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Energy Systems

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CAW-91-157

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Attention: Dr. Thomas Murley, Director

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Attachment III-P to ET 91-0073, "Setpoint Calculation For RTD Bypass System Removal"

Dear Dr. Murley:

The proprietary information for which withholding is being requested in the enclosed letter by Wolf Creek Nuclear Operating Corporation is further identified in Affidavit CAW-91-157 signed by the owner of the proprietary information, Westinghouse Electric Corporation. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Wolf Creek Nuclear Operating Corporation.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-91-157, and should be addressed to the undersigned.

Very truly yours,

Stephen R Tritch for

Ronald P. DiPiazza, Manager
Operating Plant Licensing Support

Enclosures

cc: M. P. Siemien, Esq.
Office of the General Counsel, NRC

ATTACHMENT I

SAFETY EVALUATION

Safety Evaluation

Proposed Changes

This proposed license amendment request revises Technical Specification Tables 2.2-1, 4.3-1 and associated Bases to accommodate the replacement of the existing resistance temperature detector (RTD) bypass system with an RTD thermowell system. The plant modification involves removal of the bypass system piping and replacement of the existing RTDs with RTDs inserted in a thermowell installed in the existing scoops. Three dual element RTDs will be used for each hot leg. One dual element RTD will be located in the existing cold leg penetration. The nozzles in the crossover legs for the return lines which will no longer be required will be capped. This modification is desirable in order to increase plant availability and reliability due to the removal of several valves that have been the source of leakage inside containment and to reduce man-rem exposures in keeping with the ALARA program.

Background

As described in the Wolf Creek Generating Station (WCGS) Updated Safety Analysis Report (USAR) Section 5.4.3, Reactor Coolant System (RCS) hot and cold leg temperatures are measured by narrow range, direct immersion RTDs located in bypass manifolds. Through the use of a bypass manifold around each steam generator, hot leg temperatures are obtained by mixing the flow from three scoop connections which extend into the flow stream at locations 120° apart circumferentially. Flow from the cold leg manifold is obtained downstream of the reactor coolant pump. Both hot and cold leg bypass flows enter a common return line to the crossover leg (Figure 2-1 in Attachment II provides a simplified drawing of the RTD bypass system).

As discussed in USAR Section 7.2, the existing RTD temperature outputs are used for a number of purposes. The outputs are used by the Reactor Protection System for the Overtemperature Delta-T (OTDT) and Overpower Delta-T (OPDT) trip functions. These trip functions provide primary protection against departure from nucleate boiling (DNB) and fuel centerline melting (excessive KW/ft) during postulated transients (ANSI N18.2 Condition II events) in Westinghouse reactors. The OTDT and OPDT trip functions are explicitly modeled in the WCGS USAR Chapter 15 accident analyses. However, the OTDT reactor trip function is the primary trip credited, while the OPDT reactor trip function provides backup protection against excessive power.

The Loss of Flow trip function provides protection for DNB due to the loss of RCS flow in one or more primary side loops. This protection is provided by monitoring the differential pressure across the crossover leg of the primary loops. The differential pressure taps and transmitters, which are located downstream of the steam generators, are periodically normalized with a precision RCS flow calorimetric. The precision RCS flow calorimetric determines the flow through each RCS loop. The Loss of Flow trip function is dependent upon the measured temperature since a primary parameter in the determination of RCS flow is the primary side enthalpy rise.

Loop T_{avg} signals are generated from the RTDs and isolated from protection system channels. The loop T_{avg} signals are provided for rod control, pressurizer level control, steam dump control (in the T_{avg} mode), control rod insertion limits, rod stops and turbine runbacks, and certain interlocks. The Engineered Safety Features Actuation System which is designed to prevent overcooling of the RCS also receives loop T_{avg} signals. These signals are used to isolate main feedwater and the steam dumps as appropriate.

Additionally, the removal of the RTD bypass system will effect the response times of the temperature channels since the fluid transport time in the loop is eliminated.

Evaluation

The following USAR Chapter 15 non-LOCA analyses are of interest because the OTDT trip is the primary trip assumed in the analyses:

1. USAR Section 15.2.3, Turbine Trip (specifically the case with pressurizer sprays and power-operated relief valves (PORVs) available with minimum reactivity feedback).

2. USAR Section 15.4.2, Uncontrolled Rod Cluster Control Assembly (RCCA) Bank Withdrawal at Power (specifically the spectrum of cases with low reactivity insertion rates).

3. USAR Section 15.4.3, RCCA Misoperation (specifically the case for a single RCCA withdrawal at power).

4. USAR Section 15.4.6, Chemical and Volume Control System (CVCS) Malfunction that Results in a Decrease in the Boron Concentration of the Reactor Coolant (specifically the case at full power with manual rod control).

5. USAR Section 15.6.1, Inadvertent Opening of a Pressurizer Safety or Relief Valve (safety valve opening is limiting).

6. USAR Section 15.6.3, Steam Generator Tube Failure.

The OTDT and OPDT trips will continue to function in a manner consistent with the existing analyses assumptions for these events. The total response time of the RTD thermowell system is less than that for the RTD bypass system. Further, the removal of the RTD bypass system will not affect the LOCA analyses input and the results of these analyses will be unaffected. Therefore, the plant design changes associated with the removal of the RTD bypass system are acceptable from a LOCA analysis standpoint without requiring any reanalysis.

The following USAR Chapter 15 non-LOCA analyses are of interest because the Loss of Flow trip is the primary trip assumed in the analyses:

1. USAR Section 15.3.1, Partial Loss of Forced Reactor Coolant Flow (loss of two pumps with four pumps in operation).

2. USAR Section 15.3.3, Re ctor Coolant Pump Shaft Seizure (locked rotor, one locked rotor with four loops in operation).

3. USAR Section 15.3.4, Reactor Coolant Pump Shaft Break.

The Loss of Flow trip function will continue to function as previously analyzed for these events. The precision RCS flow calorimetric uncertainty and thus the Loss of Flow reactor trip setpoint uncertainty remain unchanged since the uncertainties for the RTD thermowell system are bounded by the currently assumed uncertainties.

Events initiated by a failure of those control systems that use temperature inputs from the narrow range RTDs (T_{avg}) or could be initiated by a mechanical failure of components affected by the plant modification are:

1. USAR Section 15.4.2, Uncontrolled RCCA Bank withdrawal at Power.

2. USAR Section 15.1.3, Excessive Increase in Secondary Steam Flow.

3. USAR Section 15.1.4, Inadvertent Opening of a Steam Generator Relief of Safety Valve.

4. USAR Section 15.6.5, Small Break Loss of Coolant Accident (SBLOCA).

The functions that utilize temperature input from the existing narrow range bypass RTDs will not be affected by their removal and replacement because the signals derived from the thermowell RTDs will be equivalent to those provided by the bypass RTDs. The Uncontrolled RCCA Bank Withdrawal event is an ANS Condition II (moderate frequency) event potentially initiated by a failure of the rod control system. The Excessive Steam Flow and Inadvertent Steam Generator Depressurization events are also Condition II events. These events are potentially initiated by a failure of the steam dump control system. The input to the rod control system and steam dump control system from the thermowell RTDs will be equivalent to that currently provided by the bypass RTDs. The plant modification will be done in a manner consistent with the plant design bases. As such there will be no degradation in the performance of or increase in the number of challenges to equipment assumed to function during an accident situation. Furthermore, there will be no increase in the probability of failure or degradation in the performance of the systems designed to reduce the number of challenges to equipment assumed to function during an accident situation.

The SBLOCA is an ANS Condition III (infrequent) event. It could be initiated by the highly unlikely ejection of a thermowell or the failure of one of the caps that will cover the existing crossover leg penetrations. The plant modification will preserve the qualification of the RCS pressure boundary. The scoops, crossover leg buttweld caps, and thermowells will be analyzed to the ASME Boiler and Pressure Vessel Code, Section III, Class 1 and installed in accordance with Section XI of this code. Hence, there will be no increase in the probability of occurrence of an accident or malfunction of equipment

important to safety previously evaluated in the USAR. Additionally, approximately 400 feet of small diameter piping and the associated valves will be removed from the primary system pressure boundary, thereby eliminating the possibility of a SBLOCA caused by a failure in this section of piping.

The probability and consequences of flooding and jet impingement have been reviewed. The new thermowells and caps will be located in approximately the same location as the existing bypass penetrations to the RCS. Therefore, the consequences of a postulated flooding or jet impingement are bounded by existing analyses. Because there is an actual reduction in components and welds there is no increase in probability of flooding or jet impingement.

The consequences of a missile due to the postulated ejection of a thermowell have been reviewed to confirm that upon impacting equipment or structures there will be no adverse effects on vital components. It is expected that ejected thermowells will impact floors, walls, pipe supports or other steel structures which will not be affected adversely by impact. This being the case, the consequences of an ejected thermowell will be bounded by the current SBLOCA analyses.

There will be no reduction in the margin of safety, as defined in the Bases of any technical specification, since the current USAR analyses remain bounding. The applicable margins of safety are defined in Bases Sections 2.1.1 and 2.1.2. Bases Section 2.1.1 states that the minimum value of the departure from nucleate boiling ratio (DNBR) during steady state operation, normal operational transients, and anticipated transients corresponds to a 95 percent probability at a 95 percent confidence level that departure from nucleate boiling (DNB) will not occur. The restrictions of this fuel cladding integrity safety limit prevent overheating of the fuel and possible cladding perforation which would result in the release of fission products to the reactor coolant. The minimum DNBR reported in the accident analyses will be unaffected by the plant modification.

Bases Section 2.1.2 states that the fety Limit on maximum RCS pressure protects the integrity of the RCS from overpressurization and thereby prevents the release of radionuclides contained in the reactor coolant from reaching the containment atmosphere. The maximum RCS pressure reported in the accident analyses is unaffected by the plant modification.

The plant modification will not result in a decrease of these margins of safety. As discussed above, the response time and setpoints of the OTDT and OPDT reactor trip functions will remain within the assumptions used in the safety analyses. As such, the analysis of the events which credit these functions will remain as presented in the USAR. Consequently, the margins of safety between the Fuel Cladding Limit (i.e., DNBR) and RCS pressure boundary Safety Limit and the actual failure of these barriers will not be reduced.

