Union Electric
Callaway Plant

PO Box 620
Fulton, MO 65251

December 13, 2001

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

ULNRC-04583

Gentlemen:

DOCKET NUMBER 50-483
UNION ELECTRIC COMPANY
CALLAWAY PLANT
REVISION TO TECHNICAL SPECIFICATION 3.5.5
"SEAL INJECTION FLOW"

Union Electric Company herewith transmits an application for amendment to Facility Operating License No. NPF-30 for the Callaway Plant.

This amendment application would revise LCO 3.5.5, Required Action A.1, and SR 3.5.5.1 to replace the current, single-point acceptance criterion with a reactor coolant pump seal injection flow curve that is applicable throughout the LCO Applicability.

The Callaway Plant Onsite Review Committee and the Nuclear Safety Review Board have reviewed this amendment application. Attachments 1 through 5 provide the Evaluation, Markup of Technical Specifications, Retyped Technical Specifications, Proposed Technical Specification Bases Changes, and Proposed FSAR Changes, respectively, in support of this amendment request. Attachment 4 and Attachment 5 mark-ups are provided for information only. Final Bases changes will be implemented under our Technical Specification (TS) 5.5.14 Bases Control Program after NRC approval of this amendment application. Final FSAR changes will be implemented after this amendment is approved, subject to the updating requirements of 10CFR50.71(e). It has been determined that this amendment application does not involve a significant hazard consideration as determined per 10CFR50.92. Pursuant to 10CFR51.22(b),

A001

no environmental impact statement or environmental assessment need be prepared in connection with the issuance of this amendment.

Approval of this amendment application is requested by July 1, 2002. Once approved, this amendment should be issued effective immediately and to be implemented prior to entering MODE 3 ascending during the restart from Refuel 12 (fall of 2002), subject to the note above SR 3.5.5.1.

In accordance with 10CFR50.91, a copy of this amendment application is being provided to the designated Missouri State official. There are no collateral commitments associated with this amendment application.

If you have any questions on this amendment application, please contact us.

Very truly yours,

John D. Blosser
Manager-Regulatory Affairs

Attachments:

1 - Evaluation
2 - Markup of Technical Specifications
3 - Retyped Technical Specifications
4 - Proposed Technical Specifications Bases Changes (for information only)
5 - Proposed FSAR Changes (for information only)

STATE OF MISSOURI)
)   SS
CALLAWAY COUNTY)

John D. Blosser, of lawful age, being first duly sworn upon oath says that he is Manager Regulatory Affairs, for Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By _JDBlosser_
John D. Blosser
Manager Regulatory Affairs

SUBSCRIBED and sworn to before me this ___13th___ day

of ___December___, 2001.

Gloria J. Taylor

GLORIA J. TAYLOR
NOTARY PUBLIC
STATE OF MISSOURI - CALLAWAY COUNTY
NOTARY SEAL
MY COMMISSION EXPIRES JUNE 21, 2003

cc: M. H. Fletcher
Professional Nuclear Consulting, Inc.
19041 Raines Drive
Derwood, MD 20855-2432

Regional Administrator
U.S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive
Suite 400
Arlington, TX 76011-8064

Senior Resident Inspector
Callaway Resident Office
U.S. Nuclear Regulatory Commission
8201 NRC Road
Steedman, MO 65077

Mr. Jack Donohew (2)- **OPEN BY ADDRESSEE ONLY**
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
1 White Flint, North, Mail Stop OWFN 7E1
11555 Rockville Pike
Rockville, MD 20852-2738

Manager, Electric Department
Missouri Public Service Commission
P.O. Box 360
Jefferson City, MO 65102

Ron Kucera
Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

Denny Buschbaum - TXU
Comanche Peak SES
Farm Road 56
P.O.Box 1002
Glen Rose, TX 76043

Pat Nugent - PG&E
Mail Stop: 104/5/536
P.O. Box 56
Avila Beach, CA 93424

Mr. Scott M. Head - STPNOC
Mail Code N5014
P.O. Box 289
Wadsworth, TX 77483

Scott Bauer
Palo Verde Nuclear Generating Station
Arizona Public Service Company
Mail Station: 7636
P.O. Box 52034
Phoenix, AZ 85072-2034

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ATTACHMENT ONE
ULNRC04583

EVALUATION

EVALUATION

1.0 INTRODUCTION

1.1 This amendment application revises Technical Specification (TS) 3.5.5, "Seal Injection Flow." This application revises the TS 3.5.5 Limiting Condition for Operation (LCO), Required Action A.1, and SR 3.5.5.1 to replace the current, single-point acceptance criterion with a reactor coolant pump (RCP) seal injection flow curve that is applicable throughout the LCO Applicability.

1.2 Final Safety Analysis Report (FSAR) Section

Changes to FSAR Sections and Tables will be made in conjunction with this amendment application. Proposed changes are indicated in Attachment 5.

2.0 DESCRIPTION OF PROPOSED AMENDMENT

This amendment application requests that a new seal injection flow curve be incorporated into the Technical Specifications. New Figure 3.5.5-1 will be added to depict the seal injection flow limits. The following paragraphs discuss the proposed changes for each section of TS 3.5.5.

LCO 3.5.5

The LCO currently reads:

"Reactor coolant pump seal injection flow to each RCP seal shall be 7.5 ± 0.5 gpm with a 105 (+5, -2) psi differential between the charging header and RCS pressure."

The LCO will be revised to read:

"Reactor coolant pump (RCP) seal injection flow shall be within the limits of Figure 3.5.5-1."

Required Action A.1

The Required Action currently reads:

"Adjust manual seal injection throttle valves to give a flow within limit with a 105 (+5, -2) psi differential between the charging header and RCS pressure."

The Required Action will be revised to read:

"Adjust manual seal injection throttle valves such that the RCP seal injection flow is within the limits of Figure 3.5.5-1."

Surveillance Requirement (SR) 3.5.5.1

The Surveillance Requirement currently reads:

"Verify manual seal injection throttle valves are adjusted to give a flow within limit with a 105 (+5, -2) psi differential between the charging header and RCS pressure."

The Surveillance Requirement will be revised to read:

"Verify manual seal injection throttle valves are adjusted to give a flow within the limits of Figure 3.5.5-1."

A new figure will be added. New Figure 3.5.5-1 can be applied at any time during the LCO Applicability, i.e., any time during MODES 1, 2, and 3.

Corresponding TS Bases changes will also be made. The TS 3.5.5 LCO Bases will be revised to contain the following information in the second paragraph:

"The flow line resistance is established by adjusting the RCP seal water injection throttle valves such that the analyzed ECCS flow to the RCP seals is limited to 89 gpm with one centrifugal charging pump (CCP) operating at 550 gpm on its maximum pump curve. This accident analysis limit is met by positioning the valves so that the flow to the RCP seals is within the limits of Technical Specifications Figure 3.5.5-1 for a given differential pressure between the charging pump discharge header and the RCS pressurizer steam space pressure. The seal injection flow curve is presented with the pressure difference from BGPT0120 to the pressurizer steam space pressure as a function of total seal injection line flow. A flow measurement instrument uncertainty of 0.25 gpm per loop was accounted for in the calculation of the pressure drop from

BGPT0120 to the seal injection connection. In addition, 2 psid is added to accommodate instrument uncertainty in the pressure drop measurement. An additional 4 psid has been conservatively added to the required pressure differential to allow for seal injection filter change out. Requiring as an initial condition that the filter used for each surveillance have a differential pressure less than or equal to 4 psid allows for post-surveillance filter change out with no differential pressure restriction."

Similar changes are made to the SR 3.5.5.1 Bases. In addition, corresponding changes are also required in the Applicable Safety Analysis Bases for TS 3.5.2 as indicated in the attached mark-ups.

Attachments 2 and 4 provide the TS markups and proposed TS Bases changes, respectively. Attachment 5 provides the related FSAR changes.

3.0 BACKGROUND

Two safety-related centrifugal charging pumps (CCPs) are used to provide flow to both the high head safety injection (SI) portion of the emergency core cooling system (ECCS) and to the RCP seals. The function of the seal injection throttle valves during an accident is similar to the function of the ECCS throttle valves covered in TS 3.5.2 in that they function to restrict flow from the CCP header to the RCS. The TS 3.5.5 LCO limits the amount of ECCS flow that could be diverted from the SI flow path to the seal injection flow path following a loss of coolant accident (LOCA). The seal injection flow limit supports safety analysis assumptions that are required because RCP seal injection flow is not isolated by a SI signal and RCP seal injection is not credited for core cooling in the minimum SI flow cases. The seal injection flow limit is met by controlling the seal injection flow path flow resistance. The intent of LCO 3.5.5 is to control that resistance through proper positioning of the seal injection throttle valves.

The current Seal Injection Flow TS 3.5.5 requires that the RCP seal injection flow to each pump shall be 7.5 ± 0.5 gpm with a 105 (+5, -2) psi differential between the charging header and RCS pressure. Due to errors in the Westinghouse documentation supporting Callaway Amendment 68 (References 1 and 2), new seal injection line resistance criteria are required as discussed in more detail in Section 5.0.

These errors came to light when Callaway requested clarification of the Westinghouse-prescribed method to be used for performing SR 3.5.5.1. Westinghouse was requested to confirm whether BGFCV0121, the charging flow

control valve, had to be fully open when performing SR 3.5.5.1 as they had indicated in their documentation supporting References 1 and 2. In order to answer this question, the basis for the pressure differential from the charging header to the pressurizer was rechecked. This led to the discovery of a numerical error in calculating the differential pressure specified in the surveillance; specifically, the pressurizer pressure in psia was subtracted from the pressure at instrument BGPT0120 (measuring the charging pump discharge header pressure) in psig. In addition, the seal injection line resistance used for calculating the differential pressure from the seal injection header to the pressurizer (0.2268 ft/gpm^2) was not used for calculating the ECCS flow rates. Rather, the seal injection line resistance used for calculating the ECCS branch line injection flow rates in support of OL Amendment 68 was 0.4381 ft/gpm^2, much higher than the 0.2268 ft/gpm^2 value. This had the non-conservative effect, from an analysis perspective, of diverting flow from the RCP seals to the ECCS injection lines thereby increasing the minimum injection flow for low reactor coolant system (RCS) pressures. A low seal injection line resistance is conservative from an analysis perspective since it permits a larger fraction of the CCP flow to divert to the RCP seals and seal injection flow is not credited for core cooling.

An evaluation of these errors demonstrated that the centrifugal charging pump ECCS subsystem, based on the last required flow balance test performed during Refuel 6 (fall of 1993), has been and continues to be OPERABLE and all accident analysis acceptance criteria are satisfied. However, new seal injection line resistance criteria were developed to correct these errors for future operation. The new seal injection line resistance criteria described in more detail in Section 5.0 resulted in changes to the minimum and maximum centrifugal charging pump ECCS subsystem flow rates, but these flow rate changes did not have a negative impact on the licensing basis LOCA and non-LOCA analyses.

The performance of the entire ECCS was evaluated in the documents supporting References 1 and 2. However, only the calculations applicable to the centrifugal charging pump ECCS subsystem are affected by these errors. The seal injection line resistance has no effect on the performance of the residual heat removal (RHR) and safety injection (SI) pumps; therefore, those ECCS subsystems did not require re-evaluation.

CURRENT OPERABILITY EVALUATION

The operability of the centrifugal charging pump ECCS subsystem was verified based on the last required performance (during Refuel 6 in the fall of 1993) of the

surveillance procedure corresponding to FSAR Section 16.5.2.1.1.b. That procedure establishes the flow balancing and pump runout adjustment of the CCPs. The conclusions presented below are for background information only as it relates to the need for a revision to TS 3.5.5.

ECCS Injection Flow and Pump Runout

The performance of the ECCS, based on the last required flow balance test, satisfies the minimum injection flow rates that are reported in FSAR Table 15.6-10a, upon which the minimum safety injection large break LOCA accident analysis has been based.

