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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 12 TO FACILITY OPERATING LICENSE NO. NPF-86

NORTH ATLANTIC ENERGY SERVICE CORPORATION

SEABROOK STATION, UNIT NO. 1

DOCKET NO. 50-443

1.0 INTRODUCTION

By letter dated March 20, 1992, as supplemented on June 19, 1992, the Public Service Company of New Hampshire (former licensee) submitted a request for changes to the Seabrook Station, Technical Specifications (TS). Pursuant to an order authorizing transfer of the facility, North Atlantic Energy Service Corporation is now the licensed operator of Seabrook. The June 19, 1992, letter provided clarifying information in response to NRC staff's request for additional information and was renoticed in the Federal Register on July 8, 1992 (57 FR 30256) with a new evaluation of no significant hazards considerations.

The requested changes would eliminate the Resistance Temperature Detection (RTD) Bypass Manifold System, which is currently used for the measurement of narrow range Reactor Coolant System hot leg and cold leg temperature, and replace it with direct immersion RTDs. This modification affects the reactor protection system setpoints and uncertainties for RCS flow and T-average because of the different response time characteristics and instrumentation uncertainties associated with the new thermowell mounted RTDs. The T-Average and Delta-T signal input arrangement to the reactor protection and control system is also modified. Accordingly, this amendment requires a revision of the Seabrook Station Technical Specifications for Overtemperature Delta T, Overpower Delta T, Reactor Coolant Flow, and departure from nucleate boiling (DNB) parameters.

The requirements for verification of RTD bypass loop flow are deleted. The requirements for the performance of a precision heat balance calculation for determining the Reactor Coolant System flow rate are modified by increasing the thermal power level at which the heat balance is required. The submittal proposed to change the power level below which the heat balance must be done from the current requirement of 75% of rated thermal power to 95% of rated thermal power, consistent with the Westinghouse recommendation to perform the heat balance above 90% of rated thermal power.

2.0 EVALUATION

2.1 Instrumentation and Control Issues

Instrumentation and control issues are reviewed in Section 2.1 below, and rector systems issues are reviewed in Section 2.2

2.1 Current System

The present reactor coolant temperature measurement system uses coolant scoops in the primary coolant to divert a portion of the reactor coolant into bypass loops. The RTDs for T-hot and T-cold temperature measurement are located in the bypass loop manifolds and are inserted directly into the reactor coolant bypass flow without thermowells. Separate hot leg and cold leg bypass loops are provided for each reactor coolant loop such that individual T-hot and T-cold loop temperature signals can be developed for use by the reactor protection and plant control system.

Bypass piping form the hot leg side of each steam generator is used for the T-hot RTDs. Additional bypass piping from the cold leg side of the reactor coolant pump is used for the T-cold RTD. Both T-hot and T-cold manifolds empty through a common header to the intermediate leg between the steam generator and reactor coolant pump. Flow for each T-hot bypass loop is provided by three coolant scoops located at 120 degree intervals around the hot leg piping. Because temperature streaming in the cold leg is limited by the mixing action of the reactor coolant pump only one scoop connection is installed for bypass flow to the T-cold bypass manifold.

The bypass manifold system was designed to resolve concerns with temperature streaming (temperature gradients) within the hot leg primary coolant. The temperature streaming experienced in the hot leg piping is a result of the reactor coolant leaving various regions of the reactor core at different temperatures. The bypass manifold system compensates for the temperature streaming by mixing the primary coolant within the bypass manifold. The bypass manifold system also limits high velocity coolant flow to the RTDs and allows RTD replacement without the need to draindown the reactor coolant system.

The output from the bypass loop RTDs provides the signals necessary to calculate the arithmetic average loop temperature (T-average) and the loop differential temperature (Delta-T). The T-average and Delta-T signals are then input to the reactor protection system. The T-average and Delta-T signals for the plant control/computer systems are derived from the same set of protection system RTDs and T-average and Delta-T calculations. The T-average and Delta-T values are provided to the plant control/computer systems through isolation devices.

The licensee states that the current system has caused plant shutdowns due to primary leakage through valves or flanges, and the interruption of bypass flow due to valve stem failure. Additionally, the licensee stated that the bypass piping contributes to increased radiation exposure to personnel when maintenance is performed in bypass manifold system areas.