The setpoint calculations incorporate an uncertainty to account for the difference between the actual hot leg temperature and the measured hot leg temperature caused by the incomplete mixing of coolant leaving regions of the reactor core at different temperatures. This uncertainty consists of two parts that is discussed further in Section 2.0 of Attachment III.

To determine the impact of the removal of the RTD bypass system on the WCGS temperature-related control and protection functions, Wolf Creek Nuclear Operating Corporation (WCNOC) performed instrument uncertainty calculations. These calculations utilized the latest available information on plant installed instrumentation and the proposed RTD thermowell design as well as previously approved setpoint methodology (revised slightly to reflect the additional RTDs and electronics). The calculation results support the conclusions that the temperature-related protection functions (i.e., OTDT and OPDT trips) will maintain their current technical specification nominal trip setpoints. Changes to the technical specification Z, S, and Allowable Values for OTDT and OPDT will be necessary.

Based on these setpoints studies, the OTDT and OPDT instrument loops see reductions in the theoretical sensor and rack calibration uncertainty for each. These reductions are primarily due to the increase in the number of RTDs and R/E converters used for the measurement of T_H. The uncertainties used for the instrumentation remain specific to the type and manufacturer of the hardware and are not a function of the presence, or absence, of the RTD bypass system. The only uncertainties that change as a direct result of the removal of the RTD bypass system are the T_H streaming values.

Testing of the RTD thermowell design resulted in a small temperature measurement bias. However, net reductions are seen in the instrument uncertainties which offset this bias to the extent that only minor technical specification changes are required.

In conclusion, the replacement of the existing narrow range RTDs and removal of the RTD bypass system does not involve an unreviewed safety question. The possibility for an accident or malfunction of a different type other than any previously evaluated in the USAR is not created. There will be no reduction in the margin of safety as defined in the Bases of any technical specification. The plant modification will increase plant availability and reliability and reduce man-rem exposures.

Therefore, the plant modification and proposed technical specification changes will not adversely affect or endanger the health or safety of the general public.

ATTACHMENT II (NON-PROPRIETARY)

DESCPIPTION OF PROPOSED PLANT MODIFICATION FOR

RTD BYPASS SYSTEM REMOVAL

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NON-PROPRIETARY

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1.0 INTRODUCTION

The existing resistance temperature detector (RTD) bypass system is scheduled to be removed during the 1991 refueling outage scheduled to begin in September 1991. A new narrow range inline thermowell measurement system will be installed during this outage to replace the RTD bypass system. Combustion Engineering (CE) has been selected by Wolf Creek Nuclear Operating Corporation (WCNOC) to perform the detailed engineering and installation of the RTD thermowell system. This report is submitted in support of continued operation of Wolf Creek Creek Generating Station (WCGS) with the installation of the RTD thermowell system.

2.0 BACKGROUND

The current method of measuring the hot and cold leg reactor coolant temperatures uses the RTD bypass system. This system was designed to address temperature streaming in the hot legs and to allow replacement of the direct immersion RTDs without draindown of the Reactor Coolant System (RCS). For increased accuracy in measuring the hot leg temperatures, mixing scoops are located in each hot leg at three locations of a cross section, 120 degrees apart. Each scoop has five orifices which sample the hot leg flow. The flow from the scoops is piped to a manifold where a direct immersion RTD measures the hot leg loop temperature upstream of the steam generator. The cold leg temperature is measured in a similar manner with piping to a separate bypass manifold, except that no scoops are used as temperature streaming is not a problem due to the mixing action of the reactor coolant pump. The RTD bypass system consists of nearly 400 feet of Reactor Coolant Pressure Boundary (RCPB) piping, associated valves, hangers, snubbers, 8 sets of flanges and 8 RTD manifolds. See Figure 2-1 for a simplified drawing of the RTD bypass system. Plant experience has demonstrated two major drawbacks to this design:

Lack of Reliability - Plant startup delays have been required because of leakage. (Other plants have had forced outages due to leakage and flow problems with bypass system valves.)

High Radiation Dose - The RTD bypass system piping is a significant contributor to man-rem exposure because the numerous valves and socket-welded pipes act as crud traps. Man-rem is expended not only in maintaining and inspecting the RTD bypass system but in performing work near the RTD bypass system such as steam generator and reactor coolant pump maintenance.

These problems are not unique to WCGS, but appear to be common to plants with a RTD bypass system. The proposed RTD thermowell system removes the bypass piping and associated problems, while maintaining accurate hot leg temperature determination, a fast response time, and the capability to replace RTDs without draining down the RCS.

3.0 OVERVIEW OF THE PROPOSED RTD THERMOWELL SYSTEM

3.1 Mechanical Changes

The bypass piping, associated valves, and RTD manifolds for the RTD bypass system will be removed.

The three mixing scoops in each hot leg will be retained. [ ]
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[ ] The top of the hot leg mixing scoops will be modified to allow installation of a welded thermowell. The thermowell will become part of the RCPB. The RTD nipple and pigtail assembly screws into the thermowell (three RTDs for each hot leg). The use of thermowells allows RTD replacement without RCS draindown.

The nozzle on the cold leg will be modified to allow welding in a thermowell. The cold leg configuration is simpler because the steam generator and reactor coolant pump provide mixing of the fluid in that piping.

The crossover leg connection, through which the RTD bypass system flow is returned to the main RCS piping, will no longer be required and, therefore, will be capped.

3.2 RTD Design

Weed Instrument Co., Inc. dual element RTDs will be used in the RTD thermowell system. Each RTD element has been shop tested inside a thermowell to ensure that the response time of both elements is within required values. Response time of the RTDs will be verified in the field using Loop Current Step Response (LCSR) methodology. RTD accuracy will be improved over the accuracy of the existing RTDs. The spare RTD element will be wired to the 7300 Process Protection System cabinets (hereinafter referred to as 7300 cabinets) so that switchover to the spare element can be accomplished from the Control Room if necessary.

3.3 Electronic Modification

Each of the three hot leg temperature (T_H) RTDs per loop will be connected to an RTD amplifier (R/E converter or NRA) card and the three signals then averaged to produce one T_H signal which will replace the loop's T_H signal of the RTD bypass system. The added electronics will be identical to the existing 7300 cabinet electronic hardware. Figure 5-1 shows the concept and outlines the added modules required.

3.4 System ccuracy

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CE has installed similar narrow range inline thermowell measurement systems at other facilities including Public Service Electric & Gas Company (PSE&G) Salem Generating Station Unit Nos. 1 and 2. CE has compared the temperature measurement accuracy of the RTD thermowell system with that of the RTD bypass system, using PSE&G post-modification scoop temperature data with CE scoop test results. In addition, PSE&G compared T_H before the modification with T_H after the modification on Salem Units 1 and 2 using 100% power calorimetrics. Agreement was obtained on both units within the accuracy of the data. CE has established the temperature measurement bias as [ ].

By retention of the mixing concept at the hot leg scoops, the sampling performed by the RTD thermowell system and, therefore, the process measurement accuracies will be preserved. A conservative temperature measurement bias of [ ] has been included in the setpoint calculations discussed in Section 7.5 to reflect hot leg streaming effects. The electronic modifications represent an accuracy improvement, due to the use of three hot leg RTDs and their separate RTD amplifier cards, that virtually offsets the effects of the hot leg streaming bias.

The same rack functional checks and calibration accuracy requirements will be maintained. The proposed Weed RTD has an overall sensor accuracy, shown in Table 5-1, which is an improvement over the existing RTDs as discussed in Sections 3.1.1 and 3.1.2 of Attachment III.

3.5 ALARA Benefit

An exposure savings of approximately 60-90 man-rem per refueling outage is projected as a result of this plant modification. This is equivalent to approximately 2000 man-rem dose savings over the remaining life of the plant, assuming a 40-year operating license. The exposure savings identified in the ALARA cost benefit analysis is based upon the reduced radiation levels, reduced maintenance requirements for the RTD bypass system, increased accessibility inside the bioshield, elimination of inservice inspection weld examination interferences, exposure associated with implementing this modification, reduced forced outage potential and increased unit reliability over the life of the plant.

3.6 Insttrumentation Response Times

The Overtemperature Delta-T (OTDT) reactor trip function response time is the time lag from when the hot leg temperature reaches trip conditions at the scoop until the control rods start to drop into the core. The technical specification response time includes only that portion which can be tested. The testable response time of the RTD thermowell system, provided in Table 7-1, is less than six seconds. The RTD thermowell system total response time

is reduced from that of the RTD bypass system through the reduction of loop travel and thermal lag time from the scoop inlet ports to the RTD. Since the response time of the RTD thermowell system is less than the technical specification requirement, no technical specification changes to response time are necessary. The response time used in the safety analyses is eight seconds and, therefore, will also remain unchanged.[1]

4.0 DESCRIPTION OF MECHANICAL MODIFICATIONS

4.1 Hot Leg

The hot leg has three nozzles, 120° apart, around its circumference. The nozzles extend into the pipe to form mixing scoops to sample RCS flow. The scoops will be retained in the RTD thermowell system and will collect a flow sample in a manner equivalent to the present configuration. A thermowell will be installed inside each scoop with the Weed RTD inserted in the thermowell. The scoops will be modified so that the flow goes past the thermowell (Figure 4-1).

Since the existing mixing scoops are being retained, the method of sampling the stratified flow in the hot legs will remain unchanged. [ ]
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1. USAR Table 15.0-4, "Trip Points and Time Delays to Trip Assumed in Accident Analyses"

The portion of overall response time attributable to the flow through the scoop is 0.25 seconds or less. This value includes fluid transit and heat capacity effects and was conservatively estimated using:

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4.2 Cold Leg

The cold leg has a single nozzle without a flow mixing scoop. The nozzle is a 2" IPS socket-weld nozzle. The cold leg thermowell will be installed directly into the nozzle (Figure 4-2). As is the case with the RTD bypass system, no flow mixing will be necessary because the reactor coolant pumps will provide mixing of the flow after it exits the steam generator.

