Mr. William T. Cottle
President and Chief Executive Officer
STP Nuclear Operating Company
South Texas Project Electric
Generating Station
P. O. Box 289
Wadsworth, TX 77483

April 19, 1999

SUBJECT: SOUTH TEXAS PROJECT, UNITS 1 AND 2 - ISSUANCE OF AMENDMENTS RE: REACTOR COOLANT SYSTEM FLOW MONITORING (TAC NOS. M99245 AND M99246)

Dear Mr. Cottle:

The Commission has issued the enclosed Amendment No. 108 to Facility Operating License No. NPF-76 and Amendment No. 95 to Facility Operating License No. NPF-80 for the South Texas Project, Units 1 and 2, respectively. The amendments consist of changes to the Technical Specifications (TSs) in response to your application dated August 6, 1997, as supplemented by letters dated September 4 and 18, 1997, December 9, 1997, and February 4, 1999.

The amendments revise TS Table 2.2-1 and TS 3/4.2.5 to allow the reactor coolant system total flow rate to be determined using cold leg elbow tap differential pressure measurements.

A copy of our related Safety Evaluation is enclosed. The Notice of Issuance will be included in the Commission's next biweekly Federal Register notice.

Sincerely,

ORIGINAL SIGNED BY:

Thomas W. Alexion, Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

DF01

Docket Nos. 50-498 and 50-499

Enclosures: 1. Amendment No. 108 to NPF-76
2. Amendment No. 95 to NPF-80
3. Safety Evaluation

cc w/encls: See next page

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

April 19, 1999

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President and Chief Executive Officer
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Docket Nos. 50-498 and 50-499

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1. Amendment No. 108 to NPF-76
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3. Safety Evaluation

cc w/encls: See next page

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

STP NUCLEAR OPERATING COMPANY

DOCKET NO. 50-498

SOUTH TEXAS PROJECT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 108
License No. NPF-76

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by STP Nuclear Operating Company* acting on behalf of itself and for Houston Lighting & Power Company (HL&P), the City Public Service Board of San Antonio (CPS), Central Power and Light Company (CPL), and City of Austin, Texas (COA) (the licensees), dated August 6, 1997, as supplemented by letters dated September 4 and 18, 1997, December 9, 1997, and February 4, 1999, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

*STP Nuclear Operating Company is authorized to act for Houston Lighting & Power Company (HL&P), the City Public Service Board of San Antonio, Central Power and Light Company and City of Austin, Texas and has exclusive responsibility and control over the physical construction, operation and maintenance of the facility.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and Paragraph 2.C.(2) of Facility Operating License No. NPF-76 is hereby amended to read as follows:

   2. <u>Technical Specifications</u>

      The Technical Specifications contained in Appendix A, as revised through Amendment No. 108, and the Environmental Protection Plan contained in Appendix B, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. The license amendment is effective as of its date of issuance to be implemented within 7 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Robert A Gramm

Robert A. Gramm, Chief, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: April 19, 1999

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

STP NUCLEAR OPERATING COMPANY

DOCKET NO. 50-499

SOUTH TEXAS PROJECT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 95
License No. NPF-80

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by STP Nuclear Operating Company* acting on behalf of itself and for Houston Lighting & Power Company (HL&P), the City Public Service Board of San Antonio (CPS), Central Power and Light Company (CPL), and City of Austin, Texas (COA) (the licensees), dated August 6, 1997, as supplemented by letters dated September 4 and 18, 1997, December 9, 1997, and February 4, 1999, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, as amended, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

---

*STP Nuclear Operating Company is authorized to act for Houston Lighting & Power Company (HL&P), the City Public Service Board of San Antonio, Central Power and Light Company and City of Austin, Texas and has exclusive responsibility and control over the physical construction, operation and maintenance of the facility.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and Paragraph 2.C.(2) of Facility Operating License No. NPF-80 is hereby amended to read as follows:

   2. <u>Technical Specifications</u>

      The Technical Specifications contained in Appendix A, as revised through Amendment No. 95 , and the Environmental Protection Plan contained in Appendix B, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. The license amendment is effective as of its date of issuance to be implemented within 7 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Robert A Gramm

Robert A. Gramm, Chief, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: April 19, 1999

ATTACHMENT TO LICENSE AMENDMENT NOS. 108 AND 95

FACILITY OPERATING LICENSE NOS. NPF-76 AND NPF-80

DOCKET NOS. 50-498 AND 50-499

Replace the following pages of the Appendix A Technical Specifications with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
2-3	2-3*
2-4	2-4
3/4 2-11	3/4 2-11
B 3/4 2-5	B 3/4 2-5*
B 3/4 2-6	B 3/4 2-6

*Overleaf pages provided to maintain document completeness. No changes contained on these pages.

2.2 LIMITING SAFETY SYSTEM SETTINGS

REACTOR TRIP SYSTEM INSTRUMENTATION SETPOINTS

2.2.1 The Reactor Trip System Instrumentation and Interlock Setpoints shall be set consistent with the Trip Setpoint values shown in Table 2.2-1.