The Bases for TS 3.5.2 and TS 3.5.5, as well as FSAR Section 16.5.2, discuss a maximum CCP flow rate limit of 550 gpm. Calculations indicate that this maximum flow rate could have been slightly exceeded during the injection phase of a large break LOCA (i.e., pump flow rate of 551.7 gpm vs. 550 gpm) for the "B" centrifugal charging pump with the RWST at its maximum level (the high level alarm setpoint graphically depicted on FSAR Figure 6.3-7). The "B" CCP is the limiting pump with regard to runout flow. At the RWST level corresponding to the switchover from injection to recirculation, the maximum pump flow rate limit of 550 gpm is satisfied. This maximum pump flow rate exceedance is within the maximum tested pump flow rate with sufficient net positive suction head (NPSH) to prevent cavitation at the predicted operating condition. In addition, the predicted runout flow rate of the "B" CCP during the recirculation phase after a large break LOCA, when the CCP suction pressure is boosted by the piggy-back operation of the RHR pump, is within the maximum flow capability of the pump as tested, with available NPSH in excess of the required NPSH. A spare CCP rotating element had been previously tested to 574 gpm by Pacific Pumps, with a required NPSH of 48 feet vs. the available NPSH of 79 feet with the RWST at its maximum level during the injection phase. The available NPSH is higher during the recirculation phase based on the RHR piggy-back configuration. The "B" CCP has also been favorably evaluated with respect to the issue of potential shaft dynamic instability (vibration). The total developed head of the pump is sufficient to satisfy the shaft support requirement.

Seal Injection Flow

The Bases for TS 3.5.2 and TS 3.5.5, as well as FSAR Section 16.5.2, also discuss a maximum total seal flow diversion of 81 gpm at a maximum pump flow rate of 550 gpm. This limitation is based on ECCS performance issues, and does not represent a concern for the operability of the RCPs or the RCP seals. The total seal injection flow during a large break LOCA is significant only in terms of

its effect on the maximum pump flow rate and on the minimum injection flow rate, as discussed above.

The normal operating range of seal injection flows to each RCP is specified in the pump instruction manual as 8 to 13 gpm, with a minimum of 6 gpm and a maximum of 20 gpm. Historically, the Westinghouse fluid systems group had placed an upper flow bound of approximately 20 gpm delivered to each RCP from the centrifugal charging pump ECCS subsystem at 0 psig RCS pressure during a large break LOCA. This would allow a total diversion of safety injection flow to the RCPs of 80 gpm. The seal injection flow delivered to the RCPs is not credited for core cooling calculations in the minimum ECCS flow case. Seal injection flow is considered in the maximum ECCS flow case only because it is conservative to do so for that case which intentionally maximizes core flow. The primary purpose of the seal injection flow rate limit is to limit the amount of injection flow that could be diverted to the seals without cooling the reactor core. A secondary purpose of the seal injection flow rate limit is to ensure that flow delivered to the seals would not result in unacceptable runout of the CCPs during a large break LOCA which could damage the pumps.

The 20 gpm per pump and 80 gpm total were not based on mechanical limitations of the RCPs or the RCP seals. During a large break LOCA with a depressurized RCS, the injection flow passes downward through the labyrinth into the RCS, rather than through the seals. The seal leak-off flow is driven by the prevailing RCS pressure, not by the seal injection flow rate. This is true at normal operating plant conditions, as well as during a large break LOCA. Excess injection flow delivered to the RCP seals during normal operation passes, by design, down into the RCS through the labyrinth. During normal operation of the RCP, the seal injection flows are nominally controlled by procedure to the normal range of seal injection flow. Prolonged operation during power operation with greater than 20 gpm seal injection to the pump could represent a long-term erosion concern; however, this is not a problem during a short duration event such as a large break LOCA. During a large break LOCA, the seal injection flow rate will increase due to the reduced RCS pressure. The amount of seal injection flow delivered to the RCPs during a large break LOCA is accounted for in the calculations of the ECCS flow rates used for accident analysis and is accounted for in the evaluation of CCP runout flow limits. Seal injection flow rates (total to four pumps) which may reach typical values of approximately 105 to 110 gpm do not represent a mechanical concern for the RCPs or the seals during a postulated accident.

NEED FOR CHANGE

The shaded box on FSAR Figure 6.3-4 depicts the required performance of the CCPs to satisfy the accident analysis. The proposed changes are needed to assure future CCP subsystem flow balances are correctly performed consistent with accident analysis requirements, when required per FSAR Section 16.5.2.1.1.b. The proposed changes also retain the relative dimensions of the acceptable performance range in the shaded box on FSAR Figure 6.3-4 with regard to the window for pump runout adjustment and flow balancing, rather than reducing the size of the shaded box. Specifying a curve, rather than a single point, also facilitates the determination of an acceptable surveillance test and is an improvement from a human factors perspective.

4.0 REGULATORY REQUIREMENTS AND GUIDANCE

The regulatory requirements associated with ECCS seal injection flow, TS 3.5.5, are covered in 10CFR50.46 and 10CFR Appendix A, GDCs 35, 36, and 37.

TS 3.5.5, in conjunction with TS 3.5.2, helps to ensure that the following acceptance criteria, established by 10CFR50.46, will be met following a LOCA:

a. Maximum fuel element cladding temperature is ≤ 2200°F;

b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;

c. Maximum hydrogen generation from a zirconium-water reaction is ≤ 0.01 times the hypothetical amount generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react;

d. Core is maintained in a coolable geometry; and

e. Adequate core cooling capability is maintained.

GDC 35, "Emergency Core Cooling," requires that a system be provided for abundant emergency core cooling. The GDC requires redundancy be provided such that the safety function of the ECCS shall be met while energized from either offsite or onsite power, assuming a single failure.

GDC 36, "Inspection of Emergency Core Cooling System," requires the ECCS to be designed to permit periodic inspections.

GDC 37, "Testing of Emergency Core Cooling System," requires the ECCS to be designed to permit periodic demonstrations of the full operational sequence that brings the system into operation.

5.0 TECHNICAL ANALYSIS

New Seal Injection Line Resistance Criteria

The following new seal injection line resistance criteria were developed to support this amendment application:

1. The difference in static pressure between BGPT0120 (FSAR Figure 9.3-8, sheet 3, grid D-3), which measures the CCP discharge header pressure, and the pressurizer steam space with a total seal injection flow rate ≤ 32 gpm shall be ≥137 psid (-2 psi) with a pressurizer level of 25% of span and ≥142 psid (-2 psi) with a pressurizer level of 65% of span.

2. The required pressure differential from BGPT0120 to the pressurizer steam space includes an additional 4 psid to accommodate seal water injection filter change out (see FSAR Figure 9.3-8, sheet 3, grid C-3). It is acceptable to change the seal water injection filter flow path after the surveillance test as long as the following criterion is maintained:

   $$\Delta P_{\text{TEST FILTER}} \leq 4 \text{ psid.}$$

   The seal water injection filter flow paths (depicted on FSAR Figure 9.3-8, sheet 3, grid C-2 and C-3) are discussed further below.

The above criteria ensure a minimum seal injection line resistance of 0.225 ft/gpm^2. Since this value is lower than the 0.2268 ft/gpm^2 value discussed in Section 3.0 above, new centrifugal charging pump ECCS subsystem flow rates were calculated. Using the 0.225 ft/gpm^2 minimum seal injection line resistance, a seal injection line curve was developed by Westinghouse. The curve is a function of the total RCP seal injection line flow versus the pressure differential between the charging pump header (as measured at BGPT0120) and the RCS pressurizer steam space pressure (as determined by the average of four pressurizer pressure measurements). The seal injection line flow curve graphically represents the above acceptance criteria.

Development of the New Seal Injection Flow Curve

One seal injection flow curve was developed that envelopes all conditions in MODES 1, 2, and 3. The following assumptions were used to develop the seal injection line curve:

1. SR 3.5.5.1 will be performed with all four RCPs in operation, with a pressurizer level of ≤ 65% of span, at any power level ≤ 100% rated thermal power, and with the plant at normal operating pressure/normal operating temperature (NOP/NOT) conditions.

2. For purposes of calculating the elevation head of the water in the pressurizer and the surge line, the water was assumed to be saturated at a nominal pressurizer pressure of 2250 psia. The elevation head of steam in the pressurizer was ignored.

3. For purposes of calculating the friction pressure losses around the reactor coolant loop from the surge line to the RCP, the pressure losses used were those corresponding to operation at 100% power fluid conditions of pressure and temperature.

4. For purposes of calculating the developed head of the RCP auxiliary impeller and for calculating elevation head of water from the loop midplane to the RCP seal injection connection, the water density used corresponds to the zero load temperature of 557°F. The variation of T_{cold} from zero power to full power is only 3.25°F. The cold leg temperature at zero load is 557°F. The steam generator outlet temperature at 100% load is 553.75°F for the 0% tube plugging case.

To calculate the total pressure difference from the CCP discharge header to the RCS pressurizer steam space pressure, the following pressure differentials were determined:

- Pressurizer steam space to the RCP seal injection connection, and

- Seal injection line from BGPT0120 to the RCP seal injection connection.

Since the seal injection line resistance criteria is cast in terms of a pressure differential between the CCP discharge header and the pressurizer, it is necessary to determine the portion of that pressure difference which is between the pressurizer and the RCP seal injection connection. The higher pressure occurs at the seal injection connection. Considered in this pressure difference

are the elevation heads of the hot water in the pressurizer and in the surge line above the loop midplane, the friction losses due to RCS loop piping and the steam generator, the head developed by the auxiliary impeller inside the RCP which determines the balance chamber head at the RCP seal injection connection, and the small elevation difference of the RCP seal injection connection above the loop midplane.

The plant elevation of the pressurizer surge nozzle weld (2029.75 ft), the elevation of the loop centerline (2014.5 ft), and the elevation of the RCP seal injection connection (2017.5 ft) were established. The reactor coolant loop pressure drops were based on the most recent Westinghouse calculations for best-estimate flow with all RCPs in operation. The calculation also considered the range of uncertainty or variation of the balance chamber head developed by the auxiliary impeller in the RCP. The pressure drop from the RCP seal injection connection to the pressurizer is independent of the seal injection flow rate and is the sum of the pressure differential from the surge line connection to the pressurizer steam space and the pressure differential from the surge line connection to the RCP seal injection connection. The maximum pressure differential between the RCP seal injection connection and the pressurizer steam space was determined to be 21.89 psid with a pressurizer level of 65% of span.

The pressure difference from BGPT0120 to the RCP seal injection connection varies with seal injection flow. The pressure difference includes the 40.5 ft elevation difference from BGPT0120 (at an elevation of 1977 ft) to the RCP seal injection connection (at an elevation of 2017.5 ft). A seal injection line resistance of 0.225 ft/gpm^2 was used to calculate the pressure difference at several seal injection flow rates, summarized in tabular form below.

There are two parallel flow paths containing seal water injection filters, one path contains a 2-3 micron filter and the other path typically contains a 0.1 micron filter. Occasionally, the seal injection line flow is directed through the line containing the 2-3 micron filter, which has a clean filter pressure drop of 0.5 - 1.0 psid, during the surveillance test. For normal operation, the flow path with the 2-3 micron filter is closed and the seal injection flow is directed through the path with the 0.1 micron filter. The 0.1 micron filter has a clean filter pressure drop of 1.0 - 2.0 psid. It is also possible that the reverse could occur, the 0.1 micron filter may be used in the test and the 2-3 micron filter may be used in operation. As an additional conservatism to account for any change in seal injection line filters, the required pressure differential from BGPT0120 to the pressurizer steam space is increased by 4 psid. With this additional 4 psid, it is acceptable to change the seal injection filter flow path after the surveillance test as long as the following criterion is maintained:

$$\Delta P_{TEST\ FILTER} \leq 4 \text{ psid.}$$

The seal injection flow curve being added as TS Figure 3.5.5-1 is presented with the pressure difference from BGPT0120 to the pressurizer pressure as a function of the total seal injection line flow rate. To add conservatism for filter changes, 4 psid is added to the required pressure differential as discussed above. In addition, 2 psid is added to accommodate instrument uncertainty. A flow measurement instrument uncertainty of 0.25 gpm per loop was accounted for in the calculation of the pressure drop from BGPT0120 to the RCP seal injection connection. The minimum required pressure difference from the CCP discharge header (BGPT0120) to the pressurizer steam space pressure (average of four pressurizer pressure measurements) is calculated by the following equation:

$$\Delta P_{Required} = (\Delta P_{\text{Pressurizer to Seal Injection Connection}}) + (\Delta P_{\text{Seal Injection Connection to BGPT0120}}) + 6 \text{ psid (due to filters and instrument uncertainty).}$$

The data points below, corresponding to a pressurizer level of 65% of span, were used to generate new TS Figure 3.5.5-1.