4.3 Crossover Leg

The return for the RTD bypass system loops is a 3" nozzle in the crossover leg. This connection will no longer be used. A 3" schedule 160 buttweld cap will be installed on this connection (Figure 4-3).

4.4 Inspection, Welding and Hydrostatic Test Requirements

4.4.1 Hot Leg and Cold Leg Thermowells

The following requirements are applicable to the 12 hot leg thermowells and 4 cold leg thermowells:

1. Liquid penetrant inspect all accessible field machined surfaces in accordance with the 1980 Edition through Winter 1981 Addendum of Section XI of the ASME Boiler and Pressure Vessel (B&PV) Code.

2. Welding to be in accordance with the 1980 Edition through Winter 1981 Addendum of Section XI of the ASME B&PV Code. (Root Pass-GTAA, Fill-GTAA or GTAW)

3. Liquid penetrant inspect the root weld pass in accordance with the 1980 Edition through Winter 1981 Addendum of Section XI of the ASME B&PV Code.

4. Liquid penetrant inspect final weld pass in accordance with the 1980 Edition through Winter 1981 Addendum of Section XI of the ASME B&PV Code.

5. Weld material to be supplied in accordance with ASME Section II with additional requirements of ASME Section III NB-2400 (1974 Edition through Summer 1975 Addenda).

4.4.2 Crossover Leg Piping

The following inspection and welding requirements are applicable to capping of the 3" crossover piping at four locations in addition to the five requirements noted in Section 4.4.1:

1. Radiographically inspect the completed weld in accordance with the 1980 Edition through Winter 1981 Addendum of Section XI of the ASME B&PV Code.

2. An open butt weld configuration will be used with argon as purge gas.

4.4.3 Hydrostatic Test Requirements

Hydrostatic testing of all nozzles will be performed during inservice testing in accordance with the 1980 Edition through Winter 1981 Addendum of the ASME Section XI IWB 5000.

4.5 Analysis of RCS Penetrations

The thermowells are pressure boundary parts which completely enclose the RTD. The thermowells will be machined from a solid bar of SB-166, a nickel-chromium-iron alloy and will be hydrostatically tested in the shop to 1.25 times the RCS design pressure. The external design pressure and design temperature will be the RCS design pressure and temperature. The RTD, therefore, will not be part of the RCPB.

For both the hot leg and cold leg, the nozzle, thermowell, and the entire thermowell/nozzle assembly will each be analyzed to the ASME B&PV Code, Section III, Class 1. The analysis of the entire assembly will consider the weight of the RTD, the connectors as applicable, and an assumed length of cabling. The effect of seismic and flow-induced loads will also be considered. Seismic response spectra enveloping WCGS will be used. Flow-induced vibration will also be evaluated. This stress analysis will be completed by April 1, 1991; however, based on CE's past experience, Code allowables will be satisfied. The crossover leg connection will be analyzed to the same requirements as the hot and cold leg connections. Since the connection will be capped and have no piping loads, stress levels will be lower than what exists in the RTD bypass system.

4.6 Debris Control During Modification

Control of metal chips and fragments will be as follows:

Hot Leg Scoop Modifications: (12 locations).

The hot leg scoop piping and machine modifications of the hot leg scoops will be completed with the RCS hot leg drained. A mechanical plug will be

installed in the scoop after the piping is removed and prior to any machining which would develop metal chips or fragments. Any chips or fragments will be removed by vacuum prior to removal of the mechanical plug. The outlet ports in the scoops will be made using the Electrical Discharge Machining (EDM) process.

EDM is a process that utilizes electrical discharges, or sparks, to machine metal. The surface being machined is bombarded with high intensity electrical energy pulses that gradually melt away the stock until the desired configuration is obtained.

A high energy spark, through vaporization, melting and an explosive effect, dislodges a minute particle of metal from the workpiece, leaving a small crater. The dislodged particle is then solidified and washed away by the dielectric fluid.

The Freeze Seal Option is not being considered at WCGS.

Cold Leg Nozzle: (4 locations)

The cold leg nozzle will be cut-off after draindown of the RCS. A barrier will be installed prior to cut-off to catch chips or fragments which will then be removed by vacuum. There will also be a barrier in place during weld preparation machining of the nozzle.

Crossover Leg Nozzle: (4 locations)

The primary system will be drained prior to any cutting operation on the crossover leg nozzle. The cutting operation will be performed in a manner to minimize the development of metal chips and fragments. A mechanical plug will be installed prior to machining of the weld preparation and the nozzle vacuum cleaned prior to cap installation.

5.0 DESCRIPTION OF ELECTRICAL/INSTRUMENTATION MODIFICATIONS

5.1 Hot Leg Temperature Averaging

5.1.1 RTD Bypass System

The reactor coolant from the three scoops for each loop is mixed together before being directed to the T_H RTD bypass manifold. At the manifold, a single RTD is used to measure the temperature. The resistance across this RTD is connected to a resistance bridge. The resultant differential voltage is amplified to provide an amplified voltage output (R/E) before being combined with the T_C signal to generate the loop's Delta-T and T_{avg} signals used by the 7300 cabinets.

5.1.2 RTD Thermowell System

The RTD thermowell system will locate a dual element RTD in the thermowell in each of the three scoops. Averaging of the RTDs at the three locations will

be done electronically. Figure 5-1 provides a simplified schematic of the RTD averaging circuitry. The resistance across one RTD element at each location will be connected to its respective RTD amplifier. The amplified signal from the three RTD amplifiers will be averaged together to generate a single T_H signal for that loop, T_{Havg} which along with the T_C signal is then used to generate the loop's Delta-T and T_{avg} signal.

The second RTD element at each location is considered an installed spare. This element will be connected to the Master Test (NMT) cards in the 7300 cabinets, but not normally connected to the RTD amplifier cards. On failure ofthe first element, the second element is available. (Section 5.6 addresses the detection of a failed RTD)

The existing RTD amplifier cards (R/E converter or NRA) are designed to accept 3 wires. The 4th RTD lead wires are connected to the NMT cards in the 7300 cabinets.

5.2 Cold Leg Temperature Monitoring

The impact on the T_C portion of the system is limited to:

1. Relocation of the RTD from the bypass manifold into a thermowell directly in the RCS cold leg piping.

2. Use of one dual element RTD instead of two single element RTDs. As with the hot leg RTDs, both elements will be wired to the 7300 cabinets but only one element will input into the RTD amplifier cards.

As discussed above, the reactor coolant is mixed by the reactor coolant pump before reaching the cold leg. No mixing scoop is required. The intended location of the cold leg RTD/thermowell is the nozzle used as a tap-off point for the existing cold leg RTD bypass line.

5.3 Weed RTD

Dual element RTDs have been supplied and are in use at other operating plants including the Callaway Plant and Salem Units 1 and 2. The RTDs are provided with resistance vs. temperature calibration curves which are accurate to a specification of $\pm 0.3^{O}F$. The RTD drift is specified to be within $\pm 1^{O}F$ over a five (5) year period. Table 5-1 below is based on the drift term being linear with respect to time.

TABLE 5-1

WEED RTD ACCURACY*

ACCURACY (Includes hysteresis and repeatability)	$\pm 0.3^{O}F$
DRIFT (@ 24 months)	$\pm 0.4^{O}F$
TOTAL UNCERTAINTY	$\pm 0.7^{O}F$

* The more conservative RdF values were retained in the new WCGS setpoint calculations in Attachment III.

The Weed RTD initial shop calibration is performed by immersion in ice and oil baths whose temperature is monitored by a standard RTD calibrated to National Bureau of Standards standards. The RTD/Thermowell response time is measured by plunge method by causing step change from ambient room temperature to elevated temperature. All RTDs must meet a specified response time requirement.

The dual element design provides an installed spare connected to the 7300 cabinets for use when primary element failure is detected. For this reason, both elements of each RTD will be tested by Loop Current Step Response (LCSR) for in-situ response times on a refueling outage interval in accordance with Technical Specification Surveillance Requirement 4.3.2.1.

The contact between the RTD and thermowell is a critical item in maintaining the response time. [ ]
[ ]
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[ ] The above provides high assurance of consistent response time.

5.4 In-situ Testing

The Weed RTD is capable of being tested by the in-situ LCSR method. A continuous current of 20-40 mA will not damage the RTD.

5.5 Equipment Qualification

The Weed model N9004 RTD is qualified to IEEE 323-1974[2], IEEE 344-1975[3] and 10 CFR 50.49[4] to levels which envelope WCGS requirements, as specified in the Updated Safety Analysis Report (USAR) Sections 3.7(N), 3.9(N), and 3.11(B). Based on an RTD service temperature of 135^{o}F at the epoxy-sealed RTD lead wire transition, to be established by shop testing with consideration given to process fluid heat rise effects, a qualified life of 40 years has been established.

The 4-wire dual element Weed RTD to be used in this modification is qualified by similarity to the combined features of two of eight RTD test specimens in Southwest Research Institute Report #06-8680-003. One of these two, a fast response dual element 3-wire RTD/thermowell assembly, also featured a sealed NEMA-4 head. The other specimen taken credit for is a direct immersion RTD assembly with Swagelok fittings and stainless steel flexible tubing, seal welded or brazed to the fittings. WCGS will use a 4-wire, fast response dual element RTD/thermowell assembly (no head) with the required fittings and sealed flexible tubing necessary to mate up with the quick disconnect

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

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

4. 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants"

assemblies discussed below. The 4-wire leads are made of the same insulation and jacket as that tested. The test RTDs were calibrated after the LOCA simulation and demonstrated only a $\pm 0.1^{o}F$ change from the baseline calibration data. See Figures 5-2 and 5-3 for a schematic of the RTD assembly.

Containment Penetration Module Assemblies:

The Bunker Ramo 85#16 AWG and 20#16 AWG penetration modules with shielded twisted quad pigtail assemblies are qualified for WCGS applications, including IEEE 317-1976[5] and IEEE 323-1974. Wyle Labs Test report #17040-1 documents the qualification tests performed on two spare penetration module/pigtail assemblies obtained from Callaway which are the same as those used at WCGS.

