unexpected differences or anomalies will be evaluated and addressed. The impact of this new method of obtaining a representative T_{avg} signal is not expected to affect control systems that relay on T_{avg} as an input signal because these control systems receive their inputs after the RCS temperature signal has been processed.

Instrument uncertainty calculations account for drift. The response time of the thermowells/RTDs will be checked using the Loop Current Step Response (LCSR) test prior to plant startup, following the refuel outage. Subsequent testing will be performed each cycle per the TS requirements to verify that RTDs have not drifted unacceptably. As discussed in NUREG-0809 (Safety

Evaluation Report, "Review of Resistance Temperature Time Response Characteristics," August 1981) and in NUREG/CR-5560 ("Aging of Nuclear Plant Temperature Sensors," June 1990), RTD response times have been known to degrade and the LCSR methodology which the licensee plans to use is the recommended onsite method for checking RTD response times.

Based on the above, the staff finds that the RTD response time has been addressed in an acceptable manner and that the licensee has proposed an acceptable program to check for possible degradation of RTD response times. The new method of measuring each hot leg temperature with three thermowell RTDs (one in each scoop) has been evaluated to be at least as accurate as the existing bypass system with three scoops in each hot leg and one RTD measurement. Since the new method uses three RTDs for each hot leg temperature measurement, it is a statistically more accurate temperature measurement than the existing method which uses only on RTD for each hot leg temperature method.

The licensee and Westinghouse reevaluated all of the accident analyses in Chapter 15 of the Updated Final Safety Analysis Report (UFSAR) that might possibly be impacted by a change in the OTΔT and OPΔT response time breakdown. The following events trip on OTΔT:

1. Loss of electrical load/turbine trip (FSAR Sections 15.2.2 and 15.2.3).

2. Uncontrolled rod cluster control assembly (RCCA) bank withdrawal at power (FSAR Section 15.4.2).

3. Chemical Volume Control System (CVCS) malfunction that results in a decrease in the boron concentration in the reactor coolant (FSAR Section 15.4.6).

4. Inadvertent opening of a pressurizer safety or relief valve (FSAR Section 15.6.1).

The following events trip on OPΔT:

1. Steamline break at hot full power for core response.
2. Steamline break superheat analysis.

Based on existing sensitivity studies and evaluations performed for all of the Byron/Braidwood licensing basis events which explicitly rely on the OTΔT and OPΔT reactor trips for protection, it is demonstrated that for a combined RTD response time (lag) and pure delay totalling 8 seconds, regardless of the distribution within the combined total, the DNB ratio safety analysis limits and other applicable safety analysis criteria continues to be met. The evaluations also show that due to the magnitude of the duration of the event, when compared to magnitude of an increase in the time of reactor trip on an OPΔT signal which may occur as a result of the change in the RTD lag and time delay distribution with a total combined time of 8 seconds, the results of the

Steamline Break Outside Containment Superheat analysis applicable to Byron/Braidwood will not be affected by the proposed response time breakdown for this reactor trip function. Hence, the conclusions in the UFSAR and supporting analysis basis documentation remain valid for all events which rely on the OTΔT and OPΔT reactor trips for protection.

4.0 EVALUATION OF TS CHANGES

The licensee has proposed the following changes to the TSs associated with replacement of the present direct immersion single-element RTDs mounted in the four manifolds with thermowell-mounted dual element fast response RTDs:

1) Table 2.2-1, "Reactor Trip System Instrumentation Trip Setpoints"

a. Reference to the RTD manifold will be eliminated in Note 1. Note 1 will be revised to define ΔT as the measured ΔT by RTD Instrumentation.

b. Note 1 also defines τ_3 and τ_6 as the time constants utilized in the lag compensators for the individual loop ΔT and measured T_{avg}, respectively. The time constant on the lag compensator can be adjusted to serve as an electronic filter for signal conditioning. TS Table 2.2-1 currently defines the value of the time constants, τ_3 and τ_6, as 0 seconds which effectively turns off the electronic filter. As discussed previously, signal conditioning (electronic filtering) may be required to eliminate temperature spikes not indicative of actual RCS conditions that may be sensed by fast response RTDs. Therefore, the licensee proposes revising the value of the time constants, τ_3 and τ_6, to be less than or equal to 2 seconds following implementation of the modification. A value of 2 seconds is used, as industry experience has shown that a 2 second filter is adequate in eliminating temperature spikes. The values of τ_3 and τ_6 will be annotated to reflect applicability based on implementation of the modification on the respective units.

c. Note 2 provides the allowable value for the OTΔT trip setpoint. The proposed modification which provides slightly more accurate RTDs, has a minor effect on T_{hot} streaming process measurement accuracy, and modifies the 7300 logic. Thus, the allowable value has been affected. The allowable value following installation of the proposed modification will be 1.33% of ΔT span. The revised value will be annotated to coincide with implementation of the modification on the respective units.

d. Correspondingly, Note 4 provides the allowable value for the OPΔT trip setpoint. The allowable value following installation of the proposed modification will be 3.65% of ΔT span. The revised value will be annotated to coincide with implementation of the modification on the respective units.

2) Bases of Section 2.2, "Limiting Safety System Settings"

The licensee proposes to delete a parenthetical reference to 4 seconds in the bases for the OTΔT which is not applicable after the modification.

3) Table 3.3-4, Engineered Safety Features Actuation System Instrumentation Trip Setpoints

The allowable value for the Low-Low T_{avg} (P-12) engineered safety feature setpoint is affected due to the proposed modification. The new Low-Low T_{avg} allowable value has been calculated to be greater than or equal to 546.9 degrees Fahrenheit. The revised value will be annotated to coincide with implementation of the modification on the respective units.

4) Table 4.3-1, "Reactor Trip System Instrumentation Surveillance Requirements

Note 13 in Table 4.3-1 indicates that the channel calibration for the OTΔT reactor trip system shall include the RTD bypass loops flow rate. The proposed modification places the thermowell-mounted RTDs directly into the flow scoops (hot leg) and penetration (cold leg), eliminating the bypass piping. Therefore, the licensee proposes annotating Note 13, and indicating its applicability dependent on implementation of the modification on the respective units.

We have reviewed the proposed changes to the TSs and have determined that they are acceptable.

5.0 STATE CONCLUSION

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

6.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and change surveillance requirements. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents 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 the amendments involve no significant hazards consideration, and there has been no public comment on such finding (60 FR 35063). Accordingly, the amendments meet 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 the amendments.

7.0 CONCLUSION

The Commission 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 the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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