Seal Injection Flow Data Points

Total Seal Injection Line Flow, GPM	Flow per RCP, GPM	ΔP Charging Pump Discharge Header to RCS, PSIG
25	6.25	110.8
28	7	126.8
32	8	150.8
36	9	178.0
40	10	208.2

It is noted that new TS Figure 3.5.5-1 is applicable for all of the LCO Applicability (MODES 1, 2, and 3). The data points above are sufficient for setting the seal injection line resistance throughout the LCO Applicability.

A seal injection line resistance of 0.225 ft/gpm^2 limits the seal injection line flow rate to 89 gpm (an increase from the current 81 gpm limit) with one charging pump operating at 550 gpm on its maximum pump curve for the ECCS analysis. The increased seal injection line flow rate will be limited to 87 (+ 2, - 4) gpm during surveillance testing to account for instrument uncertainty.

This seal injection line resistance was used to determine the minimum and maximum centrifugal charging pump ECCS subsystem flow rates in attached Tables 1 through 5. All of the total CCP injection flow values in the attached

Table 2 (for one ECCS train spilling to 0 psig) are lower than the corresponding values for charging injection in FSAR Table 15.6-10a (minimum safeguards case). On the other hand, all of the total CCP injection flow values in the attached Table 5 (for both ECCS trains spilling to 0 psig) are higher than the corresponding values in FSAR Table 15.6-10b for charging plus seal injection (maximum safeguards case). These FSAR Section 15.6 tables establish the ECCS flow rates used in the large break LOCA peak cladding temperature analyses. In addition, the CCP injection flow values in the attached Tables 1 and 4 are lower than the values used in the FSAR Section 6.2 LOCA mass and energy release calculations for the containment pressure and temperature analyses. Therefore, the impact of these revised flow rates was investigated.

Impact on Licensing Basis Non-LOCA and LOCA Analyses

A. Steamline Break Mass and Energy Release Analyses Inside and Outside Containment

An evaluation was performed by Westinghouse with respect to a reduction in the minimum centrifugal charging pump ECCS subsystem injection flows related to the licensing basis analyses of the steamline break mass and energy releases inside and outside containment. A direct comparison has been made between the lower centrifugal charging pump ECCS subsystem flow rates from the attached Table 1 and the analysis values for the steamline break mass and energy releases. For the steamline break transient outside containment, the ECCS flow comparison indicates that the analysis flows are nearly the same as the reduced flows. The conclusion is made that the analysis results for the steamline mass and energy releases outside containment remain valid with respect to the minimum ECCS injection flows.

For the steamline break mass and energy releases inside containment analysis, a direct comparison of the analysis values indicates that the values are non-conservative with respect to the lower centrifugal charging pump ECCS subsystem flow rates from the attached Table 1. A sensitivity analysis for the double-ended rupture (DER) steamline break initiated from a full-power condition has been performed by Westinghouse in which the only parameter changed is the ECCS flow data as a function of pressure. The results of the parametric sensitivity analysis indicate an increase of 1.2×10^6 BTU at 1800 seconds after event initiation. This represents a 0.172% increase in the integrated energy release at this time. There is no change in the integrated mass release over the duration of the transient. This increase in the energy release is typical of all DER steamline breaks in the Callaway licensing basis and is expected to be a

representative increase regardless of the power level. This increase is also expected to bound any increase in total energy released from a split rupture steamline break since the rapid depressurization from a DER provides a more pronounced effect of the ECCS on the transient results.

Therefore, the reduction in the centrifugal charging pump ECCS subsystem flow rates, as presented in the attached Table 1, do not change the conclusions in the Callaway licensing basis steamline break mass and energy release analyses, inside or outside containment. All FSAR results and conclusions remain valid with respect to this minimum ECCS injection flow issue.

B. Non-LOCA Transients

The two non-LOCA transients that model minimum ECCS flows were evaluated to determine the impact of a reduction in safety injection flow. Specifically, the steam line break (core response) and feedwater line break transients were evaluated assuming that the available ECCS flow was that shown in the attached Table 1. In both transients, it was determined that the impact on previously reported results would be negligible.

In the case of the steam line break event (FSAR Section 15.1.5), a sensitivity analysis was performed by Westinghouse and its results showed that the transient remained basically unchanged from the current analysis of record for Callaway. For the feedwater line break event (FSAR Section 15.2.8), existing plant-specific sensitivities presented as the "No SI Cases" in the FSAR previously considered the complete elimination of safety injection flow with little impact on transient results. This supports a conclusion that a minor reduction in ECCS flows, as being investigated herein, would not significantly alter the results for licensing basis cases presented in FSAR Section 15.2.8 for this event. Furthermore, the FSAR "No SI Cases" obviously bound this ECCS flow reduction evaluation.

The impact of revised maximum ECCS flows on non-LOCA transients was also evaluated. Maximum flow rates are used by Westinghouse in the analysis of the inadvertent ECCS actuation at power (FSAR Section 15.5.1) and chemical and volume control system (CVCS) malfunction (FSAR Section 15.5.2) events. The inadvertent ECCS actuation at power event also considers the flow provided by the normal charging pump (NCP). The maximum flow rates for this event were confirmed by Union Electric to remain valid. Finally, the maximum flow rates currently assumed in the CVCS malfunction event were confirmed by Westinghouse to remain unchanged. Based on this, both the inadvertent ECCS actuation at power and the CVCS malfunction event are unaffected by the

revised centrifugal charging pump ECCS subsystem flow rates.

Based on the above, it can be concluded that the revised ECCS flow rates which reflect the new seal injection line resistance criteria are acceptable with respect to the affected non-LOCA transients.

C. LOCA Long Term and Short Term Mass and Energy Releases

LOCA Long Term Mass and Energy Releases

Minimum ECCS Flow Rate Case

During the accumulator injection period, the accumulator flow is more than sufficient to condense all of the steam flowing in the intact loops. Thus, the pumped ECCS flow does not contribute to steam condensation, but only adds mass and energy. Between the end of accumulator injection and the beginning of the ECCS recirculation phase, pumped ECCS flow not only adds mass and energy but will also condense steam. These effects will be accounted for in determining the effect of reduced centrifugal charging pump ECCS subsystem flow rates on the large break LOCA (double-ended pump suction guillotine, DEPSG) mass and energy releases. For a DEPSG break location, which is the limiting case for containment pressure/temperature analyses (see FSAR Section 6.2.1.3), the ECCS injection branch lines are modeled as being connected to and injecting against RCS backpressure.

A comparison of the analysis of record flow rates against the reduced minimum safety injection flow rates in the Attachment 5 mark-up of FSAR Table 6.2.1-52 shows a reduction in the minimum safety injection flow rate of about 80 gpm at an RCS backpressure equal to the containment design pressure of 60 psig (74.7 psia). This single interpolation point at 60 psig was used as a point of reference for comparison purposes pursuant to the post-reflood mass and energy release data discussion in FSAR Section 6.2.1.3.1 item d. It was determined that this reduction in flow would result in an additional release of 2.585 E06 BTUs after 1509 seconds (time in FSAR Section 6.2.1.3 to reach the ECCS cold leg recirculation phase for the minimum SI flow case in FSAR Table 6.2.1-9 and Figure 6.2.1-1). This increase is a result of less steam condensation. Based on the analysis presented in FSAR Section 6.2.1.3, peak pressure for the double-ended pump suction break with minimum safety injection flow rates was calculated to occur at 134 seconds. The increased energy release would result in an increase in containment peak pressure. However, the analysis of record is based on a conservative value for core stored energy (discussed further below in the next subsection). A review of recent reloads for Callaway shows a reduction

of about 1.06 full power seconds in core stored energy for the newer fuel which utilizes improved predictive methods for core stored energy (see the discussion in the next subsection). A reduction of 1.06 full power seconds will provide an energy benefit of 3.654 E06 BTUs, which exceeds the penalty resulting from the reduced centrifugal charging pump ECCS subsystem flow rates.

The Westinghouse scope for this evaluation is limited to the calculation of the LOCA mass and energy releases up to the initiation of ECCS cold leg recirculation. Union Electric is responsible for the LOCA cold leg and hot leg recirculation phase mass and energy releases and the associated long term containment pressure calculation. Union Electric confirmed that there is no adverse impact on the LOCA cold leg and hot leg recirculation phase mass and energy releases and the associated containment pressure.

Core Stored Energy for the Callaway Containment Analysis

Core stored energy (CSE) is an input to the containment analysis to address the energy that is present in the fuel rods due to the temperature of the fuel in excess of the local coolant temperature. The NRC-approved Westinghouse fuel performance code (PAD) is used to generate fuel temperatures for the core stored energy calculation. The assumptions used to calculate the fuel temperatures for the core stored energy calculation account for appropriate uncertainties associated with the models in the PAD code (e.g., calibration of the thermal model, pellet densification model, cladding creep model, etc.). In addition, the fuel temperatures for the core stored energy calculation account for appropriate uncertainties associated with manufacturing tolerances (e.g., pellet as-built density). The total uncertainty for the fuel temperature calculation is a statistical combination of these effects and is dependent upon fuel type, power level, and burnup.

Previous CSE calculations for Callaway were based on an older version of the PAD code for the original 17x17 fuel product used at Callaway. The updated CSE calculation is based on fuel temperatures plus uncertainties generated for VANTAGE+, non-IFBA fuel using the PAD 3.4 code. The PAD 3.4 code was reviewed and approved by NRC, as documented in WCAP-11873-A (August 1988). The PAD 3.4 fuel temperatures plus uncertainties used in the CSE calculation are the same upper bound temperatures that were previously supplied for the Callaway large break LOCA peak cladding temperature (PCT) analysis for the VANTAGE+, non-IFBA fuel product. The continued applicability of these fuel temperatures for the Callaway safety analyses are verified each cycle as part of the Westinghouse reload safety evaluation process performed per WCAP-9272-P-A (July 1985).

A reduction in the CSE value primarily reflects the lower fuel temperatures associated with the NRC-approved PAD 3.4 code as compared to the older code version. Additionally, the previous CSE value was for the original 17x17 fuel design (0.374" fuel rod outside diameter) used at Callaway which is overly conservative for the current fuel product (0.360" fuel rod outside diameter). The larger diameter fuel rod has more stored energy due to the additional fuel pellet mass.

The change to the new CSE value in the above Callaway containment analysis requires an update to the descriptive text in FSAR Section 6.2.1.3.2 regarding the application of the uncertainties for CSE. For the previous CSE value, a fixed 15% uncertainty was applied to the CSE value that was derived using fuel temperatures based on best estimate model assumptions and nominal parameters. For the older model, this fixed 15% uncertainty was shown to bound the statistical combination of the effects of fabrication uncertainties and fuel performance code model uncertainties at beginning-of-life when the fuel temperatures and the CSE were predicted to be the highest. For the combination of the newer PAD code and more recent fuel product features (e.g., ZIRLO cladding), the fixed 15% uncertainty was not necessarily appropriate. To calculate the PAD 3.4 CSE value used in the Callaway analysis, the fuel temperatures with the statistical combination of uncertainties are included in the CSE calculation rather than calculating the CSE with nominal fuel temperatures and directly applying a fixed 15% increase to the nominal CSE value. Because of the variation of the uncertainty with power and burnup, the total CSE uncertainty is not currently quantified as a single percentage of a nominal CSE. All appropriate uncertainties for the fabrication process and the fuel performance code models continue to be addressed in the CSE calculation. The required FSAR text revision is provided in Attachment 5.