APPLICABILITY: As shown for each channel in Table 3.3-1.

ACTION:

a. With a Reactor Trip System Instrumentation or Interlock Setpoint less conservative than the value shown in the Trip Setpoint column but more conservative than the value shown in the Allowable Value column of Table 2.2-1, adjust the Setpoint consistent with the Trip Setpoint value.

b. With the Reactor Trip System Instrumentation or Interlock Setpoint less conservative than the value shown in the Allowable Value column of Table 2.2-1, either:

   1. Adjust the Setpoint consistent with the Trip Setpoint value of Table 2.2-1 and determine within 12 hours that Equation 2.2-1 was satisfied for the affected channel, or

   2. Declare the channel inoperable and apply the applicable ACTION statement requirement of Specification 3.3.1 until the channel is restored to OPERABLE status with its Setpoint adjusted consistent with the Trip Setpoint value.

Equation 2.2-1 $$Z + R + S \leq TA$$

Where:

Z = The value from Column Z of Table 2.2-1 for the affected channel,

R = The "as-measured" value (in percent span) of rack error for the affected channel,

S = Either the "as-measured" value (in percent span) of the sensor error, or the value from Column S (Sensor Error) of Table 2.2-1 for the affected channel, and

TA = The value from Column TA (Total Allowance) of Table 2.2-1 for the affected channel.

TABLE 2.2-1

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TOTAL ALLOWANCE (TA)	Z	SENSOR ERROR (S)	TRIP SETPOINT	ALLOWABLE VALUE
1. Manual Reactor Trip	N.A.	N.A.	N.A.	N.A.	N.A.
2. Power Range, Neutron Flux					
a. High Setpoint	7.5	6.1	0	≤109% of RTP**	≤110.7% of RTP**
b. Low Setpoint	8.3	6.1	0	≤25% of RTP**	≤27.7% of RTP**
3. Power Range, Neutron Flux, High Positive Rate	2.1	0.5	0	≤5% of RTP** with a time constant ≥2 seconds	≤6.7% of RTP** with a time constant ≥2 seconds
4. Deleted					
5. Intermediate Range, Neutron Flux	16.7	8.4	0	≤25% of RTP**	≤31.1% of RTP**
6. Source Range, Neutron Flux	17.0	10.0	0	$\leq 10^5$ CPS	$\leq 1.4 \times 10^5$ cps
7. Overtemperature ΔT	10.7	8.7	1.5 + 1.5#	See Note 1	See Note 2
8. Overpower ΔT	4.7	2.1	1.5	See Note 3	See Note 4
9. Pressurizer Pressure-Low	5.0	2.3	2.0	≥1870 psig	≥1860 psig
10. Pressurizer Pressure-High	5.0	2.3	2.0	≤2380 psig	≤2390 psig
11. Pressurizer Water Level-High	7.1	4.3	2.0	≤92% of instrument span	≤94.1% of instrument span
12. Reactor Coolant Flow-Low	N/A	N/A	N/A	≥91.8% of loop design flow*	≥91.4% of loop design flow*

* Loop design flow = 95,400 gpm (or 92,500 gpm for alternate operation with reduced RCS flow)
**RTP = RATED THERMAL POWER
1.5% span for ΔT; 1.5% span for Pressurizer Pressure

3/4.2.5 DNB PARAMETERS

LIMITING CONDITION FOR OPERATION

3.2.5 The following DNB-related parameters shall be maintained within the limits following:

a. Reactor Coolant System T_{avg}, ≤ 598°F
(or ≤ 595°F with reduced RCS flow of 3.2.5.c)

b. Pressurizer Pressure, > 2189 psig*

c. Reactor Coolant System Flow, ≥ 392,300 gpm**
(or ≥380,500 gpm** with reduced RCS T_{avg} of 3.2.5.a)

APPLICABILITY: MODE 1.

ACTION:

With any of the above parameters exceeding its limit, restore the parameter to within its limit within 2 hours or reduce THERMAL POWER to less than 5% of RATED THERMAL POWER within the next 4 hours.

SURVEILLANCE REQUIREMENTS

4.2.5.1 Each of the parameters shown above shall be verified to be within its limits at least once per 12 hours. The provisions of Specification 4.0.4 are not applicable for verification that RCS flow is within its limit.

4.2.5.2 The RCS flow rate indicators shall be subjected to a channel calibration at least once per 18 months.

NOTE
SR 4.2.5.3 is required at beginning-of-cycle with reactor power ≥90% RTP.

4.2.5.3 The RCS total flow rate shall be determined by precision heat balance or elbow tap ΔP measurements at least once per 18 months. The provisions of Specification 4.0.4 are not applicable.

* Limit not applicable during either a Thermal Power ramp in excess of 5% of RTP per minute or a Thermal Power step in excess of 10% RTP.