RTD Quick Disconnect Assemblies:

The Patel/EGS Quick Disconnect assemblies are supplied by Weed as part of the RTD assembly. One connector half will be connected approximately 5 feet from the RTD and be made an integral part of the RTD assembly. The other connector half will be provided with a 25 foot pigtail having a qualified Patel/EGS conduit seal with #20 AWG wires for splicing to field cable. The assembly also provides an environmental seal for protecting the RTD lead wires from harsh environments during accident conditions.

The Patel/EGS assemblies are qualified to IEEE 323-1974 and IEEE 344-1975. The qualification levels exceed WCGS requirements. Two of the connector assembly test specimens included Weed #20 AWG leads and used the Weed potting procedure.

Sealed Flexible Tubing:

A sealed stainless steel flexible tubing will be installed between the RTD Quick Disconnect Assembly and the existing Junction Box. The 3/4" stainless steel flexible tubing is qualified to IEEE 344-1975. The qualification levels exceed WCGS requirements.

Field Cables:

The new field cable to be used for this modification is Rockbestos 32/C, 8 shielded twisted quads, #16 AWG tinned copper, insulated and jacketed with flame retardant cross-linked polyethylene (FR-XLPE). Each quad is twisted with a #18 AWG drain wire in contact with an aluminum/mylar shield. This cable will be qualified to IEEE 323-1974 and IEEE 383-1974[6] plant requirements.

Junction Boxes and Splices:

Current plans call for existing junction boxes to be used to house the splices between the extension leads from the quick disconnect assemblies and the field cable. These junction boxes are NEMA 3R, Hoffman terminal boxes with low

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5. IEEE 317-1976, "Electrical Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations"

6. IEEE 383-1974, "Standard for Type Test of Class 1E Electrical Cables, Field Splices, and Connections for Nuclear Power Generating Stations"

point drain holes. If needed, additional junction boxes of this type will be added. The conductors to be spliced will be joined by either ring tongue terminals bolted together (Wyle Labs Test Report #58722-2) or by Burndy type YSV (or equivalent) butt splices (Wyle Labs Test Report #58442-1) and then sealed with Raychem WCSF-N heat shrink tubing. This splicing methodology is also used at the containment penetration and is qualified to IEEE 323-1974 and IEEE 383-1974 for plant requirements.

Reactor Protection System (RPS) Hardware:

The added test cards (Temperature Channel Test, NTC and Master Test, NMT) RTD amplifier cards (R/E converter or NRA), summing amplifier cards (NSA), and isolator cards (NLP) are identical to the existing 7300 cabinet electronic components.

The electronic module used to derive the loop's average T_H signal (T_{Havg}) from the individual T_H inputs is identical to the existing module to derive the loop's average temperature (T_{avg}) from the T_H and T_C inputs.

The added electronics will be installed in spare card locations in the existing 7300 cabinets. Existing divisional separation will be maintained. All additional mounting hardware will be identical to existing mounting hardware. All new electronics and mounting hardware will be procured through the same source used to supply the present equipment. Cabinet wiring will meet Class 1E requirements.

The 7300 cabinets were qualified per WCAP-8687, "Equipment Qualification Test Report", Report Numbers E13A through E13D, to IEEE 344-1975. The 3-bay test cabinet was loaded with cardframes, power supplies and dummy weights to simulate possible loading extremes that could exist. The dummy weights included an allowance to simulate internal cable weights. Five operating bases earthquakes and four safe shutdown earthquakes were simulated with fully loaded cabinets to g-levels more than 3 times higher than anticipated. The additional mass due to new cards and cables associated with this modification has been determined to be enveloped by this test program. The above ensures that the added electronics will be compatible with existing electronics. It also minimizes the impact on present training and procedures. In addition, all the equipment has been fully qualified and has a demonstrated high reliability.

5.6 Detection of a Failed RTD

A failed RTD would be picked up by the loop Delta-T vs. auctioneered (high) Delta-T deviation alarm currently set at ±7.41% rated thermal power and/or the loop T_{avg} vs. auctioneered (high) T_{avg} deviation alarm currently set at ±3°F. Also, each channel is checked once per 12 hours as required by the technical specifications. On failure of an RTD, the channel would be tripped and the technical specification Action Statement would go in effect. Since the Delta-T protection functions require 2 out of 4 logic, the failed channel would have no impact on the safe operation or shutdown of the plant.

As discussed in Sections 5.1 and 5.2, the second element of each RTD is an "installed spare" which is connected to the Master Test (NMT) cards in the 7300 cabinets. This facilitates changing to the spare element as well as minimizing the time that one channel would have to be tripped.

6.0 ALARA

6.1 Description

This plant modification will involve the removal of the RTD bypass system piping including associated valves, hangers, snubbers and restraints. Following the removal of the piping, existing penetrations into the RCS piping will be modified to allow the installation of the new thermowells.

The major steps involved in the removal of the RTD bypass system piping are:

1. Scaffold platform installation and removal of insulation.

2. Removal of interferences such as hangers, snubbers and restraints.

3. Removal of all RTD bypass piping (excluding the first isolation valves/piping to the RCS).

4. Packaging and preparation for shipment of radioactive waste generated during the removal phase.

5. Drain the RCS and remove the isolati[illegible] ves.

The major steps involved in installation of the hot leg thermowells are:

1. Cut the pipe stubs remaining.

2. Prepare the end of the nozzle for acceptance of the thermowell.

3. Using the EDM tool, bore out the new flow ports.

4. Install thermowells and weld.

The major steps involved in installation of the cold leg thermowells are:

1. Cut the pipe stubs remaining.

2. Prepare the end of the nozzle.

3. Bore out the cold leg nozzle to accommodate the new thermowell.

4. Install thermowells and weld.

The major steps involved at the crossover leg are:

1. Cut the pipe stubs remaining.

2. Prepare the end of the nozzle.

3. Weld on the new caps.

The isolation valves, manifolds, flow orifices and elements associated with the RTD bypass system are the major sources of radiation. It is expected that these components will contribute significantly to the exposures received during the removal phase. The use of temporary shielding and scheduling efforts that support the expedient removal of high radiation sources will be the major ALARA considerations.

The radiation exposure rates at the RCS penetration work areas will be reduced by the removal of the isolation valves and RTD manifolds as well as the installation of temporary shielding on the RCS piping.

6.2 Dose Savings

The arrangement of the RTD bypass system is such that the respective high radiation fields increase the collective exposures for the majority of all inspection or maintenance activities performed inside the bioshield. Although temporary shielding is used to reduce these radiation levels, its effectiveness is limited by the seismic and stress analysis considerations associated with the RTD bypass system. Even with the use of temporary shielding, approximately half of the dose received during steam generator and reactor coolant pump maintenance is attributed to the close proximity of RTD bypass piping. The RTD bypass system has also been identified as a significant exposure contributor with respect to the inservice inspection program. The configuration of the seismic supports for the RTD bypass system manifolds does not allow access to adjacent spuncast weld examination locations on the RCS piping. Significant collective exposures have been projected for the removal and replacement of those seismic supports in support of the inservice inspection program.

The removal of the RTD bypass system is expected to reduce the collective exposure by about 60-90 man-rem each refueling outage. In addition, the potential for forced outages will be reduced due to the avoidance of leaks and equipment failures. The exposure associated with implementing this modification is approximately 50-150 man-rem based on available nuclear industry experience. The overall reduction in collective exposures due to this modification is projected to be about 2000 man-rem over the remaining life of the plant.

6.3 ALARA Methods

This plant modification is being designed, reviewed, and planned in accordance with ALARA procedures. The design process for this modification has incorporated numerous ALARA consideration such as minimizing the introduction of foreign material to the RCS (cobalt reduction program) and the utilization of existing electrical conduits, cabling, or termination boxes whenever practical. The implementation of this modification will incorporate ALARA considerations such as use of temporary shielding and scheduling efforts that support the expedient removal of high radiation sources. The use of respiratory protection equipment will be minimized whenever possible by the use of decontamination and/or engineering controls.

6.4 Radioactive Waste

The radioactive waste generated by this plant modification will consist largely of the removed piping and semi-encapsulated insulation. It is expected that a waste volume of less than 800 ft^3 (including piping, insulation, valves and supports) will result. Disposal of radioactive waste generated during this modification will be in accordance with applicable plant procedures.

7.0 SYSTEM FUNCTIONAL IMPACTS

The narrow range RTD temperature outputs are used for a number of purposes including reactor trips and Engineered Safety Features (ESF) actuation, as well as electrically isolated control systems, alarms, computer inputs and indicators.

7.1 System Accuracy

The effect on accuracy of the RTD thermowell system is insignificant because of the following:

1. Hot leg scoop mixing has been retained as discussed in Section 4.1.

2. The replacement RTD is specified to have an improved accuracy/drift over the existing RTDs. The accuracy of the new RTD is discussed in Section 5.3. Since the new RTDs will not be in contact with the primary fluid and will be provided with a quick disconnect at approximately 5 feet beyond the union along the pigtail, they can be readily removed. Little, if any, decontamination would be required to allow transport to a testing facility to check calibration of the RTDs.

3. Each hot leg RTD will be wired to an RTD amplifier card (R/E converter or NRA) which is then wired with the other hot leg RTDs in that RCS loop to a summing amplifier card (NSA) which averages the three signals to obtain the loop's T_H. By having three parallel path T_H RTDs, R/E converters, and interconnecting wiring, the sensor errors are noticeably reduced while the rack errors are only slightly reduced due to the added NSA card, as discussed in Attachment III.

4. The impact of the T_H electronics (Figure 5-1) has been evaluated as discussed in Section 3.4. The existing technical specification channel functional checks, response time tests, and calibration accuracy requirements will be maintained. The impact of each drift has been considered in the evaluation.

5. There is no change to the cold leg's electronics; and therefore, no impact to the accuracy other than the benefit obtained from a more accurate RTD.

6. These factors virtually offset all of the effects of the hot leg streaming temperature measurement bias.

7.2 Response Time Impact

This plant modification will not impact the technical specification instrumentation response times. This is due to the total testable response time of the RTD thermowell system being shorter than the time specified in the technical specifications as shown in Table 7-1. With the RTD thermowell system, the response time of the RTDs will be determined with the RTDs in the thermowells (using LCSR methodology); therefore, the thermal lag associated with the thermowell will be included in the RTD tested response time. The response time for the RTD thermowell system is 0.75 seconds slower than the existing direct immersion RTD's response time. However, the RCS flow travel time from the inlet port of the scoop to the RTD is reduced from 2.0 seconds to 0.25 seconds with the RTD thermowell system.