Therefore, the reduction in the minimum centrifugal charging pump ECCS subsystem flow rates at Callaway will not result in a change in the calculated peak containment pressure due to the revised CSE value. Attachment 5 also provides FSAR text revisions for the evaluation of the LOCA long term mass and energy releases.

Maximum ECCS Flow Case

During the accumulator injection period, the pumped ECCS flow does not contribute to steam condensation, but only adds mass and energy. Between the end of accumulator injection and the beginning of the ECCS recirculation phase, pumped ECCS not only adds mass and energy but will also condense steam. These effects will be accounted for in determining the effect of reduced centrifugal charging pump ECCS subsystem flow rates on the large break LOCA

(double-ended pump suction guillotine) mass and energy releases.

A comparison of the analysis of record flows against the reduced maximum safety injection flow rates in the Attachment 5 mark-up of FSAR Table 6.2.1-52 shows a reduction in the maximum safety injection flow rate of about 401 gpm at an RCS backpressure equal to the containment design pressure of 60 psig (74.7 psia). It was determined that both the analysis of record maximum flow rates and the reduced maximum flow rates were greater than needed to condense all of the steam generated by core decay heat and metal energy up to the initiation of ECCS cold leg recirculation at 849 seconds (analysis time in FSAR Section 6.2.1.3 to reach the ECCS cold leg recirculation phase for the maximum SI flow case in FSAR Table 6.2.1-10 and Figure 6.2.1-2). Based on the analyses presented in FSAR Section 6.2.1.3, the peak pressure for the double-ended pump suction break with maximum safety injection flow rates was calculated to occur at 115 seconds. Thus, a reduction in safety injection flow rates in the injection phase time frame would result in less mass and energy release to the containment, which is a benefit for the calculated peak pressure.

Since the reduction in the maximum centrifugal charging pump ECCS subsystem flow rates at Callaway will not result in an increase in the mass and energy releases, it follows that the calculated peak containment pressure will not increase.

Maximum ECCS Flow Case Plus NCP

The increase in the maximum safety injection flow rates due to the addition of the NCP is 146.5 gpm, based on interpolation at an RCS backpressure of 60 psig (74.7 psia). This increase is less than the above flow decrease of 401 gpm calculated from the reduced maximum flow rates generated with a seal injection line surveillance pressure difference of 135 psid with a pressurizer level of 25% of span or 140 psid with a pressurizer level of 65% of span. Therefore, the analysis of record maximum safety injection flow rates bound the maximum safety injection flow rates from the Attachment 5 mark-up of FSAR Table 6.2.1-52 with the NCP flow addition. Therefore, there is no effect on the analysis of record LOCA mass and energy releases for maximum safety injection flow rates due to the operation of the NCP.

LOCA Short Term Mass and Energy Releases

The containment subcompartment analysis is performed to ensure that the walls of a subcompartment can maintain their structural integrity during the short pressure pulse (generally less than 3 seconds) which accompanies a high-

energy line pipe rupture within the subcompartment. Since the maximum consequence for this analysis occurs within 3.0 seconds, which is prior to initiation of pumped ECCS flow, changes in pumped ECCS flow do not affect the results or conclusions.

Therefore, the change in the Callaway centrifugal charging pump ECCS subsystem flows due to the new seal injection line resistance criteria will have no effect on short-term LOCA mass and energy releases or subcompartment pressurization analyses.

D. LOCA

The current limiting break for the Callaway licensing basis large break LOCA analysis is that with a discharge coefficient (CD) of 0.6 and minimum safeguards assumptions. Minimum safeguards assumptions were examined with respect to the revised centrifugal charging pump ECCS subsystem flows. No changes to the RHR or SI pump flows were made. The total decrease of the revised flows (0.63%) was evaluated and the results show that the impact to the current analysis is considered insignificant. Note that the flow rate decrease of 80 gpm cited on page 14 of 29 refers to the flow reduction of one ECCS train (one CCP, one SI pump, one RHR pump) spilling to an RCS backpressure of 60 psig for a DEPSG break. The 0.63% flow rate decrease cited here is the flow reduction for one ECCS train spilling to 0 psig for a double-ended cold leg guillotine (DECLG) break over the range of pressures included in the attached Table 2.

Maximum safeguards assumptions were also evaluated and concluded that the minimum safeguards assumption case continues to be more limiting and bounds the maximum safeguards assumption case.

The current limiting break size for the Callaway licensing basis small break LOCA analysis is a 4 inch equivalent diameter break. The method of evaluation for the SI shortfall involves the calculation of integrated SI reduction from SI initiation to PCT time based on the revised flow rates. The results of this evaluation show that for the 3 inch and the 4 inch break cases, the net integrated ECCS flow results in a small decrease in the injected ECCS mass. The 3 inch break case resulted in a 0.24% decrease in injected ECCS mass while the 4 inch break case resulted in a 0.94% decrease in injected ECCS mass. Both of these cases resulted in total vessel mass differences that are much less than 1%. As a result, the minimum SI flows that are used in the analysis of record are consistent with the new centrifugal charging pump ECCS subsystem flows. Based on this, there is no adverse effect on the net PCT due to the revised flows and the impact to the current analysis is considered insignificant. Maximum SI flows do not have a

negative effect on small break LOCA analysis.

Probabilistic Risk Assessment (PRA) Evaluation

Although all ECCS subsystems, including the centrifugal charging pump subsystem, are credited for injection in the safety analysis for large break LOCA, the Callaway PRA large break LOCA success criteria require ECCS injection by one (1) train of residual heat removal (RHR) only. Therefore, this proposed change has no impact on the Callaway large break LOCA core damage frequency. In addition, the operability evaluation discussed previously verified that the currently available CCP flow to the ECCS branch lines is consistent with safety analysis requirements. Therefore, there is no impact on the Callaway core damage frequency stemming from smaller LOCA break sizes, which do credit the centrifugal charging pump ECCS subsystem for mitigation.

Summary/Conclusion

This amendment application revises the LCO, Required Action, and Surveillance Requirement dealing with RCP seal injection flow requirements. The analyses presented above assess the potential impact of the proposed changes on applicable safety analyses. The assessments demonstrate that the change will not adversely affect the design basis, safety analyses, or the safe operation of the plant.

6.0 REGULATORY ANALYSIS

There have been no changes to the plant design such that any of the regulatory requirements in Section 4.0 would come into question. This amendment application revises the LCO, Required Action, and Surveillance Requirement dealing with RCP seal injection flow requirements. The evaluation performed by Union Electric Company in Section 5.0 concludes that Callaway Plant will continue to comply with all applicable regulatory requirements.

Based on the considerations discussed above, (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) issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7.0 NO SIGNIFICANT HAZARDS DETERMINATION

This amendment application revises the LCO, Required Action, and Surveillance Requirement dealing with RCP seal injection flow requirements. The revised requirements ensure all safety analysis requirements will continue to be satisfied.

The proposed amendment does not involve a significant hazards consideration for Callaway Plant based on the three standards set forth in 10CFR50.92(c) as discussed below:

(1) Do the proposed changes involve a significant increase in the probability or consequences of an accident previously evaluated?

Response: No

Overall protection system performance will remain within the bounds of the previously performed accident analyses since there are no hardware changes. The RTS instrumentation and reactivity control systems will be unaffected. Protection systems will continue to function in a manner consistent with the plant design basis. All design, material, and construction standards that were applicable prior to the request are maintained.

The probability and consequences of accidents previously evaluated in the FSAR are not adversely affected because the changes continue to assure the analysis assumptions and initial conditions included within the safety analysis and licensing basis are satisfied.

The proposed changes will not involve a significant increase in the probability of any event initiators. The initiating event for a loss of coolant accident, as discussed in FSAR Section 15.6.5, is a break in the RCS piping. Since the RCS piping design is unchanged, there will be no initiating event frequency increase associated with pipe breaks. There will be no degradation in the performance of, or an increase in the number of challenges imposed on, safety-related equipment assumed to function during an accident situation. There will be no change to normal plant operating parameters or accident mitigation performance.

The proposed changes will not alter any assumptions or change any mitigation actions in the radiological consequence evaluations in the FSAR.

Therefore, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

(2) Do the proposed changes create the possibility of a new or different kind of accident from any accident previously evaluated?

Response: No

There are no hardware changes nor are there any changes in the method by which any safety-related plant system performs its safety function. This amendment will not affect the normal method of plant operation. The proposed changes do not introduce any new equipment into the plant or alter the manner in which existing equipment will be operated. The changes to operating procedures are minor, with clarifications provided that required limits must continue to be met. No performance requirements or response time limits will be affected. These changes are consistent with assumptions made in the safety analysis and licensing basis regarding limits on RCP seal injection flow.

No new accident scenarios, transient precursors, failure mechanisms, or limiting single failures are introduced as a result of this amendment. There will be no adverse effect or challenges imposed on any safety-related system as a result of this amendment.

This amendment does not alter the design or performance of the 7300 Process Protection System, Nuclear Instrumentation System, or Solid State Protection System used in the plant protection systems.

Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any previously evaluated.

(3) Do the proposed changes involve a significant reduction in a margin of safety?

Response: No

The proposed changes do not alter the input parameters listed in FSAR Table 15.6-9 and used in large break and small break LOCA peak cladding temperature analyses. The containment pressure and temperature analyses are not adversely impacted. The nominal reactor and ESFAS trip setpoints (Technical Specification Bases Tables B 3.3.1-1 and B 3.3.2-1), reactor and ESFAS allowable values (Technical Specification Tables 3.3.1-1 and 3.3.2-1), and the safety analysis limits assumed in the transient and accident analyses (FSAR Table 15.0-4) are unchanged. None of the acceptance criteria for any accident analysis is changed.

There will be no effect on the manner in which safety limits or limiting safety system settings are determined nor will there be any effect on those plant systems necessary to assure the accomplishment of protection functions. There will be no impact on the overpower limit, departure from nucleate boiling ratio (DNBR) limits, heat flux hot channel factor (F_Q), nuclear enthalpy rise hot channel factor ($F\Delta H$), loss of coolant accident peak cladding temperature (LOCA PCT), peak local power density, or any other margin of safety. The radiological dose consequence acceptance criteria listed in the Standard Review Plan will continue to be met.

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

Conclusion:

Based on the above, Union Electric Company concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c) and, accordingly, a finding of "no significant hazards consideration" is justified.

8.0 ENVIRONMENTAL CONSIDERATION

Union Electric Company has determined that the proposed amendment would change requirements with respect to the installation or use of a facility component located within the restricted area, as defined in 10CFR20, or would change an inspection or surveillance requirement. Union Electric Company has evaluated the proposed change and has determined that the change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amount of effluent that may be released offsite, or (iii) a significant increase in the individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10CFR51.22 (c)(9). Therefore, pursuant to 10CFR51.22 (b), an environmental assessment of the proposed change is not required.

9.0 PRECEDENTS

The TS changes requested in this amendment application are similar to changes previously approved in References 6 and 7 for Wolf Creek Generating Station inasmuch as the single point from the NUREG-1431 Standard Technical

Specification 3.5.5 is replaced with a figure contained within the body of the Technical Specifications. Figure 3.5.5-1 in the Wolf Creek Generating Station Technical Specifications presents a limit on seal injection flow to each RCP and was initially issued with their ITS conversion amendment (Reference 6) and later revised (Reference 7). In contrast, the changes proposed herein for Callaway provide a limiting curve for the total seal injection flow rate.

10.0 REFERENCES

1. ULNRC-2535 dated December 18, 1991, "Revision to Technical Specification 4.5.2.h, Emergency Core Cooling Systems."

2. Callaway Plant License Amendment 68 dated March 24, 1992, Revision to TS 4.5.2.h (TAC No. M82301).

3. ULNRC-04481 dated May 30, 2001, " Revision to Technical Specification 3.5.5, Seal Injection Flow."

4. Callaway Plant License Amendment 146 dated August 7, 2001, Revision to TS 3.5.5 (TAC No. MB2083).

5. Callaway Plant License Amendment 133 dated May 28, 1999, Conversion to Improved Technical Specifications (TAC No. M98803).