2.1.2 Proposed System

The modified system hot leg temperature measurement for each loop will be obtained using three fast response, narrow range, dual element RTDs mounted in thermowells. One element of each RTD will be utilized as a spare. Two of the hot leg RTDs will be mounted in thermowells within the existing bypass manifold scoop penetrations. Each bypass scoop will be modified such that reactor coolant will flow in through the existing holes of the bypass scoop past the RTD/thermowell assembly and out through a new hole machined in the bypass scoop. Because of structural interference a new penetration will be installed to accommodate the third RTD/thermowell assembly. The modified RTD arrangement will perform the same sampling/temperature averaging function as the original bypass manifold system. The modified location for the third RTD in each loop has been evaluated by the licensee and the revised streaming uncertainties applied to the setpoint calculations.

The cold leg temperature measurements will be obtained by one fast response, narrow range, dual element RTD located at the discharge of the reactor coolant pump. This RTD will be mounted in a thermowell within the existing cold leg bypass manifold penetration. Because of the mixing action of the reactor coolant pump, temperature gradients in the cold leg are minimized and only one RTD is used for cold leg temperature measurement. Although cold leg streaming is minimized by RCP mixing a cold leg streaming bias is incorporated into the uncertainty calculations. As in the hot leg, the bypass manifold penetration will be modified to accept the RTD thermowell.

The licensee will replace the bypass manifold direct immersion RTDs with Weed Instrument Company Inc. dual element RTDs mounted in thermowells. The spare element of each RTD will be terminated at the 7300 rack input terminals in the control room. This arrangement is intended to allow on-line accessibility to the RTD spare elements in the event of an RTD failure.

The licensee states that the new thermowell mounted RTDs have a response time equal to the time of the old bypass piping transport, thermal lag and direct immersion RTDs (about 4 seconds). The 4-second response time of the Weed RTD thermowell assembly is supported by industry experience. The 2-second electronics delay specified by the licensee is identical to the value for the RTD bypass system. The licensee concluded that the safety analysis value of 6-seconds remains valid noting that the 2-second electronic delay is conservative and provides some margin. The RTD manufacturer will perform response time testing of each RTD and thermowell prior to installation to ensure the RTD/thermowell response time is bounded by the safety analysis value. The licensee will also verify the response time of the new RTDs using loop current step response (LCSR) methodology following installation in the plant.

To accomplish the hot leg temperature function previously done by the bypass manifold system, the modified hot leg RTD temperature signals (three per loop) will be electronically averaged in the protection system. The averaged T-hot signal will then be used with the T-cold signal to calculate reactor coolant system loop Delta-T and T-average values for use in the reactor protection and plant control systems. The averaging function will be accomplished by additions to existing 7300 reactor protection equipment.

The control system T-average and Delta-T signals are derived from the reactor protection system T-average and Delta-T calculations and provided to the plant control system through isolation devices. The isolation devices and control system input methodology for T-average and ΔT are not revised per this TS amendment and continue to meet the licensee basis as outlined in Chapter 7 of the Seabrook Station Final Safety Analysis Report.

The licensee states that existing control board indicators and alarms provide a means to identify RTD failures. A cold leg RTD failure can be handled by disconnecting the failed element and connecting the spare element provided within each RCS loop.

A failure of a hot leg RTD can be managed in one of two ways. The first method disconnects the failed hot leg RTD element and reconnects the spare element of the same RTD. The second method requires plant personnel to manually defeat the failed hot leg RTD signal and rescale the electronics to average the remaining two RTD inputs. A bias value is incorporated into the T-hot average signal to compensate for hot leg streaming and maintain a value comparable with the previous three RTD average. The bias value is developed per procedure/TS requirements using data recorded at full power and during protection system surveillance.

The proposed TS changes also include a revision to the precision heat balance requirements. The licensee has modified the thermal power level at which the precision heat balance must be performed. Previously, the heat balance was performed prior to exceeding 75% of rated power. Now it will be performed prior to exceeding 95% of rated thermal power. As stated by the licensee, this is consistent with the Westinghouse recommendation to perform the precision heat balance above 90% of rated thermal power to minimize measurement uncertainties aggravated at lower power levels.

The licensee stated that following the initial thermowell RTD cross calibration, the calibration reference will consist of the average of the RTD temperatures. The staff is concerned that the use of an average RTD value as a reference during cross calibration instead of a calibrated reference may lead to a net drift of the average temperature value indicated by the RTDs over time should the installed RTDs drift systematically. The licensee indicated that RTD drift is random and with a total uncertainty of less than ± 1.2 degrees specified in the submittal. NUREG/CR-5560, "Aging of Nuclear Plant Resistance Temperature Detectors" recognizes that on-line cross calibration can be a reasonable method for RTD calibration. However, as stated in NUREG/CR-5560, to perform in-situ calibration would normally require one or more newly calibrated RTDs to be used as a reference. Without a reference the cross calibration will not account for common mode (systematic) drift and will only provide information on the consistency and not the accuracy of the installed RTDs. The cross calibration technique assumes that the average of the RTD measurements represents the true process temperature and that RTD drift is random and not systematic. The project results referenced in NUREG/CR-5560 indicate that RTD drift is usually random. However, the particular testing done to validate the cross calibration methodology in NUREG/CR-5560 utilized newly calibrated RTDs for the test.

The staff agreed with the licensee's justification for RTD calibration without a reference but will continue to evaluate cross calibration techniques on a generic basis. This is acceptable in that the bypass elimination RTDs are newly calibrated and should not be influenced by systematic drift components during the initial plant cross calibration at Seabrook.

2.1.3 <u>Technical Specification Changes</u>

As a result of the modifications associated with the removal of the RTD bypass manifold system, the licensee proposed various changes to the Seabrook Nuclear Station TS. The staff finds the following changes discussed in Section 2.1.3.1 through 2.1.3.4 acceptable.

2.1.3.1 <u>Table 2.2-1: Reactor Trip System Instrumentation Setpoints (pp. 2-4, 2-5, 2-7, 2-8 and 2-10)</u>

A. Functional Unit 7, Overtemperature ΔT. Error terms Z, S, and the associated note revised to reflect new RTD instrumentation uncertainties, temperature streaming and the Westinghouse setpoint methodology. Note 2, Page 2-8, allowable value revised to 2.5% of ΔT span.

B. Note 1, Page 2-7, the reference to manifold instrumentation is deleted to agree with new RTD measurement system.

C. Functional Unit 8, Overpower ΔT. Error terms TA, Z, S revised to reflect new RTD instrumentation uncertainties, temperature streaming and the Westinghouse setpoint methodology.

D. Note 3, Page 2-10, the value for K6 has been increased. The K6 constant in the Overpower ΔT equation provides compensation for Tavg greater than nominal Tavg by reducing the overpower ΔT setpoint. The increase in uncertainties associated with RTD bypass removal increased the Technical Specification TA value. As a result, the licensee increased the safety analysis limit for K4 to allow the TS value for nominal K4 to remain unaffected. To account for this the margin in the Overpower ΔT setpoint equation for Tavg less than nominal Tavg was reduced and the value of K6 was increased to maintain the 118% thermal overpower limit.

In addition, the Note 2 allowable value was changed to 2.0% of span as a result of the RTD bypass removal uncertainties.

E. Functional Unit 12, Page 2-5, "Reactor Coolant Flow Low," the terms for Z and allowable value are modified to incorporate the modified RTD instrumentation instrument uncertainties.

2.1.3.2 Table 4.3-1: Reactor Trip System Instrumentation Surveillance Requirements (pp. 3/4 3-9, 3/4 3-13)

Functional Unit 7, "Overtemperature ΔT," the requirement to check RTD bypass loop flow has been deleted to be consistent with the replacement of the RTD bypass manifold system.

2.1.3.3 Bases 3/4 2.5: DNB Parameters (pp. B 3/4 2-4)

The licensee (supplement 1) increased the measurement error for RCS total flow rate from 2.1% to 2.4%. The increase in flow measurement uncertainty reflects the values documented in WCAP-13181 for RTD bypass removal. The 2.4% flow uncertainty also includes a 1% flow penalty to account for possible feedwater venturi fouling.

2.1.3.4 Specification 3/4.2.5: DNB Parameters (pp. 3/4 2-10)

Revised the surveillance requirements for the precision heat balance from prior to operation above 75% of rated thermal power after each refueling to prior to exceeding 95% of rated thermal power. Additionally, the DNB related parameter for reactor coolant system flow is increased from the current value of 391,000 gpm to a new value of 392,000 gpm by supplement 1 to the licensee submittal. The revised value of RCS flow reflects increased uncertainties for RTD bypass removal and 1% flow penalty for possible feedwater venturi fouling.

2.2 Reactor Systems Issues

Sections 2.2.1 through 2.2.3 discuss the review of reactor systems issues.

2.2.1 Current Method

The current method of measuring the hot and cold leg reactor coolant temperatures uses an RTD bypass system. The hot and cold leg temperature readings from each coolant loop are used for protection and control system inputs. The RTD bypass system was designed to address temperature streaming (non-uniform stratified flow in the cross section) in the hot legs and, by use of shutoff valves, to allow replacement of the direct immersion narrow-range RTDs without draindown of the reactor coolant system (RCS). For increased accuracy in measuring the hot leg temperatures, sampling coops were placed in each hot leg at three locations of a cross-section, 120° apart. Each scoop has five orifices which sample that hot leg flow along the leading edge of the scoop. The flow from the scoops is piped to a manifold where a direct immersion RTD measures the average hot leg temperature of the flow stream from the three scoops in the hot leg. This bypass flow is routed back at a point downstream of the steam generator. The cold leg temperature is measured in a similar manner except that scoops are not used. This is because temperature streaming is not a problem due to the mixing action of the RCS pump.

2.2.2 New Method

The new method proposed for measuring the hot and cold leg temperatures includes the use of narrow range dual element RTDs manufactured by WEED Company, which are mounted in thermowells to facilitate replacement without draindown of the RCS. The average hot leg temperature and the cold leg temperature are used to generate the reactor coolant loop differential temperature (ΔT) and average temperature (T_{avg}).

The hot leg temperature is measured using three of the WEED RTDs. Both elements of each hot leg RTD are wired to the appropriate process instrument rack where the second RTD input is a spare. The thermowells are located within two of the three existing RTD bypass manifold scoops, minimizing the need for additional hot leg piping penetrations. The third RTD will be located in an independent penetration nozzle. On loops A, B, and D the independent penetration nozzle is located in the same cross-sectional plane as the existing scoops, but offset 30° from the unused location. On loop C, the penetration nozzle will be relocated to a position approximately 12 inches upstream of the existing scoops at approximately 105° from top dead center. The unused scoops will be capped. The Weed RTDs are mounted to line up with the center hole of the five holes in the scoop. In the cases where new penetration nozzles are made the WEED RTDs will be inserted to the same depth as those in the scoops, which is the center hole depth.

Although unlikely, the RTD, or its electronics channel, can fail gradually, causing a gradual change in the loop temperature measurements. The licensee has committed to take regular temperature measurements to monitor RTD performance, so that any abnormal temperature shifts will be indicated.

An RTD failure will most likely result in an off scale high or low indication and will be detected through the existing control board T_{avg} and ΔT deviation alarms. If a failure of the RTD is diagnosed, two methods are available for addressing the failed RTD. Plant personnel can disconnect the failed element from the rack terminal strip and connect the other RTD element. Another option is for plant personnel to defeat the failed hot leg RTD and rescale the electronics to average the remaining two signals and incorporate a bias based upon the hot streaming measured in the loop.

One RTD will be located in each cold leg at the discharge of the reactor coolant pump. Again the existing RTD bypass penetration nozzle will be modified to accept the RTD thermowell. One element of the RTD will be considered active and the other element will be reserved as a spare. If a failure of a cold leg RTD is diagnosed, plant personnel can disconnect the failed element from the rack terminal strip and connect the other RTD element.

2.2.3 Analysis

The RTD response time is restricted with a technical specification Limiting Condition for Operation (LCO) to ensure consistency with assumptions in the accident analyses. The licensee presented information regarding the response time of the new RTD measurement system and also the accuracy of the new method for measuring the hot leg temperature which is discussed below.

2.2.3.1 RTD Response Time

The total response time for the current RTD bypass system and the proposed thermowell RTD system consist of the RTD bypass piping and thermal lag time, the RTD response time, and the electronic delay. The thermowell mounted RTDs have a response time equal to or better than the old bypass piping transport, thermal lag and direct immersion RTD. This allows the total RCS temperature measurement response time specified in technical specifications to remain unchanged at 6.0 seconds.

NUREG-0809 indicated 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 has stated that they perform RTD response time testing, using the recommended LCSR method as stated in NUREG/CR-5560, for checking the RTD response time, which is acceptable to the staff.

Based on the above information the staff finds that the RTD response time has been addressed in an acceptable manner.

2.2.3.2 RTD Uncertainty

The following protection and control system parameters were affected by the change from one hot leg RTD to three hot leg RTDs; the Overtemperature delta T, Overpower delta T, Low RCS Flow rector trip functions, the RCS average temperature measurements used for control board indication and input to the rod control system, and the calculated value of the RCS flow uncertainty. System calculations were performed for each of the parameters and the results indicated that a sufficient margin exists to account for all known instrument uncertainties.

2.2.3.3 Non-LOCA Accidents

Only those transients which assume overtemperature delta-T (OTΔT) and overpower delta-T (OPΔT) protection function are potentially affected by changes in the RTD response time. As noted previously the new thermowell mounted RTDs have a response time equal to or better than that of the old bypass transport, thermal lag and direct immersion RTD. Because the total channel response time remains less than or equal to 6.0 seconds, it is concluded that the safety analysis assumption for the total OTΔT/OPΔT channel response time remains valid.

The change in RTDs has caused the uncertainty on T_{avg} to increase from +/-4°F to +/-5°F. However, +/-5°F is still less than the uncertainty previously assumed in the non-LOCA accident analysis.

The impact of the proposed increase in flow measurement uncertainty (i.e., 0.3%) on non-LOCA accident has also been considered. In this regard, the staff finds that the change in flow uncertainty has no impact because Thermal Design Flow is used in the non-LOCA accident analysis and the uncertainty is applied to the measured value of RCS flow.

The licensee determined that the RTD bypass elimination does not increase any uncertainty that will affect any initial condition assumed in any non-LOCA transient or the low primary coolant flow reactor trip function. Since the effect of the temperature response time is unaffected and the accuracy of the new system is bounded, the conclusions in Chapter 15 of the Seabrook FSAR remain valid.

2.2.3 ion

The the RTD bypass system impacts the uncertainties associated with temperature and flow measurement. However, the magnitude of the uncertainties are such that RCS inlet and outlet temperatures, thermal design flow rate and the steam generator performance data used in the LOCA analyses will be affected only slightly.

The T_{avg} uncertainty for Seabrook Unit 1 is now stated to increase to +/-5°F from +/-4°F. Therefore small peak cladding temperature (PCT) penalties have been applied to both the Large and Small Break LOCA analyses of record to address the T_{avg} uncertainty range increase. The PCT increases are 4°F for large break LOCA and 8°F for small break LOCA (Letter from T. C. Feigenbaum, North Atlantic Energy Service Corporation, to the NRC, "10 CFR 50.46 Annual Report," July 1, 1992). With these penalties the current PCT values become 2052.2°F for LBLOCA and 1981.2°F for SBLOCA. The PCT remains well below the regulatory limit of 2200°F. This is acceptable to the staff.

2.2.3.5 <u>Precision Heat Balance</u>

The licensee has also proposed to change TS surveillance requirement 4.2.5.3 to modify the performance of a precision heat balance which is used to determine RCS flow rate and to normalize the RCS flow instrumentation. Currently the TS requirements specify that the precision heat balance must be performed prior to operation above 75% of thermal rated power following each fuel loading. This calculation is performed each cycle to detect changes in the RCS flow element (elbow taps) characteristics that would affect the accuracy of the RCS flow indication.

The licensee proposes that the precision heat balance be performed prior to exceeding 95% thermal rated power to minimize the measurement uncertainties that are exacerbated at lower power levels. Performing the flow rate measurement prior to exceeding 95% rated thermal power provides a reasonable amount of excess margin to DNB in the highly improbable event that a degradation in RCS flow rate, masked by a simultaneous non-conservative change in all elbow taps, is not detected prior to reaching 95%. On this basis, the staff accepts the licensee's proposed change.

2.2.3.6 DNB Parameters

The licensee also proposed a change to [illegible].2.5 regarding DNB parameters. Currently the RCS flow rate is specified at greater than or equal to 391,000 gpm, which includes 2.1% flow uncertainty. The proposed change to 392,000 includes the thermal design flow of 382,800 gpm plus the cold leg elbow tap flow uncertainty of 2.4% flow. The 2.4% flow uncertainty includes 0.1% penalty for undetected feedwater venturi fouling. The staff finds the change in the flow rate acceptable.

3.0 STATE CONSULTATION

In accordance with the Commission's regulations, the New Hampshire and Massachusetts State officials were notified of the proposed issuance of the amendment. The State officials had no comments.

4.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (57 FR 30256). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

5.0 CONCLUSION

To support the modifications required to eliminate the RTD bypass manifold system, the licensee proposed changes to the Seabrook Station TS. The TS revisions are a result of differences in the instrument system uncertainties between the thermowell mounted RTD system and the bypass manifold temperature measurement system. Evaluations performed by the licensee indicate that the instrument uncertainty values are acceptable. The impact of eliminating the RTD bypass system for Seabrook Station on FSAR Chapter 15 accidents has also been evaluated by the licensee. The review by the staff supports these conclusions. Since the RTD temperature response time and accuracy of the new system is not degraded, the former conclusions in the FSAR remain valid, and acceptable as described in Section 2.0.

The staff concludes that the modified RTD system is not functionally different from the current system except for the use of three RTDs instead of one in each hot leg. Based on the above, the staff finds that the proposed plant modifications to replace the RTD bypass manifold system with thermowell mounted, fast response, narrow range RTDs located directly in the reactor coolant system piping and the proposed TS changes are acceptable.

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

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