**Includes a 2.8% flow measurement uncertainty.

HEAT FLUX HOT CHANNEL FACTOR and NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR (Continued)

When an F_Q measurement is taken, an allowance for both experimental error and manufacturing tolerance must be made. An allowance of 5% is appropriate for a full-core map taken with the Incore Detector Flux Mapping System, and a 3% allowance is appropriate for manufacturing tolerance.

The Radial Peaking Factor, $F_{xy}(Z)$, is measured periodically to provide assurance that the Hot Channel Factor, $F_Q(Z)$, remains within its limit. The F_{xy} limit for RATED THERMAL POWER (F_{xy}^{RTP}) as provided in the Core Operating Limits Report (COLR) per Specification 6.9.1.6 was determined from expected power control manuevers over the full range of burnup conditions in the core.

3/4.2.4 QUADRANT POWER TILT RATIO

The QUADRANT POWER TILT RATIO limit assures that the radial power distribution satisfies the design values used in the power capability analysis. Radial power distribution measurements are made during STARTUP testing and periodically during power operation.

The limit of 1.02, at which corrective action is required, provides DNB and linear heat generation rate protection with x-y plane power tilts. A limit of 1.02 was selected to provide an allowance for the uncertainty associated with the indicated power tilt.

The 2-hour time allowance for operation with a tilt condition greater than 1.02 is provided to allow identification and correction of a dropped or misaligned control rod. In the event such action does not correct the tilt, the margin for uncertainty on F_Q is reinstated by reducing the maximum allowed power by 3% for each percent of tilt in excess of 1.

For purposes of monitoring QUADRANT POWER TILT RATIO when one excore detector is inoperable, the moveable incore detectors are used to confirm that the normalized symmetric power distribution is consistent with the QUADRANT POWER TILT RATIO. The incore detector monitoring is done with a full incore flux map or two sets of four symmetric thimbles. The two sets of four symmetric thimbles is a unique set of eight detector locations. These locations are C-8, E-5, E-11, H-3, H-13, L-5, L-11, N-8.

3/4.2.5 DNB PARAMETERS

The limits on the DNB-related parameters assure that each of the parameters are maintained within the normal steady-state envelope of operation assumed in the transient and accident analyses. The limits are consistent with the

3/4.2.5 DNB PARAMETERS (Continued)

initial FSAR assumptions and have been analytically demonstrated adequate to maintain a minimum DNBR of greater than or equal to the design limit throughout each analyzed transient. The T_{avg} value of 598°F and the pressurizer pressure value of 2189 psig are analytical values. The readings from four channels will be averaged and then adjusted to account for measurement uncertainties before comparing with the required limit. The flow requirement (392,300 gpm) includes a measurement uncertainty of 2.8%.

Technical Specification 3.2.5 provides for an alternate minimum measured Reactor Coolant System flow limit consistent with plugging up to 10% of steam generator tubes and Departure from Nucleate Boiling requirements. When using the alternate minimum flow limit, the T_{avg} limit is reduced to 595°F for Reactor Coolant System flow no less than 380,500 gpm. Setpoint and constant values for OPΔT and OTΔT are also revised accordingly when this alternate mode of operation is entered.

The RCS flow measurement uncertainty of 2.8% bounds the precision heat balance and the elbow tap Δp measurement methods. The elbow tap Δp measurement uncertainty presumes that elbow tap Δp measurements are obtained from either QDPS or the plant process computer. Based on instrument uncertainty assumptions, RCS flow measurements using either the precision heat balance or the elbow tap Δp measurement methods are to be performed at greater than or equal to 90% RTP at the beginning of a new fuel cycle. The elbow tap Δp RCS flow measurement methodology is described in ST-HL-AE-5707, "Proposed Amendment to Technical Specification Table 2.2-1 and 3/4.2.5 for Reactor Coolant System Flow Monitoring - Revised," dated August 6, 1997, and in ST-HL-AE-5752, "Amended Response to Request for Additional Information on the Proposed Elbow Tap Technical Specification Change (Table 2.2-1 and Section 3/4.2.5)," dated September 18, 1997.

The 12-hour periodic surveillance of these parameters through instrument readout is sufficient to ensure that the parameters are restored within their limits following load changes and other expected transient operation.

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NOS. 108 AND 95 TO

FACILITY OPERATING LICENSE NOS. NPF-76 AND NPF-80

STP NUCLEAR OPERATING COMPANY, ET AL.

DOCKET NOS. 50-498 AND 50-499

SOUTH TEXAS PROJECT, UNITS 1 AND 2

1.0 INTRODUCTION

By application dated August 6, 1997 (Reference 1), as supplemented by letters dated September 4 and 18, 1997 (References 2 and 7), December 9, 1997 (Reference 10), and February 4, 1999 (Reference 9), STP Nuclear Operating Company, et al. (the licensee), requested changes to the South Texas Project (STP), Units 1 and 2, Technical Specifications (TSs). The proposed changes would revise TS Table 2.2-1, "Reactor Trip System Instrumentation Trip Setpoints," TS 3/4.2.5, "DNB [Departure from Nucleate Boiling] Parameters," and associated Bases, to allow for the use of the cold leg elbow tap differential pressure (Δp) measurement as an alternate method for measuring reactor coolant system (RCS) flow rate.