6. Wolf Creek Generating Station License Amendment 123 dated March 31, 1999, Conversion to Improved Technical Specifications (TAC No. M98738).

7. Wolf Creek Generating Station License Amendment 132 dated March 1, 2000, Revised RCP Seal Injection Flow Curve, Figure 3.5.5-1 (TAC No. MA7792).

TABLE 1

**Minimum CCP Injection ECCS Flows, Spill to RCS /No Spill Cases
Flow Rates in GPM at 37 F**

RCS, psig	Seal Line	Injection	Injection	Injection	Spill	Pump	3 Lines Inject	All Lines Inject
0	99	94.2	94.2	94.2	97.9	479.5	282.6	380.5
100	96.8	92.2	92.2	92.1	95.8	469.1	276.5	372.3
200	94.6	90.1	90.1	90.1	93.6	458.5	270.3	363.9
300	92.4	88	88	88	91.4	447.8	264	355.4
400	90.3	86	86	85.9	89.3	437.4	257.9	347.2
500	88.1	83.9	83.9	83.9	87.2	426.9	251.7	338.9
600	85.9	81.8	81.8	81.8	85	416.3	245.4	330.4
700	83.7	79.7	79.7	79.7	82.8	405.6	239.1	321.9
800	81.4	77.5	77.5	77.4	80.5	394.3	232.4	312.9
900	78.9	75.1	75.1	75.1	78	382.2	225.3	303.3
1000	76.4	72.7	72.7	72.7	75.5	370	218.1	293.6
1100	73.8	70.3	70.3	70.2	73	357.6	210.8	283.8
1200	65.9	62.7	62.7	62.7	65.1	359.5	188.1	253.2
1300	62.9	59.9	59.9	59.9	62.2	346.1	179.7	241.9
1400	59.7	56.8	56.8	56.8	59	331	170.4	229.4
1500	56.3	53.6	53.6	53.6	55.7	315.5	160.8	216.5
1600	52.9	50.4	50.4	50.3	52.3	299.7	151.1	203.4
1700	49.5	47.1	47.1	47.1	48.9	284	141.3	190.2
1800	46	43.8	43.8	43.8	45.5	267.9	131.4	176.9
1900	42.4	40.4	40.4	40.4	42	251.3	121.2	163.2
2000	38.2	36.4	36.4	36.3	37.8	231.6	109.1	146.9
2100	33.7	32.2	32.1	32.1	33.4	210.8	96.4	129.8
2200	28.7	27.4	27.4	27.4	28.4	187.2	82.2	110.6
2300	22.9	21.9	21.9	21.9	22.8	160.1	65.7	88.5
2400	10.6	10.5	10.5	10.5	11	102.5	31.5	42.5
2500	0	0	0	0	0	49.7	0	0

TABLE 2

Minimum ECCS CCP Injection Flows, Spill to 0 psig
Flows in GPM at 37 F

RCS, psig	Seal Line	Injection	Injection	Injection	Spill	Total Injected
0	99	94.2	94.2	94.2	97.9	282.6
100	96.2	91.5	91.5	91.4	100.6	274.4
200	93.3	88.7	88.7	88.6	103.3	266
300	90.5	85.9	85.8	85.8	105.9	257.5
400	87.6	83	83	82.9	108.6	248.9
500	84.8	80.2	80.2	80.1	111.2	240.5
600	81.9	77.3	77.3	77.2	113.9	231.8
700	78.9	74.4	74.4	74.3	116.5	223.1
800	75.9	71.4	71.4	71.3	119.2	214.1
900	72.9	68.4	68.4	68.3	121.8	205.1
1000	44.8	63.8	63.6	62.7	202.4	190.1
1100	42	58.2	57.9	56.9	209.5	173
1200	39.1	52.5	52.2	51	216.5	155.7
1300	36.3	46.7	46.3	44.9	223.5	137.9
1400	33.3	40.4	39.9	38.2	230.3	118.5
1500	30.3	34	33.4	31.3	237	98.7
1600	27.4	27.4	26.7	24	243.8	78.1
1700	24.3	19.9	18.9	14.8	250.4	53.6
1800	21.6	13.3	11.8	2.5	257.2	27.6
1900	19	1.8	0	0	263.9	1.8
2000	0.9	0	0	0	268.3	0
2100	0	0	0	0	268.5	0
2200	0	0	0	0	268.5	0
2300	0	0	0	0	268.5	0
2400	0	0	0	0	268.5	0
2500	0	0	0	0	268.5	0

TABLE 3

Maximum ECCS – No Spill Case – One CCP
Flows in GPM at 100F
(NCP Flow Not Included in Analysis)

RCS, psig	Seal	Injection	Injection	Injection	Injection	Total Injection
0	85.5	114.8	118.9	119	119	557.2
100	83.8	112.6	116.6	116.6	116.6	546.2
200	82.1	110.2	114.1	114.2	114.2	534.8
300	80.3	107.8	111.6	111.7	111.7	523.1
400	78.5	105.4	109.2	109.2	109.2	511.5
500	76.7	103	106.7	106.7	106.7	499.8
600	75	100.7	104.3	104.3	104.3	488.6
700	73.2	98.3	101.8	101.9	101.9	477.1
800	71.5	96	99.4	99.4	99.4	465.7
900	69.7	93.6	96.9	97	97	454.2
1000	67.7	90.9	94.2	94.2	94.2	441.2
1100	65.6	88.1	91.2	91.2	91.2	427.3
1200	63.4	85.2	88.2	88.2	88.2	413.2
1300	61.2	82.2	85.2	85.2	85.2	399
1400	59	79.2	82	82.1	82.1	384.4
1500	56.7	76.2	78.9	78.9	78.9	369.6
1600	54.4	73.1	75.7	75.7	75.7	354.6
1700	51.9	69.7	72.2	72.2	72.2	338.2
1800	49.2	66.2	68.5	68.6	68.6	321.1
1900	46.6	62.6	64.8	64.9	64.9	303.8
2000	43.6	58.6	60.7	60.7	60.7	284.3
2100	40.4	54.4	56.3	56.3	56.3	263.7
2200	37	49.8	51.6	51.6	51.6	241.6
2300	33.2	44.7	46.3	46.3	46.3	216.8
2400	28.8	38.8	40.2	40.2	40.2	188.2
2500	23.4	31.6	32.7	32.8	32.8	153.3
2600	15.7	21.5	22.2	22.2	22.2	103.8
2700	0	0	0	0	0	0
2800	0	0	0	0	0	0
2900	0	0	0	0	0	0

TABLE 4

Maximum ECCS – No Spill Case – 2 CCPs
Flows in GPM at 100F
(NCP Flow Not Included in Analysis)

RCS, psig	Seal	Injection	Injection	Injection	Injection	Total
0	127.2	172.2	178.4	178.5	178.5	834.8
100	124.8	169	175	175.1	175.1	819
200	122.4	165.7	171.6	171.7	171.7	803.1
300	119.9	162.3	168.1	168.2	168.2	786.7
400	117.4	158.9	164.5	164.6	164.6	770
500	114.8	155.4	160.9	161	161	753.1
600	112.2	151.9	157.3	157.4	157.4	736.2
700	109.6	148.3	153.6	153.7	153.7	718.9
800	106.9	144.7	149.8	149.9	149.9	701.2
900	104	140.8	145.8	145.9	145.9	682.4
1000	101.1	136.8	141.7	141.8	141.8	663.2
1100	98.1	132.8	137.5	137.6	137.6	643.6
1200	95	128.7	133.2	133.3	133.3	623.5
1300	92	124.5	128.9	129	129	603.4
1400	88.6	119.9	124.2	124.3	124.3	581.3
1500	85.1	115.2	119.3	119.4	119.4	558.4
1600	81.6	110.4	114.3	114.4	114.4	535.1
1700	77.9	105.5	109.2	109.3	109.3	511.2
1800	74	100.1	103.7	103.8	103.8	485.4
1900	69.7	94.4	97.8	97.8	97.8	457.5
2000	65.3	88.5	91.6	91.7	91.7	428.8
2100	60.7	82.2	85.2	85.2	85.2	398.5
2200	55.2	74.7	77.4	77.4	77.4	362.1
2300	49.3	66.8	69.1	69.2	69.2	323.6
2400	42.4	57.5	59.6	59.6	59.6	278.7
2500	34.1	46.3	47.9	47.9	47.9	224.1
2600	20.4	28	29	29	29	135.4
2700	0	0	0	0	0	0
2800	0	0	0	0	0	0
2900	0	0	0	0	0	0

TABLE 5

Maximum ECCS – 2 CCPs – Spill to 0 psig
Flows in GPM at 100F
(NCP Flow Not Included in Analysis)

RCS, psig	Seal	Spill	Total Injected
0	127.2	172.2	662.6
100	124.5	174.3	647.9
200	121.7	176.4	633.1
300	118.8	178.5	617.6
400	115.9	180.6	602.1
500	113	182.7	586.6
600	109.9	184.8	570.3
700	106.9	187	554.1
800	103.8	189.1	537.5
900	100.6	191.3	520.5
1000	97.3	193.4	503.1
1100	93.9	195.5	484.7
1200	90.3	197.5	465.8
1300	86.7	199.6	446.3
1400	82.9	201.8	426.3
1500	79.1	203.9	405.8
1600	75	206	384
1700	70.7	208.1	360.8
1800	66.1	210.3	336.6
1900	61.4	212.5	311.3
2000	56.5	214.7	285
2100	50.9	216.9	254.6
2200	44.9	219.2	222.2
2300	38.5	221.6	187.3
2400	39.4	157.1	152.2
2500	29.1	158.1	110.4
2600	15	159.5	51.3
2700	0	160	0
2800	0	160	0

ATTACHMENT TWO
ULNRC04583

MARKUP OF TECHNICAL SPECIFICATIONS

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.5 Seal Injection Flow

TS INSERT 1

(RCP)

LCO 3.5.5 Reactor coolant pump seal injection flow ~~to each RCP seal shall be 7.5 ± 0.5 gpm with a 105 (+5, -2) psi differential between the charging header and RCS pressure.~~

APPLICABILITY: MODES 1, 2, and 3.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Seal injection flow not within limit.	A.1 Adjust manual seal injection throttle valves ~~to give a flow within limit with a 105 (+5, -2) psi differential between the charging header and RCS pressure.~~ TS INSERT 2	4 hours
B. Required Action and associated Completion Time not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	6 hours 12 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.5.1	-----NOTE----- Not required to be performed until 4 hours after the Reactor Coolant System pressure stabilizes at ≥ 2215 psig and ≤ 2255 psig. ----- Verify manual seal injection throttle valves are adjusted to give a flow within ~~limit with a 105 (+5, -2) psi differential between the charging header and RCS pressure.~~ [TS INSERT 3]	18 months

TS INSERT 3

TS INSERT 1

shall be within the limits of Figure 3.5.5-1.

TS INSERT 2

such that the RCP seal injection flow is within the limits of Figure 3.5.5-1.

TS INSERT 3

the limits of Figure 3.5.5-1.

