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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO AMENDMENT NO. 57 TO FACILITY OPERATING LICENSE NO. NPF-30

UNION ELECTRIC COMPANY
CALLAWAY PLANT, UNIT 1
DOCKET NO. STN 50-483

1.0 INTRODUCTION

By letter dated April 12, 1990 (Ref. 1), Union Electric Company (UE), the licensee, requested an amendment to Facility Operating License NPF-30 for the Callaway Plant. The proposed system modifications would modify the Technical Specifications (TS) in response to replacement of the current Resistance Temperature Detector (RTD) bypass manifold system with a dual element narrow range thermowell type RTD system. The plant modification addresses reliability drawbacks associated with potential leakage from the bypass manifold piping and associated equipment. Removal of the associated bypass manifold piping decreases potential man-rem exposure during proximity maintenance. Additional information was provided as requested in a letter dated July 9, 1990 (Ref 2).

2.0 BACKGROUND

2.1 Currently Installed System

The current coolant temperature measurement system design measures the primary coolant loop temperature by diverting a portion of the reactor coolant into bypass manifolds. The bypass manifolds utilize direct-immersion RTDs to measure the RCS hot and cold leg coolant temperatures. These measurements are used to calculate the arithmetically averaged reactor coolant temperature, and the loop differential temperature.

The currently installed bypass system is designed to increase accuracy by correcting for temperature streaming effects in the RCS hot legs. Three hot leg sampling scoops at three locations in a pipe cross-section, 120 degrees apart, divert a representative sample of coolant for temperature measurement. Each scoop has five orifices which sample the hot leg flow along the leading edge of the scoop. The cold leg temperature is measured in a similar manner except that no scoops are used, as temperature streaming is not a problem due to the mixing action of the Steam Generators (S/Gs) and the Reactor Coolant Pumps (RCPs). The bypass flows are then routed back to a location downstream of the steam generators via the crossover leg connection.

The existing system consists of approximately 400 feet of RCS Pressure Boundary piping, 64 associated valves, 85 hangers (which include 59 snubbers), 8 sets of flanges and 8 RTD manifolds. Valves facilitate direct replacement of the direct-immersion RTDs without requiring a draindown of the RCS.

The licensee has stated that the current system has been the root cause of plant shutdowns from leakage and flow reductions due to valve problems and that the bypass piping is a significant contributor to man-rem exposure.

2.2 Proposed System

2.2.1 Mechanical Changes

The licensee proposes to remove all the currently installed bypass piping, associated valves, manifolds and hangers. The scoops in the hot legs will be modified to accept RTD thermowells. Holes will be added to each scoop so that the flow from the five inlet holes passes by the new thermowell and then out of the scoop. The thermowell is installed and becomes part of the RCS pressure boundary facilitating RTD replacement without RCS draindown.

The nozzle on the cold leg will be modified to facilitate a single thermowell. As stated above, fluid mixing from the S/Gs and RCPs precludes the use of multiple RTDs for cold leg temperature measurement accuracy.

The 3" nozzle in the crossover leg will no longer be used for bypass loop return flow; therefore a buttweld cap will be installed on this connection.

2.2.2 RTD Design

The licensee will replace the direct-immersion type RTDs with Weed Instrument Co., Inc. dual element RTDs. The licensee has committed to test each RTD element to ensure that the time response of both elements is within the design criteria. The spare element in each RTD assembly will be connected to the 7300 Process Protection System cabinets so that transfer to the spare element can be accomplished from the control room.

2.2.3 Electronic Modifications

Each of the three hot leg RTDs will be connected to an RTD amplifier card. The three amplified signals from the RTDs will then be averaged by the use of Analog-based circuitry to produce one hot leg temperature signal. This signal will replace the hot leg temperature signal in the existing system. The averaged hot leg temperature will then be used with the cold leg temperature to develop loop average and differential temperatures. The added electronic components will be identical to the existing hardware. The second hot leg RTD element in each thermowell is considered an installed spare. The leads from these RTDs will be wired to the Master Test cards in the 7300 cabinets. On failure of the first element, the second element is available.

3.0 EVALUATION

The staff's review of the proposed system is based upon guidance from Sections 7.2 and 7.3 of NUREG-0800 (Ref. 3). The following discussion addresses the licensee's proposed modification confirming the reactor trip system (RTS) and the engineered safety features actuation system (ESFAS) satisfy the requirements of the acceptance criteria and guidelines applicable to the protection system and will perform their intended safety function during all postulated plant conditions for which they are required. Response time and system accuracy is evaluated for impact on current plant accident analyses.

3.1 RTD Response Time

As shown in Table 3.1 below, the response time for overtemperature delta-T for the proposed system has some gains and losses compared to the existing RTD bypass system, but the total response time of the proposed system is improved over the existing system (6.16 sec vs. 7.66 sec).