The September 4 and 18, 1997, December 9, 1997, and February 4, 1999, supplements provided clarifying information that did not change the scope of the original application and did not change the initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

Limiting Conditions for Operation (LCO) 3.2.5 requires the RCS flow to be maintained greater than or equal to the specified limit value during Mode 1 operation. This LCO RCS minimum measured flow is an input value in the safety analyses of the design-basis transients using the Revised Thermal Design Procedure (RTDP) (Reference 3) to demonstrate that the DNB ratio (DNBR) limit is not violated for these events. Surveillance Requirements (SRs) 4.2.5.1 through 4.2.5.3, respectively, require that the RCS flow be verified within its limit at least once per 12 hours, the RCS flow rate indicators be subjected to a channel calibration at least once per 18 months, and the RCS total flow rate be determined by precision heat balance measurements at least once per 18 months.

In the precision heat balance measurement, calorimetric measurements are made on the steam generator secondary side with the feedwater flow rates measured by venturi meters. The RCS flow rate is calculated from the precision calorimetric measurement in conjunction with the enthalpy rise across the reactor vessel as indicated by the hot and cold leg resistance temperature detectors (RTDs). Each hot leg has three RTDs installed around a cross-section to determine the bulk hot leg temperature. However, due to the use of low leakage core loading patterns that result in changes in the core radial power distribution, the phenomenon of increased hot leg temperature streaming has been observed in many plants. As a result of increased temperature streaming, the bulk hot leg temperature as measured by the three RTDs in each hot leg is erroneously high, resulting in a calculated RCS flow lower than the actual value. Therefore, the licensee proposes to use the cold leg elbow taps in place of the precision heat balance for the RCS flow measurements. The use of elbow taps RCS flow measurement has been approved by the NRC for the McGuire and Catawba nuclear stations (References 4 and 5).

The proposed TS changes would revise SR 4.2.5.3 to allow for the use of elbow tap Δp measurements as an alternate method for performing the 18-month RCS flow surveillance. No change is made on the RCS flow measurement uncertainty of 2.8 percent. TS Bases 3/4.2.5 is revised to reflect the use of the cold leg elbow tap Δp measurements, and to indicate that the flow measurement uncertainty of 2.8 percent assigned in the TS bounds the precision heat balance and the elbow tap Δp measurement methods.

The licensee also proposed to change the "Reactor Coolant Flow-Low" trip function in Table 2.2-1, "Reactor Trip System Instrumentation Trip Setpoints," from "Five Column" to "Two Column" specification by specifying as "N/A" for the three variables associated with instrumentation uncertainties, TA, Z, and S. Also, as a result of using the cold leg elbow taps as an alternative RCS total flow measurement, the "Allowable Value" for this trip function is revised from 90.5 percent to 91.4 percent of loop design flow.

3.0 EVALUATION

As part of the request for TS changes (Reference 1) to allow for the use of cold leg elbow tap Δp measurements in place of the precision heat balance measurements of the RCS flow, the licensee also provided a methodology of using the cold leg elbow taps for the RCS flow measurement in Attachment 5, "RCS Flow Measurement Using Elbow Tap Methodology Licensing Submittal" (Reference 6). The staff evaluation of the proposed TS changes, as discussed in the ensuing sections, includes the appropriateness of the cold leg elbow tap flow measurement, the procedure for converting the elbow tap Δp measurement to the RCS flow, the best estimate hydraulics calculation for RCS flow measurement confirmation, the flow measurement uncertainty evaluation, and the TS changes.

3.1 Elbow Tap Flow Measurement Application

3.1.1 Elbow Tap Flow Measurement

Cold leg elbow tap flow meters are used by Westinghouse plants, including STP, Units 1 and 2, for verification of the RCS flow every 12 hours. The purpose of the 12-hour elbow tap surveillance reading is to verify that the full power steady state flow has not decreased below its limit during the cycle. The principle of operation of an elbow meter is based on the centrifugal force of a fluid flowing through an elbow creating a Δp between the inner and outer radii of the elbow. The relationship between the volumetric flow rate through an elbow, Q, and Δp between the pressure taps at the outer and inner radii of the elbow can be expressed as $Q = C\,\Delta p^{1/2}$. The elbow meter coefficient C is a function of elbow bend and cross-section radii, and is affected by the location of pressure taps, upstream and downstream piping, and other factors.

The cold leg elbow tap - flow element is not calibrated in advance in a laboratory, but the measurement is typically normalized against the established RCS flow rate from the precision heat balance calorimetric flow measurement at the start of each fuel cycle. The cold leg elbow taps are typically used as an indication of relative changes in the RCS flow, rather than a measurement of absolute value of the RCS flow. The cold leg elbow tap Δp also provides a measure of the reduced RCS flow rate for the low-flow reactor trip.

The configuration of the STP, Units 1 and 2, cold leg elbow taps is described in the licensee's response to a staff request for additional information (Question number 12, Reference 7). The elbow taps are located in a plane 22.5 degrees around the first 90-degree elbow turn in each of the cold legs. Each elbow has three low pressure taps spaced 15 degrees apart on the inside pipe radius and one high pressure tap on the outside pipe radius used as a common tap. The pressure taps are connected to three differential pressure transmitters to obtain Δp data. As the elbow taps in the cold legs are fixed, the elbow meter coefficients in each elbow tap configuration should remain unchanged. The licensee also cited an ASME publication (Reference 8) stating that tests have demonstrated that elbow tap flow measurements have a high degree of repeatability, and are not affected by changes in the elbow surface roughness.

To confirm elbow tap flow measurement repeatability, Section 3.4.1 of Reference 6 provides the comparisons of the data between the RCS flow measurements using the elbow taps and ultrasonic leading edge flow meters (LEFM) from the Hydraulic Test Program at Prairie Island Unit 2. The Prairie Island Unit 2 Hydraulic Test Program was in place since 1973 and the test data covered 11 years of plant operation, during which a significant change in system hydraulics was made. The data show that the elbow tap measurements agree to within 0.3 percent of the LEFM flow measurements. The licensee also evaluated various processes or phenomena for possible effects on the elbow tap flow measurements. The evaluation includes the effects of fouling, erosion, upstream velocity distribution, steam generator tube plugging and replacement. The licensee concluded that (1) the condition for fouling process is not present in the cold leg elbow since there is no change in cross section to produce a velocity increase and ionization, (2) erosion of the stainless steel elbow surface is unlikely and the flow velocities are not large relative to the conditions that cause erosion, (3) the upstream velocity distribution, including the distribution in the elbow tap flow meter, remains constant so the elbow tap flow meter Δp versus flow relationship does not change, (4) the plenum velocity head approaching the outlet nozzle is small compared to the piping velocity head, and therefore, steam generator (SG) tube plugging does not affect elbow tap flow measurement repeatability, and (5) the configuration of the replaced SG is the same and the same difference in plenum and nozzle velocity heads will exist, therefore, SG replacement will have no impact on the elbow tap flow coefficient.

Although the elbow taps have not been calibrated and the flow coefficients have not been determined, the RCS flow measurements by the elbow taps have been normalized against the precision heat balance flow measurements. The staff concludes that as the elbow meter coefficients remain constant, the relative changes of flow rate through the cold leg elbows can be correlated with the relative changes in the elbow tap Δp.

3.1.2 <u>Elbow Tap Flow Measurement Procedure</u>

Section 3.4.2 of Reference 6 describes the procedure for determining the RCS flow from elbow tap measurements. This procedure relies on the total baseline calorimetric flow (BCF), which is based on the calorimetric flow measurements from the previous cycles. With a repeatability of elbow tap Δp to accurately verify RCS flow, the future cycle flow will be determined from the baseline calorimetric flow multiplied by the elbow tap flow ratio (R). The elbow tap flow ratio, R, is defined as $R = (K/B)^{1/2}$, where B is the "baseline elbow tap total flow coefficient" defined as $B = \Delta P_B \times v_B$, and K is the "future cycle elbow tap total flow coefficient" defined as $K = \Delta P_F \times v_F$.

The baseline and future cycle "flow coefficients" B and K, are calculated based on the average Δp from all elbow taps in the cold legs. For each individual elbow tap, the elbow meter coefficient C in the elbow meter equation would be constant, and the ratio of the volumetric flow rates through the elbow tap between two fuel cycles can be expressed in terms of the square root of the Δp ratio, which would be the same for the three elbow taps in the same cold leg, barring measurement uncertainties. In a question to the licensee (Question number 2b, Reference 9), the staff asked whether it would be appropriate to define the elbow tap flow ratio, R, based on the average of the square root of the Δp ratios from all elbow taps. In response to this question, the licensee provided comparisons of calculations of the elbow tap flow ratio R using the average of the square root of the Δp ratios and the method described in Section 3.4.2 using the average Δp, respectively, based on data from the STP, Units 1 and 2, indicated transmitter Δp values for each cycle. The results show insignificant difference between the two calculations, with the method of Section 3.4.2 being more conservative. The staff, therefore, finds this method acceptable.

The licensee also indicated, in response to a staff question (Question number 2c, Reference 9), that there is no need to include an additional allowance to the future cycle flow ratio R to account for the Δp ratio distribution among the elbow taps using an one-sided tolerance limit to provide a 95 percent probability at 95 percent confidence level. The overall approach in the elbow tap measurement procedure includes (1) a calculation of the future cycle flow ratio R based on the determination of the ratio (between the future and baseline cycles) of the average indicated Δp values, (2) a separate comparison with the predicted system flow to account for the hydraulic effects such as steam generator tube plugging, and (3) a separate uncertainty calculation to account for the flow measurement uncertainties. The best-estimate flow confirmation and the flow measurement uncertainty calculation will be discussed in Sections 3.1.3 and 3.1.4, respectively, of this Safety Evaluation. Based on the above, the staff concludes that the method of Section 3.4.2 of Reference 6 is acceptable.

Section 3.6.3 of Reference 6 describes the evaluation of calorimetric flows. For conservatism, the BCF will be calculated based on the average flow of all cycles listed in Table 3.6-3, i.e., Cycles 1 through 7 for STP Unit 1 and Cycles 1 through 6 for STP Unit 2. The staff found these average values to be lower and more conservative than the baseline Cycle 1 calorimetric flow values for STP, Units 1 and 2, and are, therefore, acceptable.

3.1.3 Best-Estimate Flow Confirmation

Section 3.4.2 of Reference 6 describes a procedure where the future total RCS flow determined from the elbow tap flow measurement is confirmed by a best-estimate hydraulics analysis. The best-estimate RCS flow calculation is based on the flow resistances of various components in the reactor coolant loops and the reactor coolant pump performance characteristics. Therefore, changes in the RCS flow rate can be evaluated based on system hydraulic changes in the plant, e.g., plugging and sleeving of SG U-tubes, reactor coolant pump wear, and changes in the fuel design.

With the best-estimate hydraulic analysis confirmation procedure, a comparison will be made between the measured elbow tap flow ratio (R) and an estimated flow ratio (R'), which is the ratio of the estimated future cycle RCS flow to the estimated initial baseline cycle flow based on the flow analysis of known RCS hydraulics changes, such as SG tube plugging or fuel design changes. If the measured elbow tap flow ratio R is greater than (1.004 x R'), R will be limited to (1.004 x R'), where the multiplier 1.004 applied to R' is a measure to provide an allowance of 0.4 percent for elbow tap flow measurement repeatability.

The repeatability value, which is used as an acceptance criterion for predicted versus measured RCS flow comparisons, was determined by a combination of the instrument uncertainties considered appropriate for two different cycle measurements of RCS flow at 100 percent rated thermal power by all of the cold leg elbow channels. A derivation of the repeatability value of 0.4 percent flow for STP, Units 1 and 2, was provided in response to staff requests for additional information (Question numbers 2 and 3, Reference 10). The repeatability allowance is implicitly included in the elbow tap flow measurement uncertainty calculations because all of the instrument uncertainties included in the repeatability derivation are common with those in the elbow tap flow measurement uncertainty calculations. The licensee states that since the elbow tap flow measurement uncertainty includes this repeatability allowance, the measured flow ratio R can be 0.4 percent higher than the estimated flow ratio R' and still define a conservative flow.

As described in Section 3.5 of Reference 6, the best-estimate RCS flow analysis employs an RCS flow calculational procedure developed by Westinghouse in 1974 using best-estimate values of the RCS component flow resistances and pump performance with no margins applied, so the resulting flow calculations define a true best-estimate of the actual flow. In the analysis, the flow resistances of the RCS loops, which are comprised of the reactor vessel, reactor coolant piping, and SGs, are used in conjunction with the reactor coolant pump head-flow performance to define individual loop and total RCS flows. The component hydraulic design data and hydraulic coefficients are determined from analyses of test data. The flow resistance of the reactor vessel, consisting of the reactor core, vessel internals and vessel nozzle, is determined from the Δp measurements of a full size fuel assembly hydraulic test, and hydraulic model test data for each type of reactor vessel. The reactor coolant piping flow resistance combines the resistances of the hot leg, crossover leg and cold leg piping, and is based on analyses of the effects of upstream and downstream components on elbow hydraulic loss coefficients, using the results of industry hydraulic tests. The flow resistance of the SG is defined in five parts: inlet nozzle, tube inlet, tubes, tube outlet, and outlet nozzle. This hydraulic analysis procedure has been confirmed by numerous component flow resistance tests and analyses, including the overall flow resistance confirmed by the Prairie Island Unit 2 Hydraulics Test Program. The licensee states that uncertainties in the best-estimate hydraulics analysis, based on both plant and component test data, define a flow uncertainty of 2 percent flow, indicating that actual flow is expected to be within 2 percent of the calculated best-estimate flow. This hydraulics analysis procedure has been applied to estimate RCS flows at all Westinghouse plants, including STP, Units 1 and 2.

The STP, Units 1 and 2, plant-specific best-estimate flow analyses are described in Section 3.6.1 of Reference 6, and the analytical model, including the RCS hydraulic network diagram, and component flow resistance values, are provided in response to a staff request for additional information (Question number 1, Reference 10). The analyses determined the baseline Cycle 1 initial startup flows of both units based on the baseline hydraulic designs.

Hydraulic changes during subsequent cycles, including pump impeller smoothing, SG plugging, and fuel design changes, are modeled to determine best-estimate flow rates of various cycles.

The licensee stated, in response to a staff question (Question number 13, Reference 10), that the best-estimate flow ratio R' is used mainly as a check on the measured elbow tap flow, and applied only if the elbow tap flow ratio R exceeds R' by more than the conservatively defined repeatability allowance or 0.4 percent flow. If such a difference occurs, it could be due either to larger instrument channel calibration uncertainties than considered in the 0.4 percent allowance or to an underprediction of best-estimate flow. In this situation, although the elbow tap flow measurement is most likely still a valid flow measurement, the conservative approach used in the procedure is to apply the lowest best-estimate flow based on the best-estimate flow ratio, increased by the repeatability allowance. The staff finds that the best-estimate hydraulic analysis will be used only as a confirmation of the elbow tap flow measurement and will not change the TS surveillance requirement for a flow measurement, and is, therefore, acceptable.

3.1.4 Flow Measurement Uncertainties

The RCS flow measurement uncertainties include the RCS flow calorimetric measurement uncertainties for the baseline cycle, and the plant process computer indication uncertainties for the current cycle RCS flow measurement using the cold leg elbow taps. Tables A-1, A-2, and A-3, respectively, in Appendix A of Reference 6 provides the values of the baseline calorimetric flow measurement instrumentation uncertainties, flow calorimetric sensitivities, and calorimetric flow measurement uncertainties. Tables A-4 and A-5, respectively, provide the cold leg elbow tap flow measurement uncertainties for the qualified digital processing system (QDPS) and process computer, and low-flow reactor trip uncertainties. The uncertainties for a calorimetric measurement or the elbow tap measurement consist of all components in the measurement channel, including noninstrument-related measurement errors such as temperature stratification of a fluid in a pipe, and instrument-related errors such as errors due to metering devices, calibration accuracies of sensors, process rack, and readout devices, drift, temperature, and pressure effects, etc. These uncertainty components are combined to derive a channel statistical allowance using the statistical combination technique consistent with the methodology recommended in NUREG/CR-3659 (Reference 11), which has been used in connection with the RTDP. In the statistical combination technique, those groups of components, which are statistically independent, are statistically combined, and those errors, which are not independent, are combined arithmetically to form independent groups, which can then be statistically combined. As the elbow tap measurements were normalized with the calorimetric measurements of the baseline cycles, the overall RCS flow measurement uncertainty is a statistical combination of the baseline cycle calorimetric measurement and elbow tap measurement uncertainties.

Table A-4 shows an overall RCS flow uncertainty of 2.6 percent for the QDPS/process computer for the four-loop STP plants. Table A-5 shows the total allowance of 4 percent flow span for the low-flow reactor trip function, which is higher than the calculated channel statistical allowance. The licensee in response to a staff question (Question number 15, Reference 10), provided the basis for the conclusion that the elbow tap measurement is a 95/95 probability/confidence value. The licensee asserted that the uncertainty input values relative to the reference accuracy, pressure and temperature effects, calibration accuracy for sensors and process racks, sensor and rack drift magnitudes, are 2σ (standard deviation) or better. In addition, a conservative baseline RCS calorimetric measurement uncertainty, and the utilization of a conservative algorithm for the determination of instrument channel uncertainties and the inclusion of conservative assumptions for systematic and process effects have lead to the conclusion that the overall uncertainty for RCS flow utilizing the cold leg elbow tap methodology and used for the RTDP analyses is a 95/95 probability/confidence value. Based on the above, the staff agrees that the overall uncertainty is a 95/95 probability/confidence value.

With the proposed TS changes to allow for the use of cold leg elbow tap measurement in place of the precision heat balance measurement of the RCS flow at the beginning of each fuel cycle, larger drift of the sensors and process racks may arise due to the absence of current normalization of the elbow taps against the precision heat balance flow measurement. In response to a staff question (Question number 3, Reference 9), the licensee provided information indicating that sufficient allowances have been included in the uncertainty calculation shown in Tables A-4 and A-5. Based on a review of the information, the staff concludes that the RCS flow uncertainty value of 2.8 percent, which is specified in the TS LCO 3.2.5 and used for the RTDP safety analysis, and the total allowance of 4 percent for the low flow reactor trip setpoint are acceptable.

3.2 <u>Technical Specification Changes</u>

TS SR 4.2.5.3 requires that the RCS total flow rate be determined by precision heat balance measurements at least once per 18 months. The proposed TS changes would revise SR 4.2.5.3 to allow for the use of elbow tap Δp measurement as an alternate method for performing the 18-month RCS flow surveillance. The flow measurement uncertainty of 2.8 percent in the existing TS LCO 3.2.5 remains unchanged. In Attachment 6 to Reference 10, the licensee also provided changes to the Bases of TS 3/4.2.5, by stating that "The RCS flow measurement uncertainty of 2.8% bounds the precision heat balance and the elbow tap Δp measurement methods. The elbow tap Δp measurement uncertainty presumes that elbow tap Δp measurements are obtained from either QDPS or the plant process computer. Based on instrument uncertainty assumptions, RCS flow measurements using either the precision heat balance or the elbow tap Δp measurement methods are to be performed at greater than or equal to 90% RTP at the beginning of a new fuel cycle." The revised Bases also identifies the documents, i.e., References 1 and 7, where the elbow tap Δp RCS flow measurement methodology is described. These changes allow for the use of elbow tap flow measurement to replace the precision heat balance measurements normally performed at the beginning of each operating cycle. In Appendix A to Reference 6, the licensee calculated the RCS measurement uncertainty, which combines the uncertainties associated with total RCS flow calorimetric measurement, and elbow tap Δp transmitters and indications via QDPS or the plant process computer, to be 2.6 percent, lower than the assigned 2.8 percent in the TSs. As discussed in Section 2.1 of this report, the staff has evaluated the elbow tap flow measurement methodology and procedure, and found them acceptable. Therefore, the proposed TS changes are acceptable.

TS Table 2.2-1, "Reactor Trip System Instrumentation Trip Setpoint," is revised for Functional Unit 12, "Reactor Coolant Flow-Low." In the proposed TS change, the low-flow "Trip Setpoint" will remain unchanged at 91.8 percent of the loop design flow, and the "Allowable Value" will be changed from the current value of 90.5 percent to 91.4 percent of loop design flow to reflect the increased uncertainties associated with the correlation of the elbow tap Δp measurement to a previous baseline calorimetric. Section 3.7.2 of Reference 6 indicates that the low-flow reactor trip limit of 87 percent flow is assumed in the current safety analyses. Therefore, margins of more than 4 percent of total allowance for the instrument uncertainties have been maintained for the low-flow trip setpoint and the allowable value above the safety analysis assumption. The staff, therefore, concludes that both the trip setpoint and the allowable value are acceptable.

In addition, the columns headed Total Allowance (TA), Z, and Sensor Error (S) are marked N/A, with only the values for the columns "Trip Setpoint" and "Allowance Value" specified. The licensee stated in Section 3.7.2 (Reference 6) that this two-column approach is consistent with the NRC position for the Standard Technical Specifications, Westinghouse Plants (NUREG-1431), which no longer includes the TA, Z, and S columns. With a two-column approach, channel operability is based on the Allowable Value/Trip Setpoint relationship as determined by the plant setpoint methodology (including process rack allowances) and confirmed through plant surveillances. As a result, the reactor coolant flow values for Z and S will no longer be applied to Equation 2.2-1, $Z+R+S \leq TA$ and are therefore marked N/A. With the values of TA, Z, and S deleted, the Action statement b.1 in LCO 2.2, Limiting Systems Settings, becomes invalid for Functional Unit 12, "Reactor Coolant Flow- Low." For Functional Unit 12, the channel must be declared inoperable when its setpoint is found less conservative than the allowable value or found inconsistent with the assumptions of the setpoint methodology. The two-column approach is conservative and is, therefore, acceptable to the staff.

4.0 <u>SUMMARY</u>

The staff has reviewed the proposed changes to TS SR 4.2.5.3 and associated Bases to allow for the use of the cold leg elbow tap flow measurement as an alternate method for performing the 18-month RCS flow surveillance, and the changes in Table 2.2-1 to use the "two column" approach for the "Reactor Coolant Flow-Low" trip channel. Based on its review of the technical bases regarding the cold leg elbow tap RCS flow measurement procedure and measurement uncertainty calculation provided in licensee's submittals, the staff finds these proposed changes to be acceptable.

5.0 <u>STATE CONSULTATION</u>

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

6.0 <u>ENVIRONMENTAL CONSIDERATION</u>

The amendments change 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 change surveillance requirements. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (62 FR 43556, August 14, 1997). 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 amendments.

7.0 CONCLUSION

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

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2. Letter, W. T. Cottle (HL&P) to US Nuclear Regulatory Commission, "South Texas Project Units 1 & 2, Docket Nos. STN 50-498, STN 50-499, Revision to Proposed Amendment to Technical Specification 4.2.5.3 for Reactor Coolant System Flow Monitoring," September 4, 1997, ST-HL-AE-5743.

3. WCAP-11397-P-A, "Revised Thermal Design Procedure," Westinghouse Electric Corporation, April 1989.

4. Letter from Victor Nerses (USNRC) to T. C. McMeekin (Duke Power Company), "Issuance of Amendments - McGuire Nuclear Station, Units 1 and 2, Reactor Coolant System (RCS) Flow Rate measurement (TAC Nos. M88659 and M88660)," January 12, 1995.

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6. Attachment 5 to Reference 1, "RCS Flow Measurement Using Elbow Tap Methodology Licensing Submittal," July 1997 (Proprietary).

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11. NUREG/CR-3659, PNL-4973, "A Mathematical Model for Assessing the Uncertainties of Instrumentation Measurements for Power and Flow of PWR Reactors," February 1985.