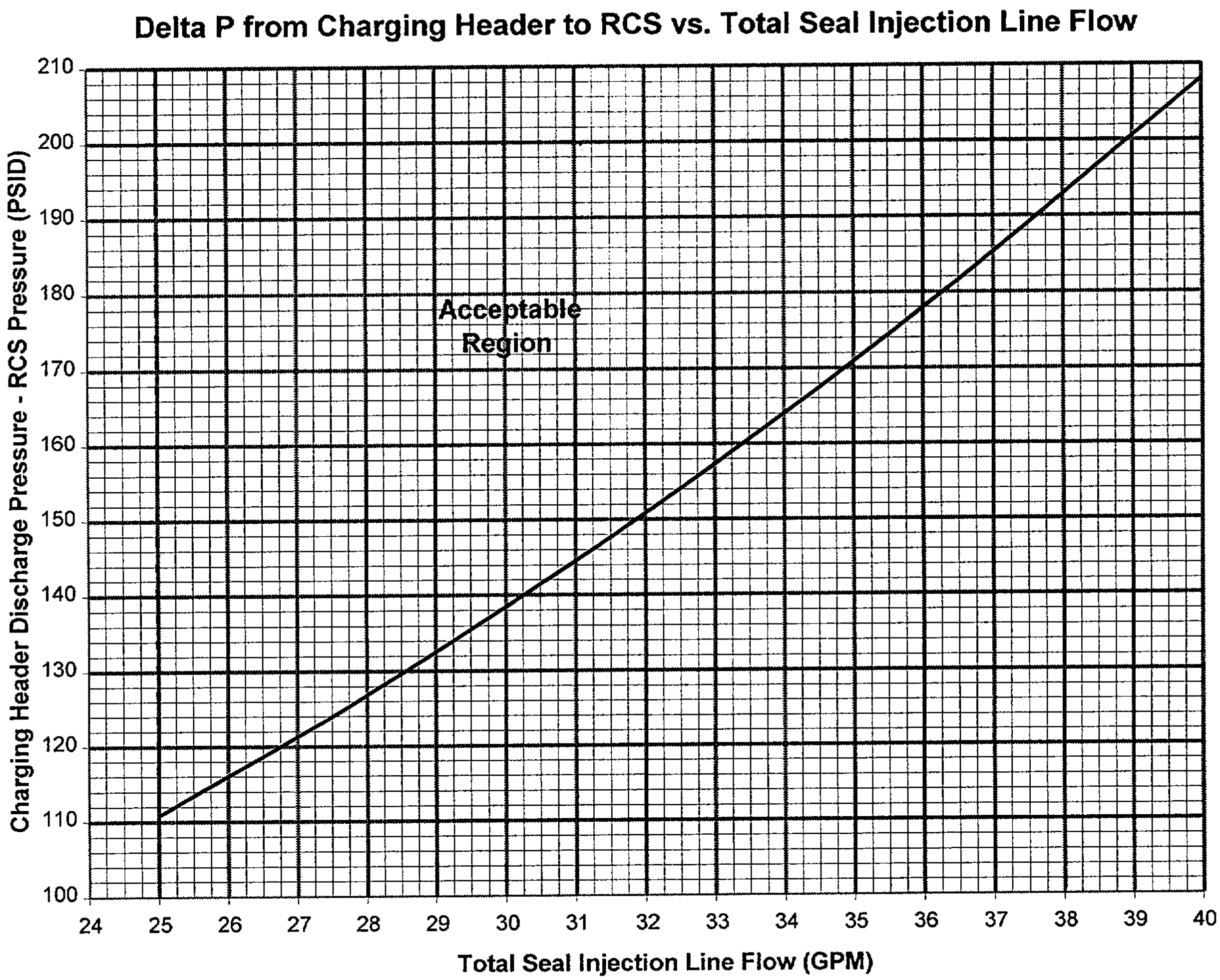

Figure 3.5.5-1 (page 1 of 1)
Delta P from Charging Header to RCS vs. Total Seal Injection Line Flow

ATTACHMENT THREE
ULNRC04583

RETYPED TECHNICAL SPECIFICATIONS

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.5 Seal Injection Flow

LCO 3.5.5 Reactor coolant pump *(RCP)* seal injection flow ***shall be within the limits of Figure 3.5.5-1.***

APPLICABILITY: MODES 1, 2, and 3.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. Seal injection flow not within limit.	A.1	Adjust manual seal injection throttle valves ***such that the RCP seal injection flow is within the limits of Figure 3.5.5-1.***	4 hours
B. Required Action and associated Completion Time not met.	B.1	Be in MODE 3.	6 hours
	AND		
	B.2	Be in MODE 4.	12 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.5.5.1	------------------------NOTE------------------------ Not required to be performed until 4 hours after the Reactor Coolant System pressure stabilizes at $\geq$ 2215 psig and $\leq$ 2255 psig. --- Verify manual seal injection throttle valves are adjusted to give a flow within ***the limits of Figure 3.5.5-1.***	18 months

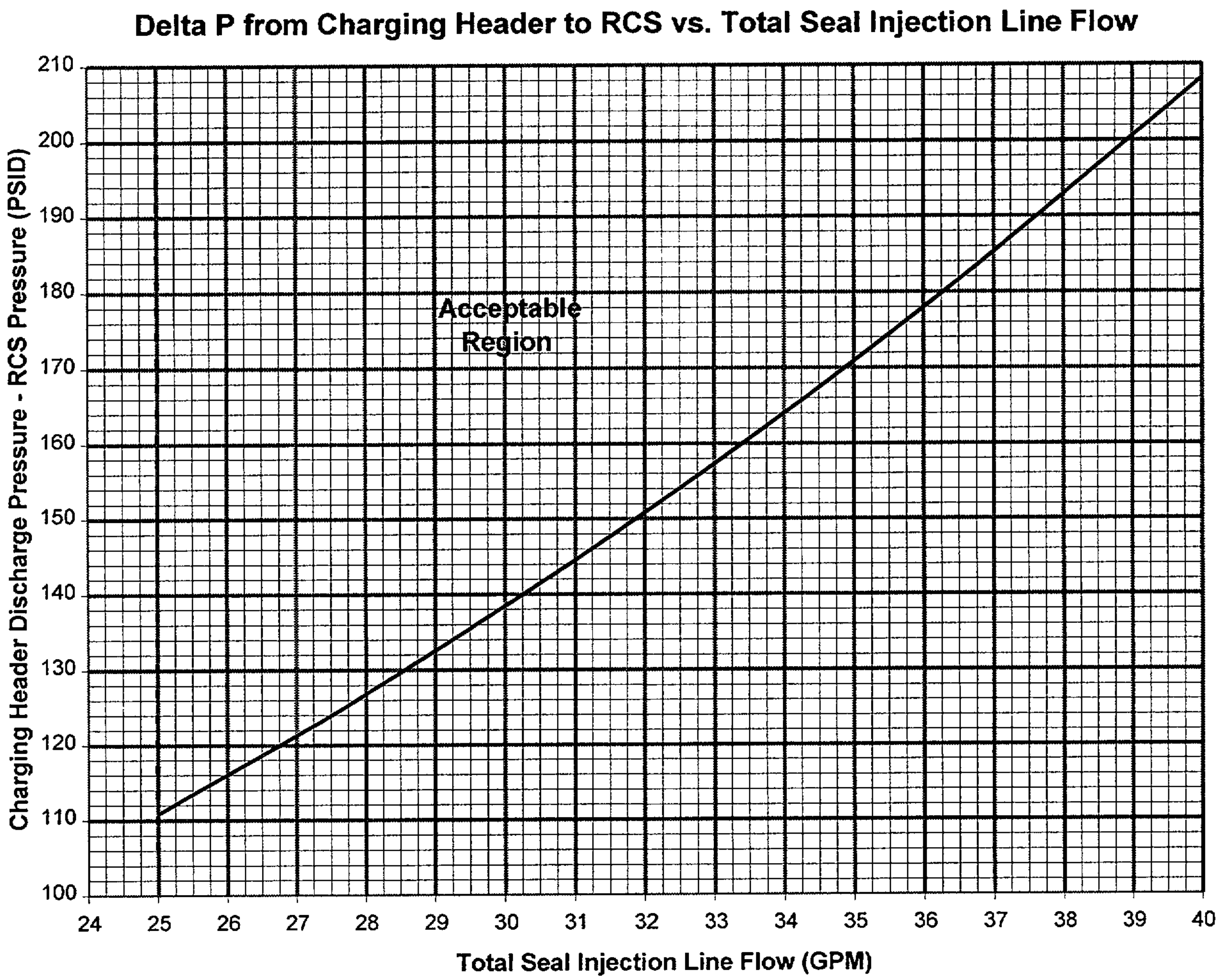

Figure 3.5.5-1 (page 1 of 1)
Delta P from Charging Header to RCS vs. Total Seal Injection Line Flow

ATTACHMENT FOUR
ULNRC04583

PROPOSED TECHNICAL SPECIFICATION BASES CHANGES
(for information only)

BASES

APPLICABLE SAFETY ANALYSES (continued)

a. A large break LOCA event, with a loss of offsite power and a single failure disabling one ECCS train; and

b. A small break LOCA event, with a loss of offsite power and a single failure disabling one ECCS train.

During the blowdown stage of a LOCA, the RCS depressurizes as primary coolant is ejected through the break into the containment. The nuclear reaction is terminated either by moderator voiding during large breaks or control rod insertion for small breaks. Following depressurization, emergency core cooling water is injected into the cold legs, flows into the downcomer, fills the lower plenum, and refloods the core.

The effects on containment mass and energy releases are accounted for in appropriate analyses (Refs. 3 and 4). The LCO ensures that an ECCS train will deliver sufficient water to match boiloff rates soon enough to minimize the consequences of the core being uncovered following a large LOCA. It also ensures that the centrifugal charging and SI pumps will deliver sufficient water and boron during a small LOCA to maintain core subcriticality. For smaller LOCAs, the centrifugal charging pump delivers sufficient fluid to maintain RCS inventory. For a small break LOCA, the steam generators continue to serve as the heat sink, providing part of the required core cooling.

The safety analyses make assumptions with respect to: (1) both the maximum and minimum total system resistance; (2) both the maximum and minimum branch injection line resistance; and (3) the maximum and minimum ranges of potential pump performance. These resistances and ranges of pump performance are used to calculate the maximum and minimum ECCS flows assumed in the safety analyses.

The CCP minimum flow SR in FSAR Section 16.5 provides the absolute minimum injected flow (at zero RCS pressure) assumed in the safety analyses (~~301.8~~ gpm). The maximum total system resistance defines the range of minimum flows (including the minimum flow SR), with respect to pump head, that is assumed in the safety analyses. Therefore, the CCP total system resistance ~~($(P_d-P_{RCS})/Q_d^2$)~~ must not be greater than 1.004E-02 ft/gpm^2, where P_d is pump discharge pressure in feet, ~~P_{RCS}~~ is RCS ~~pressure~~ in feet, and Q_d is the total pump flow rate in gpm.

The SI pump minimum flow SR in FSAR Section 16.5 provides the absolute minimum injected flow (at zero RCS pressure) assumed in the safety analyses (455.6 gpm). The maximum total system resistance defines the range of minimum flows, with respect to pump head, that is

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

assumed in the safety analyses. Therefore, the safety injection pump total system resistance ($(P_d - P_{RCS})/Q_d^2$) must not be greater than 0.423E-02 ft/gpm^2, where P_d is pump discharge pressure in feet, P_{RCS} is RCS pressure in feet, and Q_d is the total pump flow rate in gpm.

The CCP maximum total pump flow SR in FSAR Section 16.5 ensures the maximum injection flow limit of 550 gpm is not exceeded. This value of flow is comprised of the total flow to the four branch lines of ~~460~~ 461 gpm and a seal injection flow of ~~79~~ 87 gpm plus 2 gpm for instrument uncertainties. A best estimate increase of 17 gpm when aligned in the recirculation phase (maximum flow of 567 gpm) is discussed in References 8 and 9.

The SI pump maximum total pump flow SR in FSAR Section 16.5 ensures the maximum injection flow limit of 675 gpm is not exceeded. This value of flow includes a nominal 30 gpm of mini-flow. A best estimate increase of 16 gpm when aligned in the recirculation phase (maximum flow of 691 gpm) is discussed in References 8 and 9.

The test procedure places requirements on instrument accuracy (20 inches of water column for the charging branch lines and 10 inches of water column for the safety injection branch lines) and setting tolerance (30 inches of water column for both the charging and safety injection branch lines) such that branch line flow imbalance remains within the assumptions of the safety analyses.

The maximum and minimum potential pump performance curves, in conjunction with the maximum and minimum flow SRs, the maximum total system resistance, and the test procedure requirements, ensure that the assumptions of the safety analyses remain valid.

The surveillance flow and differential pressure requirements are the Safety Analysis Limits and do not include instrument uncertainties. These instrument uncertainties will be accounted for in the surveillance test procedure to assure that the Safety Analysis Limits are met.

The ECCS trains satisfy Criterion 3 of 10CFR50.36(c)(2)(ii).

LCO

In MODES 1, 2, and 3, two independent (and redundant) ECCS trains are required to ensure that sufficient ECCS flow is available, assuming a single failure affecting either train. Additionally, individual components within the ECCS trains may be called upon to mitigate the consequences of other transients and accidents.

In MODES 1, 2, and 3, an ECCS train consists of a centrifugal charging subsystem, an SI subsystem, and an RHR subsystem. Each train

(continued)

10/31/01

B 3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

B 3.5.5 Seal Injection Flow

BASES

BACKGROUND

This LCO is applicable to Callaway since the plant utilizes the centrifugal charging pumps for safety injection (SI). The function of the seal injection throttle valves during an accident is similar to the function of the ECCS throttle valves in that each restricts flow from the centrifugal charging pump header to the Reactor Coolant System (RCS).

The restriction on reactor coolant pump (RCP) seal injection flow limits the amount of ECCS flow that would be diverted from the injection path following an accident. This limit is based on safety analysis assumptions that are required because RCP seal injection flow is not isolated during SI.

APPLICABLE SAFETY ANALYSES

All ECCS subsystems are taken credit for in the large break loss of coolant accident (LOCA) at full power (Ref. 1). The LOCA analysis establishes the minimum flow for the ECCS pumps. The centrifugal charging pumps are also credited in the small break LOCA analysis. This analysis establishes the flow and discharge head at the design point for the centrifugal charging pumps. The safety analyses make assumptions with respect to: (1) both the maximum and minimum total system resistance; (2) both the maximum and minimum branch injection line resistance; and (3) the maximum and minimum ranges of potential pump performance. These resistances and ranges of pump performance are used to calculate the maximum and minimum ECCS flows assumed in the safety analyses. The CCP maximum total pump flow SR in FSAR Section 16.5 ensures the maximum injection flow limit of 550 gpm is not exceeded. This value of flow is comprised of the total flow to the four branch lines of ~~469~~ 461 gpm and a seal injection flow of ~~79~~ 87 gpm plus 2 gpm for instrument uncertainties. The Bases for LCO 3.5.2, "ECCS - Operating," contain additional discussion on the safety analyses. The steam generator tube rupture and main steam line break event analyses also credit the centrifugal charging pumps, but are not limiting in their design. Reference to these analyses is made in assessing changes to the Seal Injection System for evaluation of their effects in relation to the acceptance limits in these analyses.

This LCO ensures that seal injection flow will be sufficient for RCP seal integrity but limited so that the ECCS trains will be capable of delivering sufficient water to match boiloff rates soon enough to minimize uncovering of the core following a large LOCA. It also ensures that the centrifugal charging pumps will deliver sufficient water for a small break

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

LOCA and sufficient boron to maintain the core subcritical. For smaller LOCAs, the centrifugal charging pumps alone deliver sufficient fluid to overcome the loss and maintain RCS inventory. Seal injection flow satisfies Criterion 2 of 10CFR50.36(c)(2)(ii).

LCO

The intent of the LCO limit on seal injection flow is to make sure that flow through the RCP seal water injection line is low enough to ensure that sufficient centrifugal charging pump injection flow is directed to the RCS via the injection points (Ref. 2).

BASES INSERT A

The LCO is not strictly a flow limit, but rather a flow limit based on a flow line resistance. In order to establish the proper flow line resistance, a pressure and flow must be known. ~~The flow line resistance is established by adjusting the RCP seal water injection throttle valves such that flow to the RCP seals is limited to 20 gpm per pump in the event of a large break LOCA. This accident analysis limit is met by positioning the valves so that the flow to each RCP seal is 7.5± 0.5 gpm with a 105 (+5, -2) psi differential between the charging header and RCS pressure.~~ Once set, these throttle valves are secured with locking devices and mechanical position stops. These devices help to ensure that the following safety analyses assumptions remain valid: (1) both the maximum and minimum total system resistance; (2) both the maximum and minimum branch injection line resistance; and (3) the maximum and minimum ranges of potential pump performance. These resistances and pump performance ranges are used to calculate the maximum and minimum ECCS flows assumed in the LOCA analyses of Reference 1. The centrifugal charging pump discharge header pressure remains essentially constant through all the applicable MODES of this LCO. A reduction in RCS pressure would result in more flow being diverted to the RCP seal injection line than at normal operating pressure. The valve settings established at the prescribed differential pressure result in a conservative valve position should RCS pressure decrease.

The limit on seal injection flow must be met to render the ECCS OPERABLE. If these conditions are not met, the ECCS flow will not be as assumed in the accident analyses.

APPLICABILITY

In MODES 1, 2, and 3, the seal injection flow limit is dictated by ECCS flow requirements, which are specified for MODES 1, 2, 3, and 4. The seal injection flow limit is not applicable for MODE 4 and lower, however, because high seal injection flow is less critical as a result of the lower initial RCS pressure and decay heat removal requirements in these

(continued)

BASES INSERT A

The flow line resistance is established by adjusting the RCP seal water injection throttle valves such that the analyzed ECCS flow to the RCP seals is limited to 89 gpm with one centrifugal charging pump (CCP) operating at 550 gpm on its maximum pump curve. This accident analysis limit is met by positioning the valves so that the flow to the RCP seals is within the limits of Technical Specifications Figure 3.5.5-1 for a given differential pressure between the charging pump discharge header and the RCS pressurizer steam space pressure. The seal injection flow curve is presented with the pressure difference from BGPT0120 to the pressurizer steam space pressure as a function of total seal injection line flow. A flow measurement instrument uncertainty of 0.25 gpm per loop was accounted for in the calculation of the pressure drop from BGPT0120 to the seal injection connection. In addition, 2 psid is added to accommodate instrument uncertainty in the pressure drop measurement. An additional 4 psid has been conservatively added to the required pressure differential to allow for seal injection filter change out. Requiring as an initial condition that the filter used for each surveillance have a differential pressure less than or equal to 4 psid allows for post-surveillance filter change out with no differential pressure restriction.

BASES

APPLICABILITY (continued)

MODES. Therefore, RCP seal injection flow must be limited in MODES 1, 2, and 3 to ensure adequate ECCS performance.

ACTIONS

A.1

With the seal injection flow exceeding its limit, the amount of charging flow available to the RCS may be reduced. Under this Condition, action must be taken to restore the flow to below its limit. The operator has 4 hours from the time the flow is known to be above the limit to correctly position the manual seal injection throttle valves and thus be in compliance with the accident analysis. The Completion Time minimizes the potential exposure of the plant to a LOCA with insufficient injection flow and provides a reasonable time to restore seal injection flow within limits. This time is conservative with respect to the Completion Times of other ECCS LCOs; it is based on operating experience and is sufficient for taking corrective actions by operations personnel.

B.1 and B.2

When the Required Action cannot be completed within the required Completion Time, a controlled shutdown must be initiated. The Completion Time of 6 hours for reaching MODE 3 from MODE 1 is a reasonable time for a controlled shutdown, based on operating experience and normal cooldown rates, and does not challenge plant safety systems or operators. Continuing the plant shutdown begun in Required Action B.1, an additional 6 hours is a reasonable time, based on operating experience and normal cooldown rates, to reach MODE 4 where this LCO is no longer applicable.

SURVEILLANCE REQUIREMENTS

SR 3.5.5.1

BASES INSERT B

Verification every 18 months that the manual seal injection throttle valves are adjusted to give a flow within the limit ensures that proper manual seal injection throttle valve position, and hence, proper seal injection flow, is maintained. The seal water injection throttle valves are set to ensure proper flow resistance and pressure drop in the piping to each injection point in the event of a LOCA. ~~The seal injection flow line resistance is established by adjusting the RCP seal water injection throttle valves such that flow to the RCP seals is limited to 20 gpm per pump in the event of a large break LOCA. This accident analysis limit is met by positioning the valves so that the flow to each RCP seal is 7.5 ± 0.5 gpm with a 105 (+5, -2) psi differential between the charging header and RCS pressure.~~

(continued)

BASES INSERT B

The seal injection flow line resistance is established by adjusting the RCP seal water injection throttle valves such that the analyzed ECCS flow to the RCP seals is limited to 89 gpm with one centrifugal charging pump (CCP) operating at 550 gpm on its maximum pump curve. This accident analysis limit is met by positioning the valves so that the flow to the RCP seals is within the limits of Technical Specifications Figure 3.5.5-1 for a given differential pressure between the charging pump discharge header and the RCS pressurizer steam space pressure. The seal injection flow curve is presented with the pressure difference from BGPT0120 to the pressurizer steam space pressure as a function of total seal injection line flow. A flow measurement instrument uncertainty of 0.25 gpm per loop was accounted for in the calculation of the pressure drop from BGPT0120 to the seal injection connection. In addition, 2 psid is added to accommodate instrument uncertainty in the pressure drop measurement. An additional 4 psid has been conservatively added to the required pressure differential to allow for seal injection filter change out. Requiring as an initial condition that the filter used for each surveillance have a differential pressure less than or equal to 4 psid allows for post-surveillance filter change out with no differential pressure restriction.

ATTACHMENT FIVE
ULNRC04583

PROPOSED FSAR CHANGES
(for information only)

6.2.1.3.2 Energy Sources

The sources of energy considered in the LOCA mass and energy release analysis are given in the energy balance tables (Tables 6.2.1-43 through 6.2.1-48). These energy sources are:

a. RCS, accumulators, and pumped safety injection sensible heat

b. Decay heat

c. Core stored energy

d. Thick and thin metal energy

e. Steam generator energy

The energy balance tables show the initial energy distribution and the energy distribution at end-of-blowdown (EOB), end-of-entrainment (EOE), end-of-froth (EOF), and end-of-froth intact loops (EOFIL) for the two-phase post-reflood analyses. For the dry steam post-reflood analyses, the energy distribution at an assumed recirculation time of 1,500 seconds is given instead of EOF and EOFIL.

The methods and assumptions used to release the various energy sources are given in Reference 3.

The following items ensure that the core energy release is conservatively analyzed for maximum containment pressure.

a. Core power level of 3,636 MWt (102 percent of core power level)

b. Allowance in temperature for instrument error and dead band (+4 F)

c. Margin in volume (1.4 percent)

d. Allowance in volume for thermal expansion (1.6 percent)

e. Margin in core power associated with use of engineered safeguards design rating (ESDR)

f. Allowance for calorimetric error (2 percent of ESDR)

g. Conservatively modified coefficients of heat transfer

~~h. Allowance in core stored energy for effect of fuel densification~~

~~i. Margin in core stored energy (+15 percent)~~

FSAR INSERT A

FSAR INSERT A

h. The maximum value of core stored energy at the worst time in life for the limiting fuel rod (as calculated with the NRC-approved fuel performance model) is selected to represent the core-wide value for core stored energy.

i. The maximum value of core stored energy includes the effect of uncertainties in the fuel performance model and the fabrication process.

6.2.1.3.9 Additional Information Required for Confirmatory Analysis

System parameters and hydraulic characteristics needed to perform confirmatory analysis are provided in Tables 6.2.1-51 through 6.2.1-55.

6.2.1.3.10 FSAR INSERT B

6.2.1.4 <u>Mass and Energy Release Analysis for Postulated Secondary Pipe Ruptures Inside Containment</u>

Steam line ruptures occurring inside a reactor containment structure may result in significant releases of high energy fluid to the containment environment, possibly resulting in high containment temperatures and pressures. The quantitative nature of the releases following a steam line rupture is dependent upon the many possible configurations of the plant steam system and containment designs as well as the plant operating conditions and the size of the rupture. These variations make a reasonable determination of the single absolute "worst case" for both containment pressure and temperature evaluations following a steambreak difficult. This section describes the methods used in determining the containment responses to a variety of postulated pipe breaks encompassing wide variations in plant operation, safety system performance, and break size.

Table 6.2.1-56 lists the 16 cases that were analyzed to determine the worst case containment pressures and temperatures following a main steam line break. Out of these cases, the following four cases were reanalyzed to determine the impact of plant uprating to 3579 MWt:

1. Full double-ended rupture at 102 percent uprated power (Case 1).

2. 0.60 ft^2 double-ended rupture at 102 percent uprated power (Case 2).

3. 0.80 ft^2 split rupture at 102 percent uprated power (Case 3).

4. Full double-ended rupture at 102 percent uprated power (Case 16) assuming failure of MSIV.

The 8 percent revaporization of condensate as allowed by NUREG 0588 was modeled. The analysis was based on new mass and energy release data provided by Westinghouse. This mass and energy release data included the effects of superheated steam and no credit was taken for entrainment.

The analysis for the 0.8 ft^2 split rupture was an iterative process. For the uprated condition, the time to reach Hi-1 set pressure of 6.0 psig and Hi-2 set pressure of 20 psig were

FSAR INSERT B

6.2.1.3.10 Evaluation to Support Reduced Centrifugal Charging Pump (CCP) ECCS Subsystem Flow Rates

The documentation supporting Reference 12 includes the results of an evaluation addressing reduced CCP ECCS subsystem flow rates for both the minimum and maximum ECCS flow rate conditions. Additionally, the effect of the normal charging pump (NCP) on the maximum ECCS flow rate condition was considered. The results from the licensing basis analysis of record were shown to bound the new ECCS flow rate conditions. Tables 6.2.1-51 and 6.2.1-52 have been updated to reflect the new safety injection flow rates.

8. Letter - Docket 50-368, "Main Steamline Break Accident Environmental Qualifications," John F. Stolz (NRC) to William Cavanaugh III (Arkansas Power and Light Co.), April 14, 1978.

9. Bordelon, F. M., Massie, H. W., Jr., Zordon, T. A., "Westinghouse Emergency Core Cooling System Evaluation Model Summary", WCAP-8339, June 1974.

10. ULNRC-1471 "Callaway Plant Uprating Submittal", March 31, 1987.

11. NUREG/CR-0255, "CONTEMPT-LT/028-A Computer Program For Predicting Containment Pressure - Temperature Response To A Loss-of-Coolant Accident", March 1979.

12. Callaway Operating License Amendment dated

TABLE 6.2.1-51

BASES FOR ANALYSIS

Plant model	4 loop, 12 ft core
Core power MWt	3565
Nominal inlet temperature, F	560.0
Nominal outlet temperature, F	618.6
Steam pressure, psia	1000
Rod array	17 x 17
Total accumulator mass, lbm	235,020
Accumulator temperature, F	120
Assumed containment design pressure, psia	74.7
Assumed RWST temperature, F	120
Pumped injection (assumed for froth)	
Minimum, lb/sec	564.5 ~~586.3~~
Maximum, lb/sec	1324.5 ~~1401~~
RPV volume below break, ft^3	2959

TABLE 6.2.1-52

SAFETY INJECTION FLOW RATE
VERSUS BACKPRESSURE

Pressure (psia)	Minimum Flow Rate (ft^3/sec)		Maximum Flow Rate (ft^3/sec)	
14.7	~~11.26~~	11.08	~~26.13~~	25.23
114.7	~~8.035~~	7.86	~~19.84~~	18.95
214.7	~~2.257~~	2.08	~~7.741~~	6.86
1014.7	~~1.530~~	1.41	~~2.730~~	1.96

TABLE 15.6-10a

SAFETY INJECTION PUMPED FLOW*

ASSUMED FOR BREAKS GREATER THAN OR EQUAL TO 10 INCHES

MINIMUM SAFEGUARDS: one train operating spill to 0 psig

RCS Pressure (psig)	CHG Inject (gpm)	SI Inject (gpm)	RHR Inject (gpm)	Total Inject (gpm)
2500	0.0	0.0	0.0	0.0
2400	0.0	0.0	0.0	0.0
2300	0.0	0.0	0.0	0.0
2200	0.0	0.0	0.0	0.0
2100	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0
1900	13.7	0.0	0.0	13.7
1800	39.6	0.0	0.0	39.6
1700	64.3	0.0	0.0	64.3
1600	87.4	0.0	0.0	87.4
1500	106.8	0.0	0.0	106.8
1400	125.8	0.0	0.0	125.8
1300	144.5	42.7	0.0	187.2
1200	161.2	102.7	0.0	263.9
1100	177.7	150.1	0.0	327.8
1000	194.0	191.6	0.0	385.6
900	210.1	228.4	0.0	438.5
800	226.5	262.7	0.0	489.2
700	237.8	291.5	0.0	529.3
600	247.4	318.6	0.0	566.0
500	256.6	344.7	0.0	601.3
400	265.8	369.1	0.0	634.9
300	274.8	392.3	0.0	667.1
200	284.0	414.5	0.0	698.5
100	293.0	435.3	373.3	1101.6
0	301.8	455.6	2828.9	3586.3

*Sum of the centrifugal charging, safety injection, and residual heat removal pump flows. Does not include seal injection flow.

FSAR INSERT C

FSAR INSERT D

FSAR INSERTS C AND D

INSERT C	INSERT D
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
1.8	1.8
27.6	27.6
53.6	53.6
78.1	78.1
98.7	98.7
118.5	118.5
137.9	180.6
155.7	258.4
173.0	323.1
190.1	381.7
205.1	433.5
214.1	476.8
223.1	514.6
231.8	550.4
240.5	585.2
248.9	618.0
257.5	649.8
266.0	680.5
274.4	1083.0
282.6	3567.1

TABLE 15.6-10b

SAFETY INJECTION PUMPED FLOW*

ASSUMED FOR BREAKS GREATER THAN OR EQUAL TO 10 INCHES

MAXIMUM SAFEGUARDS: both trains operating spill to 0 psig

RCS Pressure (psig)	CHG Inject (gpm)	Seal Inject (gpm)	SI Inject (gpm)	RHR Inject (gpm)	Total Inject (gpm)
2600	36.3	15.0	0.0	0.0	51.3
2500	67.4	22.1	0.0	0.0	89.5
2400	111.0	30.2	0.0	0.0	141.2
2300	145.6	37.2	0.0	0.0	182.8
2200	173.7	43.0	0.0	0.0	216.7
2100	199.6	48.4	0.0	0.0	248.0
2000	223.6	53.5	0.0	0.0	277.1
1900	244.6	58.0	0.0	0.0	302.6
1800	264.7	62.3	0.0	0.0	327.0
1700	283.9	66.5	0.0	0.0	350.4
1600	302.4	70.5	0.0	0.0	372.9
1500	319.8	74.3	89.8	0.0	483.9
1400	336.1	77.8	175.7	0.0	589.6
1300	352.0	81.2	231.2	0.0	664.4
1200	367.3	84.6	278.4	0.0	730.3
1100	382.3	87.8	319.0	0.0	789.1
1000	397.0	91.0	355.9	0.0	843.9
900	410.9	94.1	389.8	0.0	894.8
800	424.4	97.0	420.3	0.0	941.7
700	437.6	99.9	449.2	0.0	986.7
600	450.5	102.7	476.8	0.0	1030.0
500	463.1	105.5	502.8	0.0	1071.4
400	475.6	108.2	527.2	0.0	1111.0
300	487.9	110.9	550.7	0.0	1149.5
200	499.9	113.5	573.5	0.0	1186.9
100	511.8	116.1	595.5	4000.7	5224.1
0	523.4	118.6	617.1	7596.3	8855.4

FSAR INSERT F

FSAR INSERT E

*Sum of the centrifugal charging, safety injection, and residual heat removal pump flows. Includes seal injection flow.

FSAR INSERT G

FSAR INSERTS E, F, AND G

INSERT E	INSERT F	INSERT G
81.3	29.1	110.4
112.8	39.4	152.2
148.8	38.5	187.3
177.3	44.9	222.2
203.7	50.9	254.6
228.5	56.5	285.0
249.9	61.4	311.3
270.5	66.1	336.6
290.1	70.7	360.8
309.0	75.0	384.0
326.7	79.1	495.6
343.4	82.9	602.0
359.6	86.7	677.5
375.5	90.3	744.2
390.8	93.9	803.7
405.8	97.3	859.0
419.9	100.6	910.3
433.7	103.8	957.8
447.2	106.9	1003.3
460.4	109.9	1047.1
473.6	113.0	1089.4
486.2	115.9	1129.3
498.8	118.8	1168.3
511.4	121.7	1206.6
523.4	124.5	5244.1
535.4	127.2	8876.0

TABLE 15.6-16

SAFETY INJECTION FLOW FOR SMALL BREAK ANALYSIS*

MINIMUM SAFEGUARDS: One Train Operating SI spill to RCS Backpressure, CCP spills to 0 psig

RCS Pressure (psig)	CHG Inject (gpm)	SI Inject (gpm)	Total Inject (gpm)
2500	0.0	0.0	0.0
2400	0.0	0.0	0.0
2300	0.0	0.0	0.0
2200	0.0	0.0	0.0
2100	0.0	0.0	0.0
2000	0.0	0.0	0.0
1900	13.7	0.0	13.7
1800	39.6	0.0	39.6
1700	64.3	0.0	64.3
1600	87.4	0.0	87.4
1500	106.8	0.0	106.8
1400	125.8	108.3	234.1
1300	144.5	163.8	308.3
1200	161.2	201.0	362.2
1100	177.7	232.8	410.5
1000	194.0	259.2	453.2
900	210.1	283.8	493.9
800	226.5	306.8	533.3
700	237.8	327.9	565.7
600	247.4	348.6	596.0
500	256.6	368.4	625.0
400	265.8	387.9	653.7
300	274.8	406.2	681.0
200	284.0	423.9	707.9
100	293.0	439.8	732.8
0	301.8	455.6	757.4

FSAR INSERT C

*Sum of the flows from one centrifugal charging pump and one safety injection pump. Does not include seal injection flow.

FSAR INSERT H

FSAR INSERTS C AND H

INSERT C	INSERT H
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
0.0	0.0
1.8	1.8
27.6	27.6
53.6	53.6
78.1	78.1
98.7	98.7
118.5	226.8
137.9	301.7
155.7	356.7
173.0	405.8
190.1	449.3
205.1	488.9
214.1	520.9
223.1	551.0
231.8	580.4
240.5	608.9
248.9	636.8
257.5	663.7
266.0	689.9
274.4	714.2
282.6	738.2

16.5.2 ECCS SUBSYSTEMS - $T_{avg} \geq 350°F$

16.5.2.1 LIMITING CONDITION FOR OPERATION

Two Emergency Core Cooling System (ECCS) trains shall be OPERABLE in MODES 1, 2, and 3 and one train shall be OPERABLE in MODE 4.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With less than the required number of ECCS trains OPERABLE, enter Section 16.0.1.3.

16.5.2.1.1 SURVEILLANCE REQUIREMENTS

Each ECCS subsystem shall be demonstrated OPERABLE:

a. By a visual inspection which verifies that no loose debris (rags, trash, clothing, etc.) is present in the containment which could be transported to the containment sump and cause restriction of the pump suctions during LOCA conditions. This visual inspection shall be performed:

   1) Once prior to entry into MODE 4 from MODE 5 for all accessible areas of the containment; and

   2) At the completion of each containment entry for all affected areas within containment.

b. By performing a flow balance test of the affected centrifugal charging pump portions of the ECCS subsystem, during shutdown, following completion of modifications to that centrifugal charging pump subsystem that alters the subsystem flow characteristics. The test shall be performed with a single pump running and the throttle valves set within setting tolerance to provide balanced branch line flow. Under these conditions there is zero mini-flow and ~~79~~ 87 plus 2 or minus 4 gpm simulated reactor coolant pump seal injection line flow. This test shall verify:

   1) The total flow to the four branch lines is less than or equal to ~~469~~ 461 gpm, and

   2) The total flow to the four branch lines is greater than or equal to ~~406.2~~ 411 gpm (this corresponds to an analyzed flow rate of ~~301.8~~ 305.25 gpm through the three lowest flow branch lines).

The CCP minimum flow SR provides the absolute minimum injected flow assumed in the safety analyses. The maximum total system resistance defines the range of minimum flows (including the minimum flow SR), with respect to pump head, that is assumed in the safety analyses. