BASES

Variable Power Level-High

A Reactor trip on Variable Overpower is provided to protect the reactor core during rapid positive reactivity addition excursions which are too rapid to be protected by a Pressurizer Pressure-High or Thermal Margin/Low Pressure Trip.

The Variable Power Level High trip setpoint is operator adjustable and can be set no higher than 9.61% above the indicated THERMAL POWER level. Operator action is required to increase the trip setpoint as THERMAL POWER is increased. The trip setpoint is automatically decreased as THERMAL POWER decreases. The trip setpoint has a maximum value of 107.0% of RATED THERMAL POWER and a minimum setpoint of 15.0% of RATED THERMAL POWER. Adding to this maximum value the possible variation in trip point due to calibration and instrument errors, the maximum actual steady-state THERMAL POWER level at which a trip would be actuated is 112% of RATED THERMAL POWER, which is the value used in the safety analyses.

Pressurizer Pressure-High

The Pressurizer Pressure-High trip, in conjunction with the pressurizer safety valves and main steam safety valves, provides Reactor Coolant System protection against overpressurization in the event of loss of load without reactor trip. This trip's setpoint is at less than or equal to 2375 psia which is below the nominal lift setting 2500 psia of the pressurizer safety valves and its operation minimizes the undesirable operation of the pressurizer safety valves.

Thermal Margin/Low Pressure

The Thermal Margin/Low Pressure trip is provided to prevent operation when the DNBR is less than 1.28.

The trip is initiated whenever the Reactor Coolant System pressure signal drops below either 1900 psia or a computed value as described below, whichever is higher. The computed value is a function of the higher of ΔT power or neutron power, reactor inlet temperature, the number of reactor coolant pumps operating and the AXIAL SHAPE INDEX. The minimum value of reactor coolant flow rate, the maximum AZIMUTHAL POWER TILT and the maximum CEA deviation permitted for continuous operation are assumed in the generation of this trip function. In addition, CEA group sequencing in accordance with Specifications 3.1.3.5 and 3.1.3.6 is assumed. Finally, the maximum insertion of CEA banks which can occur during any anticipated operational occurrence prior to a Power Level-High trip is assumed.

The Thermal Margin/Low Pressure trip setpoints are derived from the core safety limits through application of appropriate allowances for equipment response time measurement uncertainties and processing error. A safety margin is provided which includes: an allowance of 2.0% of RATED THERMAL POWER to compensate for potential power measurement error; an allowance of 3.0°F to compensate for potential temperature measurement uncertainty; and a further allowance of ~~91.0~~ 125 psia to compensate for pressure measurement error and time delay associated with providing effective termination of the occurrence that exhibits the most rapid decrease in margin to the safety limit. The ~~91.0~~ 125 psia allowance is made up of a ~~25.0~~ 55 psia pressure measurement allowance and a ~~66.0~~ 70 psia time delay allowance.

TABLE 3.3-2 (Continued)

REACTOR PROTECTIVE INSTRUMENTATION RESPONSE TIMES

FUNCTIONAL UNIT	RESPONSE TIME
10. Loss of Component Cooling Water to Reactor Coolant Pumps	Not Applicable
11. Reactor Protection System Logic	Not Applicable
12. Reactor Trip Breakers	Not Applicable
13. Wide Range Logarithmic Neutron Flux Monitor	Not Applicable
14. Reactor Coolant Flow - Low	0.65 second
15. Loss of Load (Turbine Hydraulic Fluid Pressure - Low)	Not Applicable

*Neutron detectors are exempt from response time testing. Response time of the neutron flux signal portion of the channel shall be measured from detector output or input of first electronic component in channel.

**Based on a resistance temperature detector (RTD) response time of less than or equal to ~~8.0~~ seconds where the RTD response time is equivalent to the time interval required for the RTD output to achieve 63.2% of its total change when subjected to a step change in RTD temperature.

16.0

ATTACHMENT 2

Safety Analysis

Introduction

A relaxation in the maximum allowable Resistance Temperature Detector (RTD) response time for St. Lucie Unit 2 from the current Technical Specification value of 8.0 seconds to a value of 16.0 seconds is proposed. Previous surveillances of the RTD response times at St. Lucie Unit 2 have been close to the Technical Specification 8.0 second maximum allowable value. An investigation into whether a longer RTD response time constant could be technically justified was conducted. The bases of the Thermal Margin/Low Pressure (TM/LP) trip setpoint include a 66.0 psia bias to account for RTD response time constants up to 8.0 seconds. For RTD time constants greater than 8.0 seconds a re-analysis of the bases for the TM/LP trip setpoint was performed.

Discussion

The Reactor Protection System uses the auctioneered higher of the ex-core power and the ΔT-power signals. The RTD response time affects the ability of the RTDs to provide an accurate measurement of the actual coolant temperature during heatup and cool down transients. Thus, the RTD response time affects the ability of the ΔT-power calculator to accurately measure the core power during power transients.

During fast power excursions, where the measured RCS temperature lags significantly behind the actual RCS temperature, a more accurate power measurement is provided by the ex-core neutron power detectors. However, during very slow power excursions where large amounts of Control Element Assembly (CEA) motion are required to produce the power excursion, the ex-core detectors may be significantly decalibrated due to temperature shadowing or rod shadowing effects. For the slower power excursions, the ΔT-power calculator provides a more accurate power measurement.

The procedure for determining the limiting power excursion has been to determine some intermediate reactivity insertion rate where the effects of the ex-core power and ΔT-power decalibration were balanced and each of these signals was decalibrated equally. To determine the limiting combination of parameters which produced this case, a parametric analysis was performed where the power excursion rates (i.e. reactivity insertion rates) were varied until ΔT and nuclear flux power signals were decalibrated by equal amounts.

In performing those parametric evaluations, it had been the practice to consider the full range of reactivity insertions; from 0.0 to a maximum possible rate of $1.6 \times 10^{-4}\ \Delta\rho$/sec. Consideration of the full range of reactivity rates was the same as considering the full spectrum of power excursion rates.

The series of parametric analyses described above produced a unique intermediate reactivity insertion rate for which a coincident high power trip signal on ex-core power detectors and the ΔT-power calculator was predicted. This reactivity insertion rate was termed the "cut-off reactivity" since it represented the point

[illegible]

[illegible]

at which reactor protection provided by one power measurement device "cuts off" and was replaced by the other power measurement device.

The St. Lucie Unit 2 Cycle 4 CEA withdrawal input data was examined and it was determined that there exists a physical minimum possible reactivity insertion rate for each initial insertion up to 25% inserted and that the rod shadowing factors (for the lead bank) are lower than previously assumed. This has enabled the justification of higher allowable RTD response times (of up to 16.0 seconds) based on the Power Dependent Insertion Limit (PDIL) allowed insertions and calculated CEA group reactivity worths.

The existence of a minimum reactivity insertion rate (greater than zero) eliminated the need to examine the very small reactivity insertion rates. The reduction in the rod shadowing factor also increased the sensitivity of the ex-core power measurement over the full range of the remaining possible reactivity insertion rates. These two improvements in the physics data input to the CEA withdrawal transient analysis were sufficient to analytically demonstrate that the ex-core power measurement input and a cold leg temperature with a RTD time constant of 16.0 seconds input to the TM/LP calculator provides adequate protection for all physically possible CEA withdrawal events. Accordingly, Table 3.3.2 of Technical Specification 3.3.1 has been revised to permit RTD response times up to 16.0 seconds.

Attachment 3 provides a detailed analysis of the CEA withdrawal event used to establish the TM/LP setpoints. This analysis used the physics data described above.

The RTD time delay is also footnoted as being applicable to the Local Power Density - High (LPD) and Variable Power Level - High (VHPT) reactor trips in Technical Specification Table 3.3 - 2. With respect to the VHPT, this trip is explicitly modeled in the CEA withdrawal analyses discussed above. The LPD trip is not credited in the CEA withdrawal analyses or any other accident analyses. As a result, the increase in RTD delay time will not result in a reduction in any margin of safety for either the LPD or VHPT reactor trips.

With regard to the change proposed in the Bases section, the following comments apply.

Section 2.2.1 of the Bases for Section 2.0, Safety Limits and Limiting Safety System Settings, discusses the allowance in the TM/LP trip setpoint to compensate for the pressure measurement error and the time delay associated with terminating the margin degradation after trip. In performing the re-analysis of the CEA withdrawal event, it was discovered that the specific values currently in the Bases do not reflect the values that had been used in the TM/LP setpoint analysis for St. Lucie Unit 2.

Since St. Lucie Unit 2 Cycle 2, a pressure measurement error of 55 psia and a pressure bias for margin degradation after trip of 70 psia has been used. When a 16.0 seconds RTD delay time constant is assumed in conjunction with an ex-core power measurement input to the TM/LP, the value of 70 psia remains valid as discussed in Attachment 3. The proposed changes to this section of the Bases are included in Attachment 1.

ATTACHMENT 3

CONTROL ELEMENT ASSEMBLY WITHDRAWAL AT POWER TO VERIFY TM/LP SETPOINTS

Summary

Two types of CEA withdrawal analyses are performed. One CEA withdrawal analysis is one performed to verify that the peak RCS pressure limit of 2750 psia is not violated. Another CEA withdrawal analysis is performed to generate the transient power decalibration and pressure bias input used in establishing the Thermal Margin/Low Pressure trip LSSS limits and equipment setpoints.

In the analysis of each of these two types of CEA withdrawal events, conservative input data is assumed. However, because the analysis acceptance criterion for each is different, the conservative input assumptions that must be made are not necessarily the same for each type of analysis.

The analysis of the CEA withdrawal to determine peak RCS pressure is the one presented in the FSAR and Reload Safety Evaluations (RSE's). The analysis done for Cycle 2 (and presented in L-CE-10395) is still conservative, even with 16 second RTD response times, and was not redone. However, the analysis done to generate the TM/LP setpoint input data was redone and is presented below. Based on these evaluations, it was determined that the Technical Specification allowable RTD response time can be increased from 8 to 16 seconds without having to change the current Technical Specification TM/LP LSSS limits or equipment setpoints.

Description of Transient and Key Assumptions Used

An uncontrolled sequential withdrawal of CEA's is assumed to occur as a result of a single failure in either the control element drive mechanism, control element drive mechanism control system, reactor regulating system, or as a result of operator error.

The withdrawal of CEA's adds positive reactivity to the core causing the core power and heat flux to increase. Since the heat extraction from the steam generators remains relatively constant, there will be an increase in reactor coolant temperature. While a continuous withdrawal of CEA's is considered unlikely, the reactor protection system is designed to terminate such a transient before fuel thermal design limits are reached.

A CEA withdrawal event can approach the DNBR Specified Acceptable Fuel Design Limit (SAFDL). With properly established setpoints, the action of the Thermal Margin/Low Pressure (TM/LP) prevents exceeding this limit. Backup trips that are available to also terminate the event, and prevent exceeding this limit, are the Variable High Power (VHP) and High Pressurizer Pressure (HPP) trips.

The input parameters and initial conditions used in the analysis to determine the input to the TM/LP setpoints are listed in Table C-1. The TM/LP setpoints are determined by selecting the most limiting CEA withdrawal event with respect to decalibration of the input power measurement signal.

A CEA withdrawal analysis from full power bounds all Mode 1 operation. For this analysis, the event was assumed to be initiated at a power level 10% below the normal High Power trip setting of 107% power. This allows for the Variable High Power setting being 10% above the initial power level to maximize the time required to get a High Power trip. In the analysis, the calculated power level accounts for any power decalibration produced as a result of the transient.

The withdrawal of CEA's causes the neutron flux power measured by the ex-core detectors to be decalibrated due to rod shadowing. Power signals from the ΔT-power calculator are also decalibrated by slow RTD response times.

The CEA's are assumed to be withdrawn at a fixed rate of 30 inches/minute. The core power will increase at a rate dependent on the differential worth of those CEA's being withdrawn. If the CEA's being withdrawn have a high differential worth, the core power will increase at a faster rate. Conversely, if the CEA's being withdrawn have a low differential worth the power will increase at a slower rate.

For positive MTC's the core average temperature and core power increase and degrade DNB margin until trip for all reactivity insertion rates. Thus, a positive MTC of $+.3 \times 10^{-4}\ \Delta\rho/^{o}F$ was assumed in the analysis.

Objective of Analysis

The CEA withdrawal event initiated at or near rated thermal power is one of the DBE's analyzed to establish the TM/LP setpoints. These setpoints, along with conservative temperature, pressure, and power trip input signals assures that the TM/LP trip prevents the DNBR from dropping below the SAFDL limit (DNBR = 1.28 based on CE-1 correlation) for a CEA withdrawal event. The objective of the analysis was to demonstrate that trips would be initiated in time to prevent violation of the DNBR SAFDL for RTD response times up to 16 seconds.

Analytical Method and Results

For the previous CEA withdrawal analysis (for Cycle 3) done to generate TM/LP input data, the limiting CEA withdrawal event was established by performing parametric studies to determine a "cut-off" reactivity insertion rate. The "cut-off" reactivity insertion rate is defined as the rate at which a high power trip will be initiated based on simultaneous ex-core power and ΔT-power signals. Reactivity insertions from 0.0 to $1.6 \times 10^{-4}\ \Delta\rho$/sec were considered.

For large reactivity insertion rates, the ex-core power detectors experience little decalibration since a trip is initiated quickly. For these large reactivity insertion rates the ΔT-power measurement lags behind the actual power due to the relatively large RTD response times, but the flux power signal provides an accurate core power indication. For small reactivity insertion rates, the ΔT-power can more accurately follow the slow temperature changes, but the ex-core power detectors can experience substantial decalibration, if the CEA motion is large enough and the reactivity insertion rate is slow enough to cause significant rod shadowing of the detectors. Thus, for slower CEA withdrawal transients the ΔT-power signal can provide a more accurate measure of core power. At some intermediate reactivity withdrawal rate (termed the "cut-off" reactivity), the two effects are balanced. This "cut-off" reactivity rate is then defined as the limiting CEA withdrawal event. For this limiting event, the trip is initiated simultaneously by flux power and ΔT-power signals, and the overall transient power decalibration and γ bias input to the TM/LP trip limits are maximized.

For Cycle 4, the physics data on differential rod worth shows that there is a minimum reactivity insertion rate associated with each initial CEA insertion. Therefore, reactivity insertion rates below these minimums need no longer be considered since they aren't physically possible at the initial insertions allowed by the Technical Specification PDIL limits. With the CEA withdrawal events with very small reactivity insertion rates and long durations thus eliminated, the ex-core detector power signals were shown to provide an acceptable measurement of power for the full range of possible CEA withdrawal events that need to be considered with respect to TM/LP input. Larger RTD response times of up to 16 seconds are, therefore, acceptable.

The worst case CEA withdrawal event, the event which causes the greatest ex-core flux power decalibration, has a reactivity insertion rate of $+.0245 \times 10^{-4}$ $\Delta\rho$/sec and was associated with an initial ASI of +.4 (i.e., highly bottom peaked axial power shape). This CEA withdrawal event simulation was terminated by a reactor trip on high power at 99.2 seconds. A duration of 99.2 seconds corresponds to an initial CEA group insertion of 36.3%.

The maximum transient power decalibration, and associated pressure (γ) bias, predicted for the worst CEA withdrawal case were less than had been assumed in generating the existing Technical Specification TM/LP setpoints. The pressure bias term accounts for the amount of DNB degradation after trip. The value of this term assumed in establishing the current TM/LP setpoints is 70 psia. Thus, the existing TM/LP LSSS limits and setpoints were verified to bound the most limiting CEA withdrawal event, including an RTD time constant of 16 seconds.

Conclusion

The analysis of the CEA withdrawal events demonstrates that the action of the RPS prevents exceeding the fuel DNBR SAFDL during an uncontrolled CEA withdrawal event.

TABLE C-1

KEY PARAMETERS ASSUMED FOR THE CEA WITHDRAWAL EVENT

Parameter	Units	Value
Total RCS Power (Core Thermal Power and Pump Heat)	MWt	2639
Initial Core Inlet Temperature	°F	548.50
Initial Reactor Coolant System Pressure	psia	2208.24
Moderator Temperature Coefficient	10^{-4} $\Delta\rho$/°F	+ 0.3
Doppler Coefficient Multiplier		0.85
CEA Worth at Trip	% $\Delta\rho$	- 4.3
Reactivity Insertion Rate	10^{-4} $\Delta\rho$/sec	0.0245
Rod Group Withdrawal Speed	inches/min	30

ATTACHMENT 4

Determination of No Significant Hazards Consideration

The standards used to arrive at a determination that a request for amendment involves no significant hazards consideration are included in the Commission's regulation, 10 CFR 50.92 which state that no significant hazards considerations are involved if the operation of the facility in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety. Each standard is discussed as follows:

(1) Operation of the facility in accordance with the proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

The Resistance Temperature Detector (RTD) response time affects only measurement hardware which passively ascertains the coolant temperature condition, not active hardware impacting the plant's physical thermal-hydraulic operations. Therefore, the proposed change does not increase the probability of occurrence of any accident. As described before, the safety analyses demonstrate that the same degree of protection is available at the longer RTD response times since the ex-core power detectors (which do not depend on RTD response time) now provide the required protection when more realistic physics inputs are used. With regard to operations, it should be noted that the plant will be operated in the same manner as before. Therefore, the calculated consequences of the accidents will not increase due to this change.

(2) Use of the modified specification would not create the possibility of a new or different kind of accident from any accident previously evaluated.

The proposed change to the Technical Specifications does not affect any active hardware involving plant operation, nor does it alter the basic methodology of the safety analyses. Therefore, it will not create the possibility of a new or different kind of accident from those accidents previously evaluated.

(3) Use of the modified specification would not involve significant reduction in a margin of safety.

The value of the RTD response time affects the ability of the ΔT-power calculator to accurately measure power during a transient. It has been demonstrated that the ex-core power detectors will provide an adequate power measurement input to the Thermal Margin/Low Pressure (TM/LP) trip for the full spectrum of possible power excursions associated with the CEA withdrawal events with a slight increase in margin to the TM/LP trip setpoint. Thus, the margin of safety is not reduced.

Based on the above, we have determined that the proposed amendment does not (1) involve significant increase in the probability or consequences of an accident previously evaluated, (2) create the probability of a new or different kind of accident from any accident previously evaluated, or (3) involve a significant reduction in a margin of safety; and therefore does not involve a significant hazard consideration.

EJWPSL2