As shown below, the Technical Specification limit is 6.0 seconds. The testable time delay for the existing system is 5.66 seconds and 5.91 seconds for the proposed system. This makes the proposed testable system response 0.25 seconds longer. However, the licensee states that total time delay of the proposed system is compensated by a reduction in the loop and scoop transient thermal lag response time and a reduction in the electronics time delay, resulting in a lower first order lag for the proposed system vs. the existing system (5.0 seconds vs. 6.0 seconds). The licensee also indicates that the reduction in the electronics time delay occurs because the actual electronics time delay is approximately 0.3 seconds, which is significantly less than the 1.0 second delay claimed in the licensee's submittal. Therefore the total system response time for the proposed system is less than for the existing design (6.16 seconds vs. 7.66 seconds).

The combined first order RTD/thermowell response time of 4.75 seconds tabulated above for the proposed system is conservative as the RTD instrument specification requires that both elements be less than 4.0 seconds and typical results for the same model Weed RTD in CE plant thermowells have demonstrated that response times less than 4.0 seconds are realistic. The licensee has reported that the response times will be checked as part of the reactor trip system instrumentation (Technical Specification Item 7, Table 3.3-2). The surveillance requirements state that response time checks are required at each refueling. NUREG-0809 (Ref. 7) has pointed out that RTD response times have been known to degrade and that the Loop Current Step Response (LCSR) methodology is the recommended on-site method for checking RTD response times. The licensee will verify the response time of the new RTDs using Loop Current Step Response (LCSR) methodology after the RTDs are installed. The response time data provided in the licensee's submittal is acceptable to the staff. The above revisions in the time delays, and the commitment to perform LCSR tests to confirm RTD response time adequacy are acceptable.

Table 3.1

Overtemperature Delta-T Response Time

	EXISTING	PROPOSED	SAFETY ANALYSIS
I. FIRST ORDER LAGS			
a. Direct Immersion Bypass Manifold RTD Response Time	4.0 sec.*	N/A	
b. Combined RTD/Thermowell Response Time	N/A	4.75 sec.*	
c. RTD Bypass Line Fluid Transport Delay and Piping Thermal Lag	2.0 sec.	N/A	
d. Scoop Transport Delay and Thermal Lag	Included in c	0.25 sec.	
SUBTOTAL FIRST ORDER LAGS	6.0 sec.	5.0 sec.	6.0 sec.
II. PURE TIME DELAYS			
a. Electronics	1.50 sec.	1.00 sec.	
b. SSPS	0.01 sec.	0.01 sec.	
c. Reactor Trip Breakers	0.15 sec.	0.15 sec.	
SUBTOTAL PURE DELAYS	1.66 sec.	1.16 sec.	2.0 sec.
TOTAL TESTABLE TIME DELAYS**	5.66 sec.	5.91 sec.	
TOTAL TIME DELAYS	7.66 sec.	6.16 sec.	8.0 sec.

* Includes 10% test allowance for LCSR testing. Existing RTD response time makes use of time margin available in the OTDT analyses.

** Technical Specification limit is 6.0 sec. (excludes transport delays and thermal lags).

3.2 RTD Calibration

A licensee review of Combustion Engineering test data, and the Salem Plant data obtained during its past two refueling cycles indicated that the Weed RTD drift is random (does not consistently trend up or down) and is less than that assumed in the licensee's analyses (±0.4°F per 2 years). In a phone conversation with the staff on September 7, 1990, to discuss RTD calibration as required by the plant Technical Specifications, the licensee committed to replace at least one installed RTD with a newly calibrated RTD on alternating refueling outages prior to performing the cross calibration procedure. The licensee's proposed cross calibration technique to be performed at least once per fuel cycle, when combined with the commitment to install a newly calibrated RTD every other fuel cycle, will confirm that the drift of the RTDs remains random and is within the limits specified in the plant setpoint analyses. This proposed method of calibrating the RTDs is acceptable to the staff.

3.3 RTD Uncertainty

The new method of measuring each hot leg temperature with three thermowell RTDs, used in place of the RTD bypass system with three scoops, has been analyzed to be slightly more accurate than with the RTDs in the existing bypass system. As previously mentioned, the scoops are used to obtain a sampling of the flow (five holes in each scoop) at three 120 degree sectors in each of the hot legs in order to obtain a more accurate hot leg average temperature that accounts for the non-uniform temperature streaming. Formerly the RTD bypass system took the sampled flows from the scoops and made an external RTD temperature measurement in a plenum section. The new method with the RTD bypass system removed will measure the sampled mixed coolant flow with a dual element Weed RTD mounted in a thermowell. The Weed RTD is mounted in a modified scoop such that flow goes past the thermowell.

A model test has been completed and calculations performed to ascertain that an accurate mixed mean temperature will be measured. The model test provided information for the selection of the proper location of the RTD sensor in the scoop for accurate measurement and the expected temperature bias. The licensee has made a commitment to obtain confirmatory information on the mixed mean temperature accuracy. This will be done by comparing pre-installation and post-installation calorimetric data on the RTD temperature measurements in the Callaway plant for matching operating conditions. The licensee will make this data available to the staff (Ref. 2).

The dual element Weed RTD has improved accuracy over the existing RTDs. The total uncertainty is ± 0.7°F. This value includes a drift (for 24 months) of + 0.4°F on top of the normal ± 0.3°F accuracy (includes hysteresis and repeatability). For the hot leg temperature measurement, there is a need to apply a small temperature bias. This temperature bias is based on the model test information which identified a scoop RTD installation location effect for the hot leg temperature measurement.

Because three RTDs are used to measure each hot leg temperature instead of the former single measurement, the error associated with the hot leg measurement is reduced to one over the square root of three compared to a single RTD. The impact of the additional electronics needed for the two additional hot leg RTDs per loop has been evaluated by the licensee to be minimal.

The three RTD signals are averaged to obtain T_{hot} value of the loop. The existing overall channel functional checks and calibration accuracy requirements are to be maintained. The impact of the rack drift has been considered in the evaluation.

There is no change to the cold leg's electronics. Therefore, there is no impact to the cold leg accuracy other than the increase obtained from the more accurate RTD.

The net result of the proposed RTD bypass system modification is a slight improvement in the accuracy of the temperature-related functions over the accuracy now achievable with the existing RTDs in the bypass system. The licensee has reviewed the impact of the proposed modifications against the Callaway setpoint study to verify that the accuracy of the temperature related functions are met. A flow measurement uncertainty analysis, which considered the new RTD temperature measurement system, was presented in Reference 2 and resulted in a calculated value of 2.0 % (2.1% including a 0.1% fouling penalty). Callaway presently assumes a 2.2% error in primary flow determination, which will remain. This allowance continues to be conservative (2.2% vs. 2.1%).

3.4 RTD Failure Detection

The licensee states that the average temperature deviation alarm setpoint is ±3°F. The average temperature valves from the four loops are auctioneered to determine the highest average temperature value. The other three loops are then compared to the highest value to detect failed RTDs in the other loops. The correct criterion is that the average temperature values from the other three loops must not be more than 3F below the highest average temperature. Nevertheless, the intent of the licensee's statement is understood, and is acceptable.

The licensee states that a failed RTD will also be detected by comparing the loop delta-T with the auctioneered high delta-T from the four loops. The auctioneered (high) delta-T deviation alarm currently set at ±7.41% rated thermal power is equivalent to a deviation of ±4.25°F. The delta-T value for each loop is obtained by subtracting the T_{cold} RTD value for the cold leg from the hot leg average temperature. The delta-T value is then compared with the delta-T value from the other loops to obtain the delta-T deviation. The licensee will then examine the RTDs in the affected loop to determine the cause of the alarm. The leads from the defective RTD(s) will then be disconnected at the instrument panel in the control room, and the spare dual element

RTD(s) would be connected to the instrument channel. Upon detection of a defective RTD channel, plant operations will be limited by the applicable TS action item requirements.

3.5 Non-LOCA Accidents

The impact of the RTD bypass elimination for the Callaway plant on FSAR Chapter 15 non-LOCA accidents has been evaluated by the licensee. Since the effect of the temperature response time and accuracy of the new system is not degraded, the former conclusions in the FSAR remain valid.

3.6 LOCA Evaluation

The elimination of the RTD bypass system has been found to not impact the uncertainties associated with RCS temperature and flow measurement. It is concluded, therefore, that the elimination of the RTD bypass piping will not affect the LOCA analyses input and, hence, the results of the analyses remain unaffected. Therefore, the plant design changes due to the RTD bypass elimination are acceptable from a LOCA analysis standpoint without requiring any detailed reanalysis.

3.7 EQUIPMENT QUALIFICATION

The licensee will qualify the equipment for the proposed system according to the guidelines given in IEEE 323-1974 (Ref.4), IEEE 344-1975 (Ref. 5), and NUREG-0588 (Ref. 6) (10 CFR 50.49) to levels that encompass the Callaway Plant requirements. A review of the licensee's submittal finds the instrumentation qualification to be acceptable.

4.0 EVALUATION OF TECHNICAL SPECIFICATIONS

As a result of the modifications associated with the removal of the existing bypass manifold and replacement with the new RTDs, changes to the plant's Technical Specifications were proposed. The following Technical Specifications were examined.

Change 1 — Table 2.2-1, page 2-4, - "Reactor Trip System Instrumentation Trip Setpoints," Item 8 - the Z and S values were changed from 1.46 and 1.8, respectively, to 1.90 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the overall margin remains within the existing margin.

Change 2 — Table 2.2-1, page 2-5, "Reactor Trip System Instrumentation Trip Setpoints," Item 13.a - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

<u>Change 3</u> <u>Table 2.2-1,</u> page 2-5, - "Reactor Trip System Instrumentation Trip Setpoints," - Item 13.a - the allowable value of vessel delta-T was changed from 14.0% rated thermal power (RTP) to 13.9% RTP. This change is a result of configuration changes in the system and changes in the sensor accuracy and bias. The new value is acceptable because the allowable value is reduced to a more conservative value.

<u>Change 4</u> <u>Table 2.2-1,</u> page 2-5(a), "Reactor Trip System Instrumentation Trip Setpoints," Item 13.b - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

<u>Change 5</u> <u>Table 2.2-1,</u> page 2-10. "Reactor Trip System Instrumentation Trip Setpoints," Note 4 - the channel maximum trip setpoint margin was changed from 3.3% of delta-T span to 3.0% of delta-T span as a result of revisions to the overpower delta-T. This change is acceptable because it changes the margin to a more conservative value.

<u>Change 6</u> <u>Table 3.3-4,</u> page 3/4 3-25(a), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.1.a - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

<u>Change 7</u> <u>Table 3.3-4,</u> page 3/4 3-25(a), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.1.a - the allowable value of vessel delta-T was changed from 14.0% rated thermal power (RTP) to 13.9% RTP. This change is a result of configuration changes in the system and changes in the sensor accuracy and bias. The new value is acceptable because the allowable value is reduced to a more conservative value.

<u>Change 8</u> <u>Table 3.3-4,</u> 3/4 3-25(b), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.1.b - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

Change 9 — Table 3.3-4 page 3/4 3-25(b), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.1.b - the allowable value of vessel delta-T was changed from 24.0% rated thermal power (RTP) to 23.9% RTP. This change is a result of configuration changes in the system and changes in the sensor accuracy and bias. The new value is acceptable because the allowable value is reduced to a more conservative value.

Change 10 — Table 3.3-4, page 3/4 3-25(d), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.2.a - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

Change 11 — Table 3.3-4, page 3/4 3-25(d), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.2.a - the allowable value of vessel delta-T was changed from 14.0% rated thermal power (RTP) to 13.9% RTP. This change is a result of configuration changes in the system and changes in the sensor accuracy and bias. The new value is acceptable because the allowable value is reduced to a more conservative value.

Change 12 — Table 3.3-4, page 3/4 3-25(e), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.2.b - the Z and S values were changed from 2.38 and 2.0, respectively, to 2.72 and 1.65. These changes are a result of configuration changes in the system and changes in the sensor accuracy and bias. The new values of Z and S are acceptable because the resulting margin between the total allowance and the expected system errors has been increased.

Change 13 — Table 3.3-4, page 3/4 3-25(e), "Engineered Safety Features Actuation System Instrumentation Trip Setpoints," Item 6.d.2.b - the allowable value of vessel delta-T was changed from 24.0% rated thermal power (RTP) to 23.9% RTP. This change is a result of configuration changes in the system and changes in the sensor accuracy and bias. The new value is acceptable because the allowable value is reduced to a more conservative value.

Change 14 — Table 4.3-1 pages 3/4 3-9 and 3/4 3-12a, "Reactor Trip System Instrumentation Surveillance Requirements," Item 7 and Note 13 - this change deletes references to the RTD bypass flow rate. This is an editorial change to reflect the new system configuration, and is acceptable.

The impact of the RTD elimination for the Callaway plant on FSAR Chapter 15 accidents has been evaluated by the licensee. Sinc the RTD temperature response time and accuracy of the new system is not degraded, the former conclusions in the FSAR remain valid and the Technical Specification changes have been determined to be acceptable as described above.

5.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21, 51.32, and 51.35, an environmental assessment and finding of no significant impact has been prepared and published in the Federal Register on September 12, 1990 (55 FR 37592). Accordingly, based upon the environmenal assessment, the Commission has determined that the issuance of this amendment will not have a significant effect on the quality of the human environment.

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; and (2) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 REFERENCES

1. Letter from D. F. Schnell, Union Electric Company, to USNRC, dated April 12, 1990, "Reactor Coolant System RTD Bypass Elimination."

2. Letter from D. F. Schnell, Union Electric Company, to USNRC, dated July 9, 1990, "Reactor Coolant System RTD Bypass Elimination."

3. NUREG-0800, "Standard Review Plan," Revision 3, February 1984.

4. IEEE 323-1974, "OIEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations," 1974.

5. IEEE 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," 1975.

6. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," July 1981.

7. NUREG-0809, Safety Evaluation Report, "Review of Resistance Temperatur Detector Time Response Characteristics," August 1981.

8.0 ACKNOWLEDGEMENT

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