OTDT trip response time can be grouped into in two parts. The first part is a first order lag (i.e., thermal lags and RTD response time) and the second part is a pure delay (i.e., electronics delay). Since the existing accident analyses was performed with 6 seconds of first order lags and 2 seconds of pure delays, as shown on Table 7-1, no previous analyses are impacted since the total response time of the RTD thermowell system is faster than the RTD bypass system.

The response times listed in Table 7-1 bound best estimate response times. The allocated time for the RTDs includes a 10% error allowance for LCSR testing.

7.3 Relocation of RTD Instruments

The function of the RTDs in the bypass manifolds is to measure the RCS hot leg and cold leg temperatures. Accordingly, physical relocation of the RTDs into the thermowells mounted directly in the RCS piping is consistent with the function of the RTDs. At the proposed locations, the RTD thermowells will be directly in the RCS flow path and not have to rely on a subsystem.

7.4 Reactor Coolant System Flow

Removal the RTD bypass system will have a very slight increase of approximately 0.1% in the flow through the reactor vessel and steam generator. Although this flow increase theoretically results in better heat removal at the core and better heat transfer at the steam generator, the change is insignificant.

7.5 Setpoint Studies

The effects on setpoint terms Z, S and Allowable Value for the OTDT and OPDT reactor trip functions were assessed using previously approved setpoint methodologies, revised in Attachment III to account for the new hot leg RTDs and added electronics yet maintainingthe basic approach (i.e. square root sum of the squares combination of independent uncertainties). Only minor changes to the technical specifications are needed to account for a worst case bounding value for the hot leg streaming temperature measurement bias, discussed in Section 3.4.

TABLE 7-1

SYSTEM RESPONSE TIMES

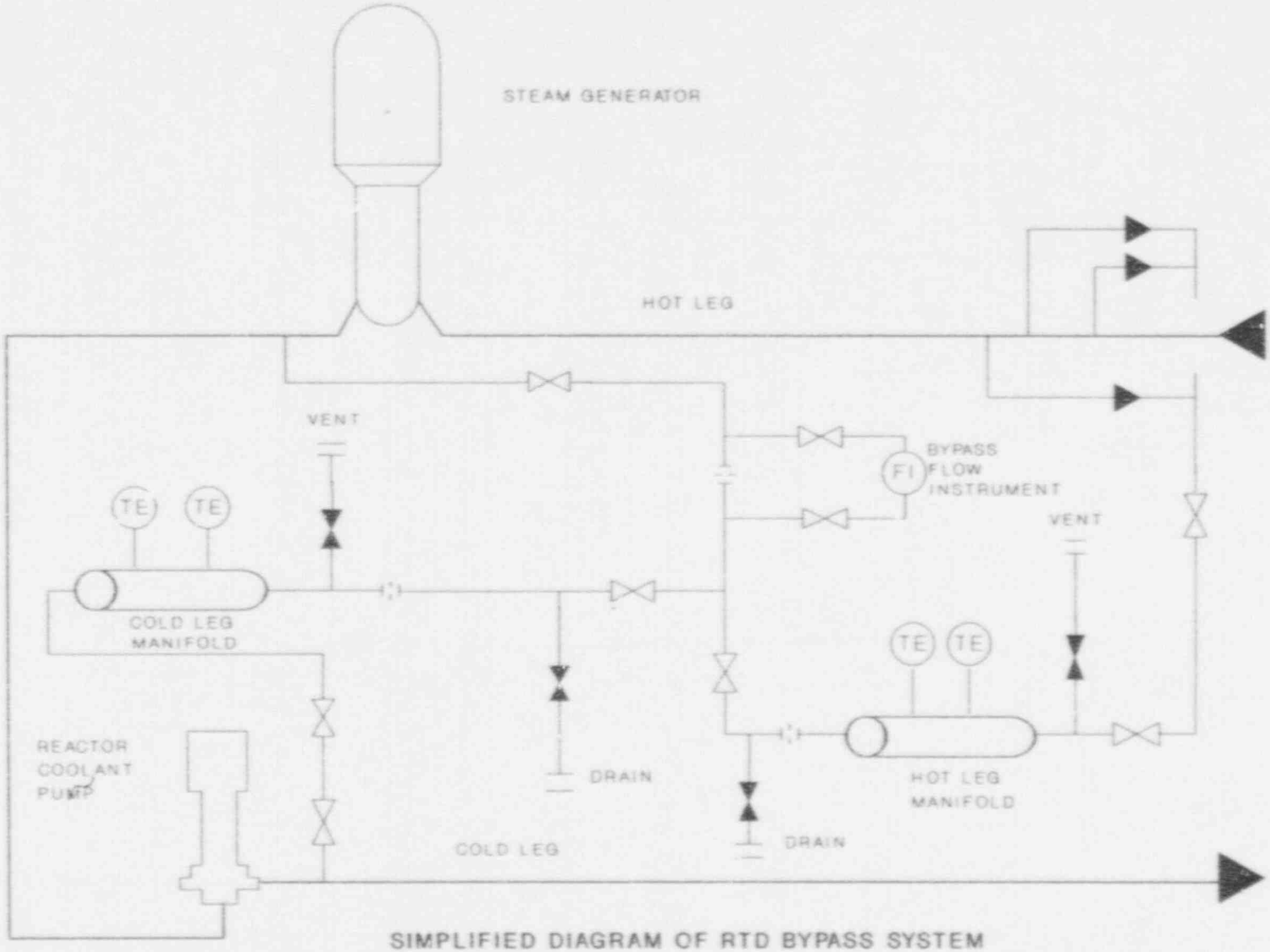
	RTD BYPASS SYSTEM	RTD THERMOWELL SYSTEM	SAFETY[2] ANALYSIS
I. FIRST ORDER LAGS			
a. RTD bypass system Response Time	4.0 sec.[1]	N/A	
b. RTD thermowell system Response Time	N/A	4.75 sec.[1]	
c. RTD Bypass Line Fluid Transport Delay and Piping Thermal Lag	2.0 sec.	N/A	
d. Scoop Transport Delay and Thermal Lag	Included i c.	0.25 sec.	
SUBTOTAL FIRST ORDER LAGS	6.0 sec.	5.0 sec.	6.0 sec.
II. PURE TIME DELAYS			
a. Electronics	0.300 sec.	0.300 sec.	
b. SSPS	0.001 sec.	0.001 sec.	
c. Reactor Trip Breakers	0.167 sec.	0.167 sec.	
Subtotal Pure Delays	0.50 sec.[4]	0.50 sec.[4]	2.0 sec.
TOTAL TESTABLE RESPONSE TIME[3]	4.50 sec.	5.25 sec.	
TOTAL SYSTEM RESPONSE TIME	6.50 sec.	5.50 sec.	8.0 sec.

[1] Includes 10% test allowance for LCSR testing. RTD bypass system response time makes use of time margin available in the OTDT analyses.

[2] See USAR Table 15.0-4.

[3] Technical specification limit is 6.0 sec. (excludes transport delays and thermal lags).

[4] Delays total 0.463 sec., but was rounded to 0.50 sec.

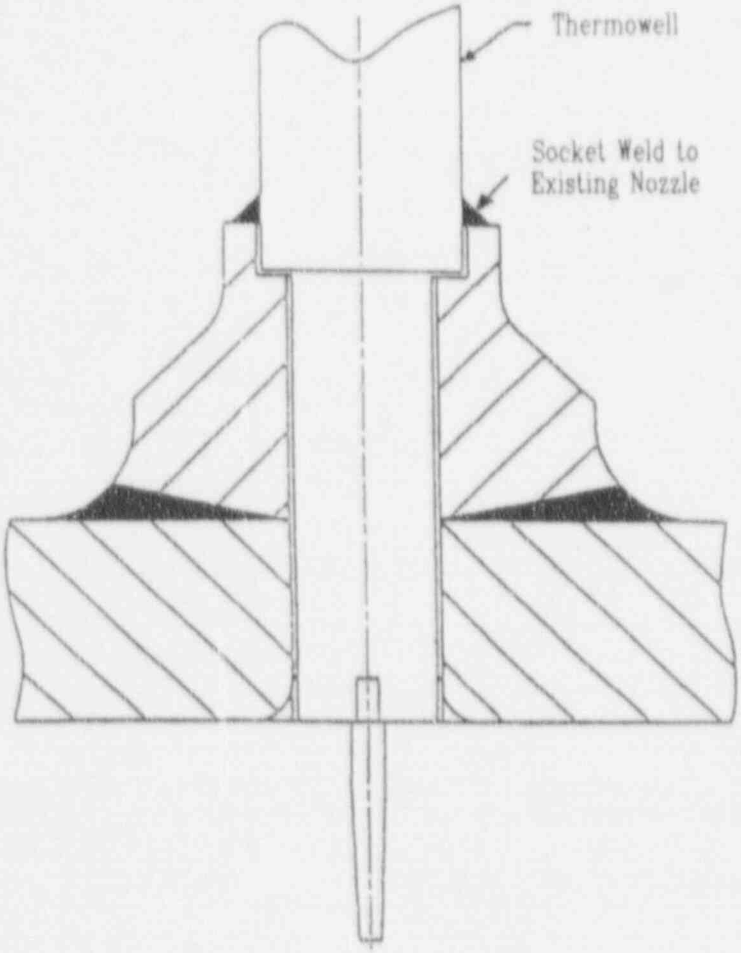


SIMPLIFIED DIAGRAM OF RTD BYPASS SYSTEM

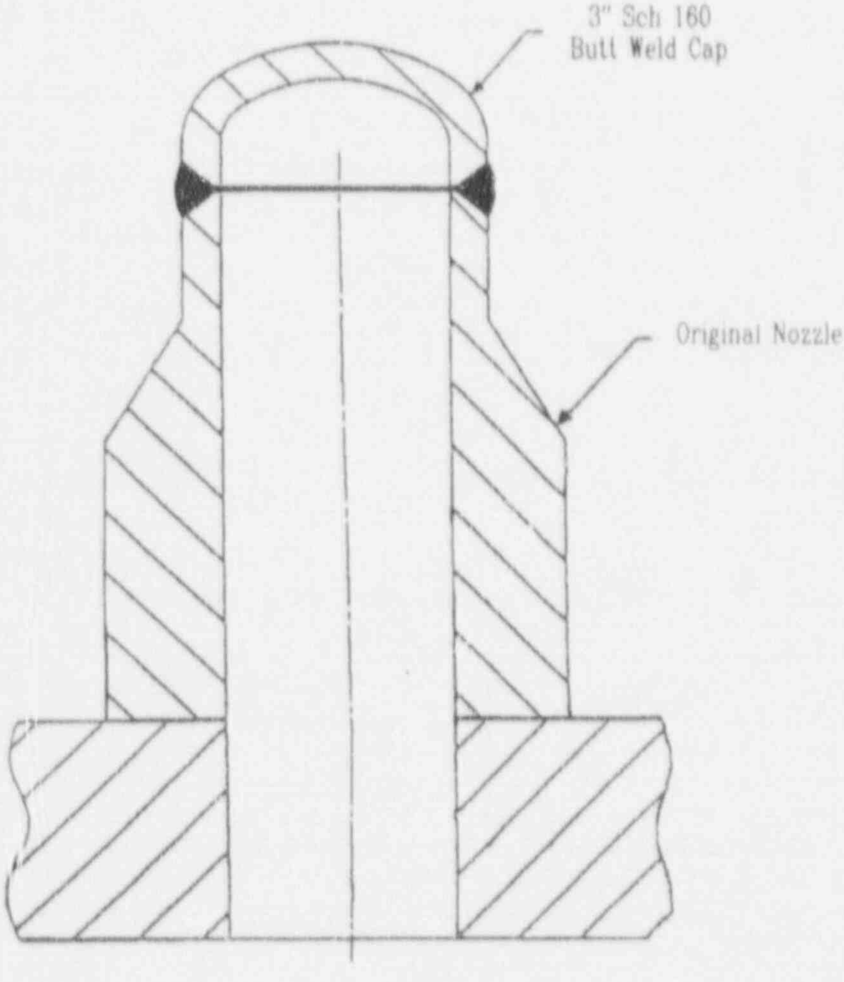
FIGURE 2-1

NON-PROPRIETARY

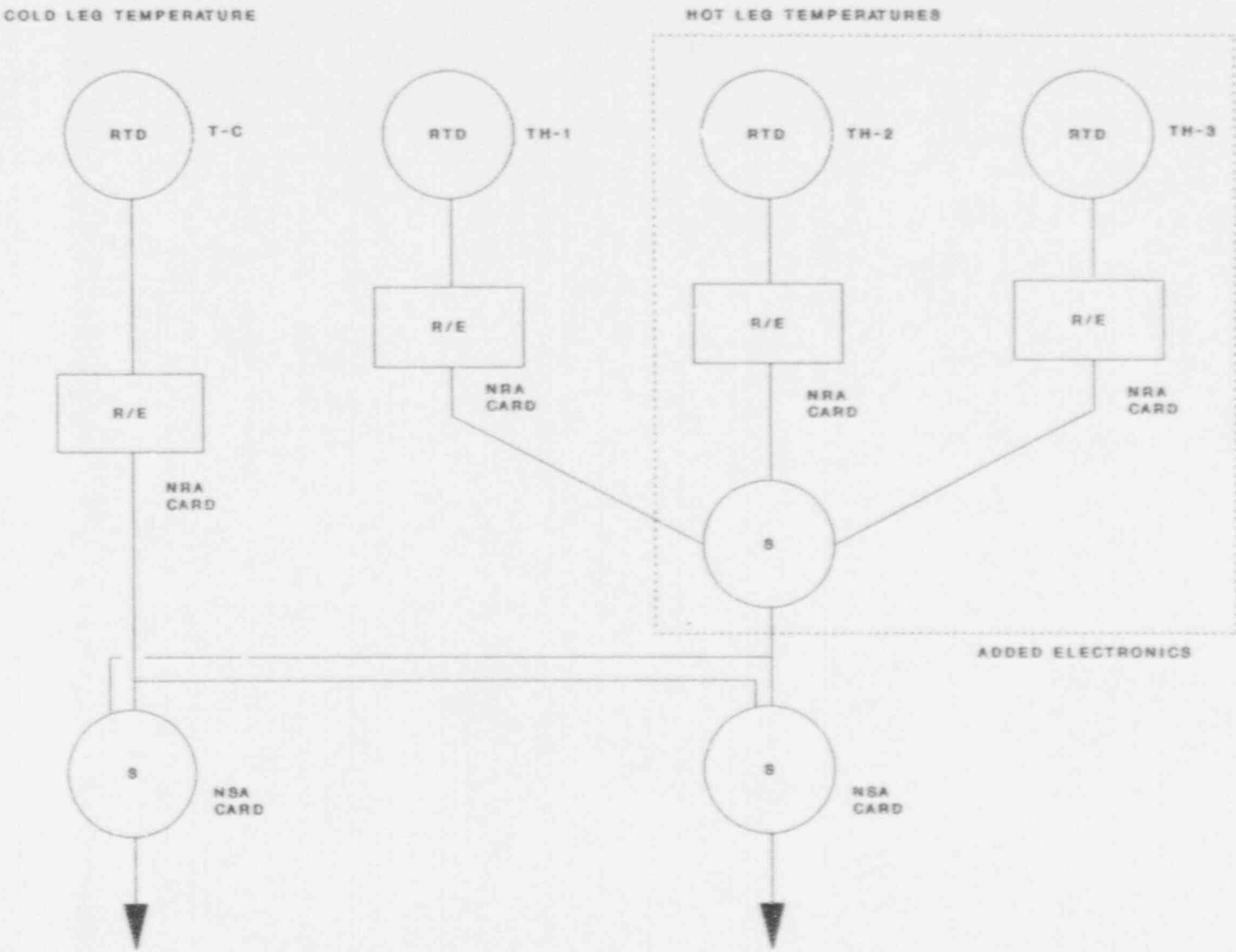
RCS HOT LEG THERMOWELL
FIGURE 4-1



RCS COLD LEG THERMOWELL
FIGURE 4-2

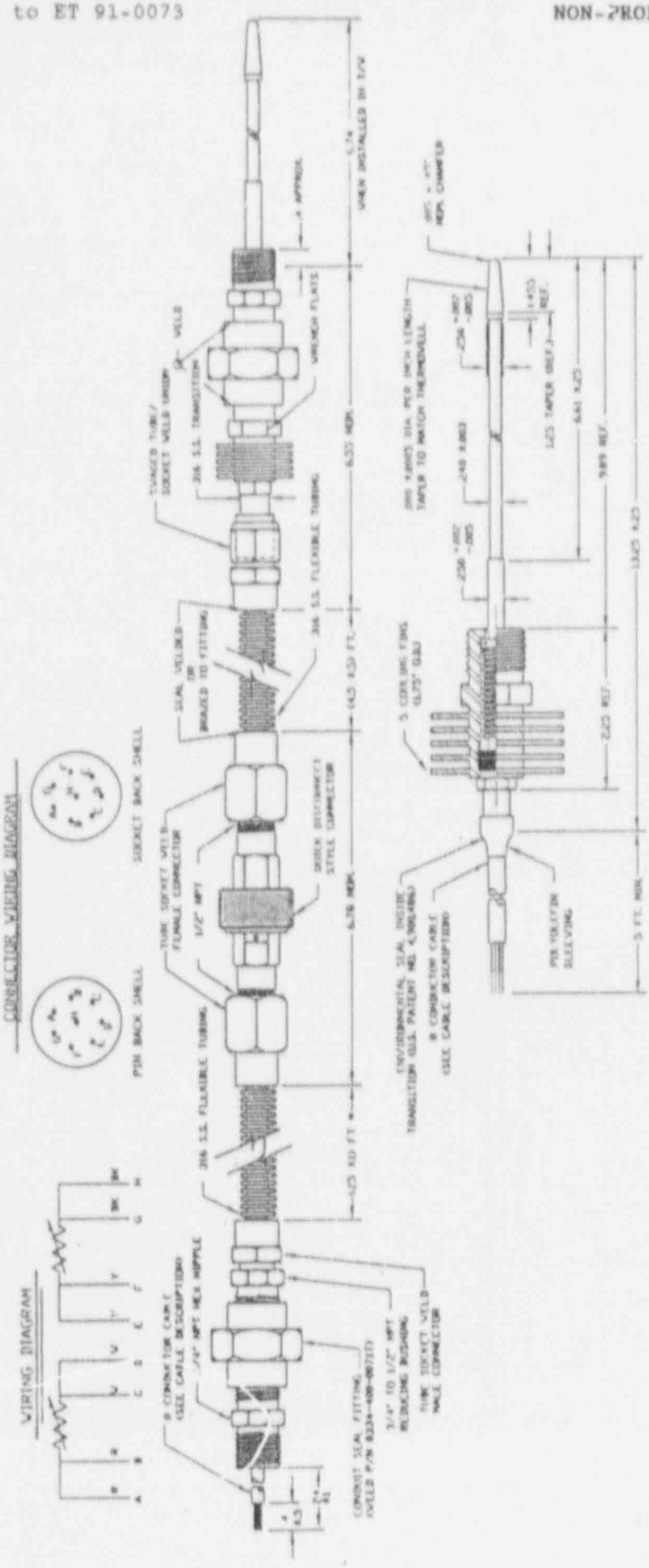


RCS CROSSOVER LEG CONNECTION
FIGURE 4-3



RTD THERMOWELL SYSTEM ANALOG RTD AVERAGING
FIGURE 5-1

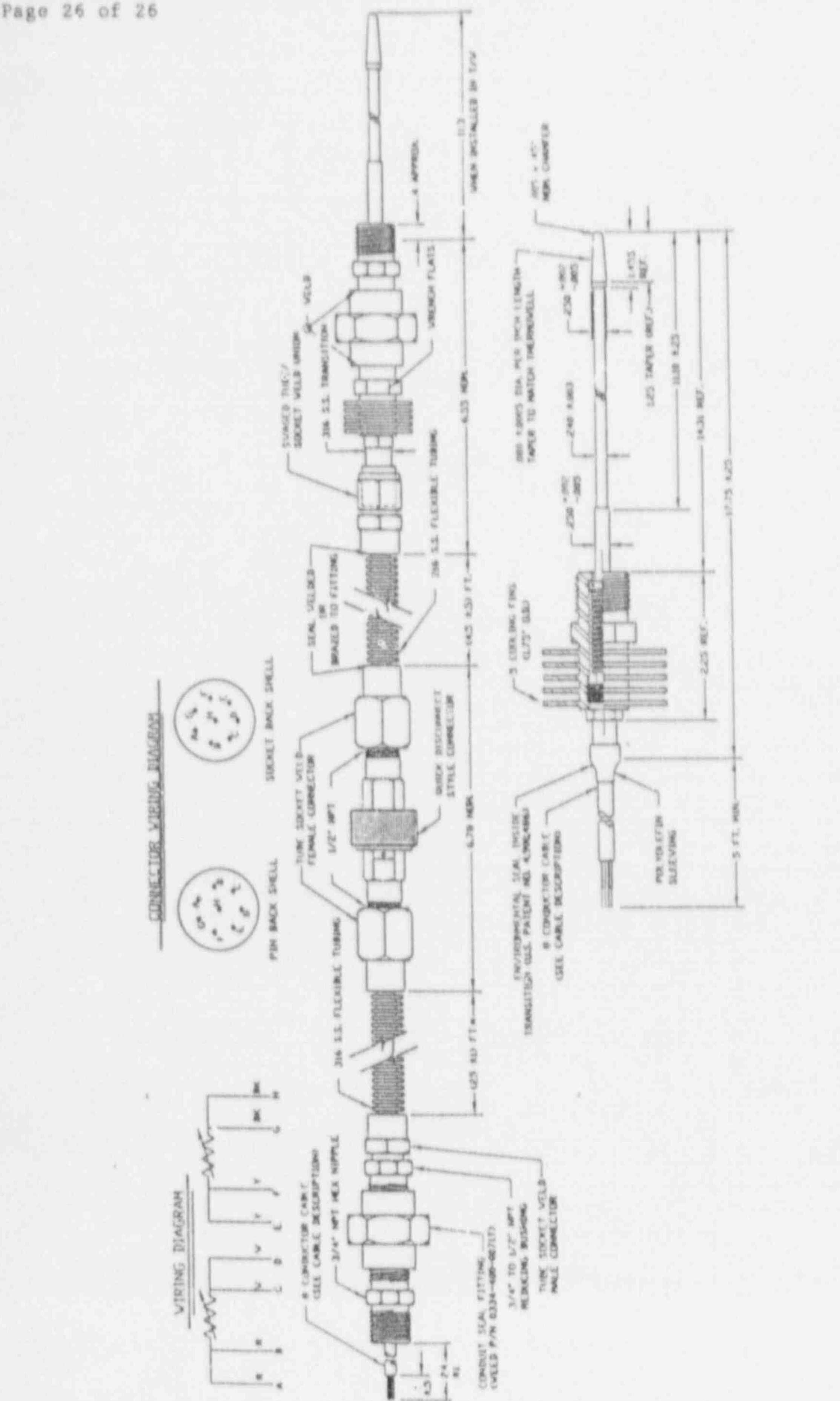
NON-PROPRIETARY



FAST TIME RESPONSE RTD ASSEMBLY FOR REACTOR COOLANT LOOP (HOT LEG)

FIGURE 5-2

NON-PROPRIETARY



FAST TIME RESPONSE RTD ASSEMBLY FOR REACTOR COOLANT LOOP (COLD LEG)

FIGURE 5-3

ATTACHMENT III (NON-PROPRIETARY)

SETPOINT CALCULATION FOR

RTD BYPASS SYSTEM REMOVAL

SETPOINT CALCULATION FOR RTD BYPASS SYSTEM REMOVAL

1.0 EVALUATION OF OTDT RESPONSE TIME

1.1 Background and Introduction

The Overtemperature Delta-T (OTDT) reactor trip function provides the primary protection against departure from nucleate boiling (DNB) during postulated transients in Westinghouse reactors. The OTDT protection function will trip the reactor when the compensated Delta-T in any two channels exceeds the setpoint. The setpoint for each channel is a continuously calculated setpoint. The Delta-T that is compared to the OTDT setpoint is calculated from the resistance temperature detectors (RTDs) which measure Reactor Coolant System (RCS) hot and cold leg temperatures. The response of the OTDT protection function is dependent on the system used to measure hot and cold leg temperatures. The current plant configuration consists of a bypass loop with the RTDs mounted in the bypass loop manifold. Due to maintenance and ALARA concerns, the bypass loop is being removed and the RTDs are being housed in thermowells which are mounted directly into the RCS hot and cold legs.

The Overpower Delta-T (OPDT) reactor trip function provides backup protection against excessive power (fuel rod integrity protection). No credit is taken for OPDT trips in the Wolf Creek Generating Station (WCGS) Updated Safety Analysis Report (USAR) Chapter 15 accident analyses.

The total response time of the OTDT and OPDT trip assumed in the safety analysis which form the licensing basis for WCGS is currently 8.0 seconds. The proposed RTD thermowell system will have a total response time as shown below:

	Thermowell System (seconds)
Direct Immersion RTD	N/A
Combined RTD Thermowell	4.75
Electronics Delay (7300 cabinets, SSPS, reactor trip breakers)	0.50
Total Testable Response Time	5.25
Scoop and Bypass Loop Delay and Thermal Lag (non-testable)	0.25
Total System Response Time	5.50

The response time can be grouped into two parts. The first part is a first order lag (i.e., thermal lags and RTD response) and the second part is a pure delay (i.e., electronics delay).

The appropriate breakdown of the total system response time in terms of first order lag and pure delay is as follows:

	Thermowell System (sec.)	Values Assumed in USAR Ch. 15 Analyses (sec.)
First Order Lag	5.0	6.0
Pure Delay	0.50	2.0
Total System Response Time	5.50	8.0

As shown above, the response times of the thermowell system are bounded by the assumed response times in the existing safety analysis. Therefore, no changes are required to the technical specification response times.

2.0 HOT LEG TEMPERATURE STREAMING AND SCOOP BIAS UNCERTAINTY

The setpoint calculations incorporate an uncertainty to account for the difference between the actual RCS hot leg temperature and the measured hot leg temperature caused by the incomplete mixing of reactor coolant leaving regions of the reactor core at different temperatures. This uncertainty consists of two parts: 1)[ ]. The [ ] is based on an analysis of test data from other Westinghouse plants and calculations to evaluate the impact of numerous possible hot leg temperature distributions on the temperature measurement accuracy. The [ ] determined is given as[ ]. The thermowell system introduces a [ ]. The magnitude of this bias has been quantified using test data from the Salem Units 1 and 2. The [ ] used in the setpoint calculation is conservatively established as [ ] in the hot leg with no bias in the cold leg.

3.0 CALCULATIONS

Wolf Creek Nuclear Operating Corporation (WCNOC) performed instrument uncertainty calculations which utilized the latest available information on plant installed instrumentation and the proposed RTD thermowell design to determine the impact of the removal of the RTD bypass system on WCGS temperature-related protection functions. Performance of these calculations concluded that the temperature-related protection functions (i.e., OTDT, OPDT and Loss of Flow reactor trips) maintain their Nominal Trip Setpoints in accordance with WCGS Technical Specifications. Changes to the Z and S parameters and Allowable Values for OTDT and OPDT in Technical Specification Tables 2.2-1 and 4.3-1 will be required to support the installation of the RTD thermowell system.

The basic methodology to calculate the WCGS existing setpoints was used to perform the setpoint calculations for the RTD thermowell system. However, changes to the input uncertainties and the calculational methodology were made to reflect the use of multiple thermowell-mounted RTDs and the removal of RTD bypass piping. In addition to the setpoint changes required for the RTD bypass removal, an effort was made to remove excess conservatism from the calculation of temperature uncertainties. These changes are discussed in the following sections.

3.1 Sensor Errors

3.1.1 Sensor Calibration Accuracy (SCA)

The existing setpoint methodology uses a value of [ ] for SCA. The value of SCA for the thermowell dual element RTD is [ ]. This is considerably less than the existing SCA value, and allows the existing conservative value of [ ] to be retained in the setpoint calculations.

3.1.2 Sensor Drift (SD)

The existing setpoint methodology uses a value of [ ] for sensor drift. The sensor drift for the thermowell dual element RTD is [ ] over 5 years. Assuming drift is linear and a calibration interval of 24 months, a value for anticipated drift of [ ] is obtained. The anticipated thermowell RTD sensor drift value is enveloped by the value assumed in the existing methodology and therefore permits the continued use of [ ] for sensor drift.

3.1.3 Calculation of Sensor Errors

In the RTD bypass system only one RTD is used to measure temperature in the RCS hot and cold legs respectively. [ ] was used for calculating the sensor errors as expressed in the following equation:

[ ]
Sensor Error (S) = [ ] (1)
[ ]

where [ ]
[ ]
[ ]
[ ]
[ ]

The following equation results if the sensor uncertainties for each channel are treated [ ]:

[ ]
Sensor Error (S) =[ ] (2)
[ ]

The RTD thermowell system uses three RTDs in the hot legs to measure the hot leg temperature (T_H). The cold leg temperature (T_C) will continue to be measured by one RTD. The existing sensor error equations were modified to incorporate the thermowell system hot leg RTDs. Since [ ] RTDs are used in the thermowell system, the sensor error for T_H is given by:

T_H Sensor Error =
[ ]
[ ] (3)
[ ]
[ ] (4)

Substituting Equation 4 into Equation 2 for the T_H term, the following equation is obtained:

[ ]
Sensor Error (S) = [ ] (5)
[ ] As shown above, the RTD thermowell system sensor error is [ ] compared to that calculated by Equation 2 because of [ ] [ ] of the hot leg RTDs.

3.2 Rack Errors

3.2.1 Rack Configuration

Minor modifications are required to the 7300 cabinets to accommodate the RTD thermowell system. In the RTD bypass system, the T_H signal is obtained from a single R/E converter (NRA card). In the thermowell system, three R/E converters (one for each hot leg RTD) feed a summing amplifier (NSA card). The output of this summing amplifier is T_H. All other rack components are unaffected.

3.2.2 Existing Rack Calculational Method

The existing setpoint methodology uses a conservative value of [ ] for the calibration accuracy of the R/E converters with a value of [ ] for Measuring and Test Equipment (M&TE) accuracy. The additional summing amplifier has a manufacturer's accuracy of [ ]. For the purposes of this calculation, the conservative value of [ ] will be retained.

The current Delta-T and T_{avg} rack errors due to the R/E converters are calculated using the following equation:

[ ]
R/E Error = [ ] (6)
[ ]

where [ ]
[ ]
[ ]
[ ]
[ ]

The following equation results if the R/E uncertainties for the Delta-T channel are treated as [ ]:

R/E Error = [ ] (7)

3.2.3 RTD Thermowell System Rack Calculational Method

The RTD thermowell system will use three R/E converters and a summing amplifier in the hot leg temperature channels.

Since three R/E converters are utilized, the error due to these cards is given by:

T_H Rack Error =

[ ] (8)
[ ]
[ ] (9)

Adding the contribution of the independent summing amplifier, the total error associated with this segment of the rack is:

[ ] (10)

Substituting Equation 10 into Equation 7 for the T_H term, the following equation is obtained:

R/E Error = [ ] (11)

3.2.4 Rack Uncertainties

The RTD thermowell design and associated calculational method results in a [ ] than previously calculated.

The proposed minor modifications made to the 7300 cabinets do not effect the validity of the assumptions for the remaining rack accuracy and rack drift allowance values. The values currently used in the setpoint methodology, therefore, remain unchanged.

3.3 Process Measurement Accuracy (PMA)

Process Measurement Accuracy is used to account for errors due to non-instrument related effects which have a direct bearing on the accuracy of an instrument channel's reading. This allowance has two parts. In the present setpoint calculation, a value of [ ] is used for the Delta-T portion of the PMA. For the RTD thermowell system, a value of [ ] with a [ ] bias will be employed.

3.4 Revised Reactor Trip Setpoint Calculation

3.4.1 Overtemperature Delta-T (OTDT)

The RTD thermowell system setpoint calculation for OTDT was constructed with the following features:

[ ]
[ ]
[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

3.4.2 Overpower Delta-T (OPDT)

The RTD thermowell system setpoint calculation for OPDT was constructed with the following features:

[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

3.4.3 RCS Flow Uncertainty

The calculations regarding the RCS flow uncertainty were reviewed. Although allowances for errors in T_H and T_C are included in the precision RCS flow calorimetric, the results are not affected. There is no PMA term in this calculation, therefore, the new scoop design has no impact. The values used for SCA and SD in this calculation envelope the values used in the RTD thermowell system for these allowances. The thermowell system uses three hot leg RTDs which lowers the SCA and SD values for these channels. Thus, the results of the precision RCS flow calorimetric are not changed. Since the value for the precision RCS flow calorimetric is used in the RCS low flow calculation, then the RCS low flow result remains valid.

3.4.4 Rod Control System

The calculations for the T_{avg} channel uncertainty were reviewed. [ ]
[ ]
[ ]
[ ]
[ ]
[ ]
[ ]. Therefore, the rod control system will operate within its currently assumed tolerances. This allows the continued use of the existing T_{avg} uncertainty for the rod control system.

4.0 CONCLUSIONS

The protection functions OTDT and OPDT will maintain their current technical specification Nominal Trip Setpoints. This is possible since the safety analysis margin increased for the RTD thermowell system. However, changes to the technical specification Allowable Value and related Z and S parameters will be required to reflect the values for the RTD thermowell system. The Loss of Flow trip is not affected since the evaluation of this trip setpoint determined that the RTD thermowell system would slightly lower the power calorimetric allowance. The rod control system was reviewed and it was determined that the existing T_{avg} uncertainty was bounding since [ ]
[ ]
[ ]. The proposed technical specification changes for OTDT and OPDT parameters are summarized below:

	OTDT (%Delta-T Span)		OPDT (%Delta-T Span)	
	Current Value	Proposed Value	Current Value	Proposed Value
Sensor Error, Z	3.40	3.50	1.43	1.83
Sensor Error, S	2.49	2.72	0.15	0.17
Allowable Value	OTDT+2.8	OTDT+2.6	OPDT+4.1	OPDT+3.7

ATTACHMENT IV

SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

This proposed license amendment request revises Technical Specification Tables 2.2-1, 4.3-1 and associated Bases to accommodate the replacement of the existing resistance temperature detector (RTD) bypass system with an RTD thermowell system. The plant modification involves removal of the bypass system piping and replacement of the existing RTDs with RTDs inserted in a thermowell installed in the existing reactor coolant system (RCS) hot and cold leg scoops.

The proposed changes do not involve a significant hazards consideration because operation of Wolf Creek Generating Station (WCGS) in accordance with these changes would not:

Standard 1 - Involve a Significant Increase in the Probability or Consequences of an Accident Previously Evaluated.

The existing RTD temperature outputs are used by the Reactor Protection System for the Overtemperature Delta-T (OTDT) and Overpower Delta-T (OPDT) trip functions. These trip functions provide primary protection against departure from nucleate boiling (DNB) and fuel centerline melting during postulated transients. The Loss of Flow trip function provides protection for DNB due to the loss of Reactor Coolant System (RCS) flow in one or more primary side loops. The Loss of Flow trip function is dependent upon the measured temperature since a primary parameter in the determination of RCS flow is the primary side enthalpy rise. Additionally, RTD temperature signals are utilized by other control systems.

Those transients and accidents that were effected by the OTDT, OPDT,and Loss of Flow trip functions were evaluated. This evaluation concluded that the OTDT, OPDT and Loss of Flow trips will continue to function in a manner consistent with the existing analyses assumptions for these events. Evaluation of events initiated by a failure of those control systems that use temperature signals from the narrow range RTDs concluded that there will be no degradation in the performance of or increase in the number of challenges to equipment assumed to function during an accident situation. On this basis it is concluded that there will be no significant increase in the probability or consequences of previously evaluated accidents.

Standard 2 - Create the Possibility of a New or Different Kind of Accident from any Previously Analyzed.

The plant modification will be performed in a manner consistent with applicable standards, preserve the existing design bases, and will not adversely impact the qualification of any plant systems. This will preclude adverse control and protection system interactions. The design, installation and inspection of the RTD thermowell system will be done in accordance with ASME Boiler and Pressure Vessel Code criteria. By adherence to industry standards, the pressure boundary integrity will be preserved. Therefore, the proposed changes will not create the possibility of a new or different kind of accident from any previously analyzed.

Standard - 3 Involve a Significant Reduction in a Margin of Safety.

The applicable margins of safety are defined in Bases Sections 2.1.1 and 2.1.2. Bases Section 2.1.1 states that the minimum value of the departure from nucleate boiling ratio (DNBR) during steady state operation, normal operational transients, and anticipated transients corresponds to a 95 percent probability at a 95 percent confidence level that departure from nucleate boiling (DNB) will not occur. The restrictions of this fuel cladding integrity safety limit prevent overheating of the fuel and possible cladding perforation which would result in the release of fission products to the coolant. The minimum DNBR reported in the accident analyses will be unaffected by the plant modification.

Bases Section 2.1.2 states that the Safety Limit on maximum RCS pressure protects the integrity of the RCS from overpressurization and thereby prevents the release of radionuclides contained in the reactor coolant from reaching the containment atmosphere. The maximum RCS pressure reported in the accident analyses is unaffected by the plant modification.

Therefore, the proposed changes do not involve a significant reduction in a margin of safety.

Based on the above discussions, it has been determined that the proposed technical specification revisions do not involve a significant increase in the probability or consequences of an accident previously evaluated; or create the possibility of a new or different kind of accident; or involve a significant reduction in a margin of safety. Therefore, this amendment application does not involve a significant hazards consideration.

ATTACHMENT V

ENVIRONMENTAL IMPACT DETERMINATION

ENVIRONMENTAL IMPACT DETERMINATION

10 CFR 51.22(b) specifies the criteria for categorical exclusions from the requirement for a specific environmental assessment per 10 CFR 51.21. This amendment request meets the criteria specified in 10 CFR 51.22(c)(9). Specific criteria contained in this section are discussed below.

(i) the amendment involves no significant hazards considerations.

As demonstrated in the Significant Hazards Consideration Determination in Attachment IV, this proposed amendment does not involve any significant hazards consideration.

(ii) there is not significant change in the types or significant increase in the amounts of any effluents that may be released offsite.

The proposed plant modification involves the removal of the resistance temperature detectors (RTD) bypass system piping and replacement of existing RTDs with RTDs inserted in thermowells into existing Reactor Coolant System (RCS) penetrations. This will not alter process parameters or function of the RCS and those systems utilizing the output from the RTDs will continue to function in a manner consistent with previous analyses. Therefore, there will be no change in the types or amounts of any effluents released offsite.

(iii) there is no significant increase in individual or cumulative occupational radiation exposure.

The removal of the RTD bypass system is expected to reduce the collective exposure by about 60-90 man-rem each refueling outage. In addition, the potential for forced outages will be reduced due to the avoidance of leaks and equipment failures. The exposure associated with implementing this modification is approximately 50-150 man-rem based on available nuclear industry experience. The overall reduction in collective exposures due to this modification is projected to be about 2000 man-rem over the remaining life of the plant.

Although implementation of the plant modification will result in a short term increase in occupational radiation exposure, the net result will be a reduction in the cumulative occupational radiation exposure over the life of the plant.

Based on the above, it is concluded there will be no impact on the environment resulting from this change and the change meets the criteria specified in 10 CFR 51.22 for a categorical exclusion from the requirements of 10 CFR 51.21 relative to specific environmental assessment by the Commission.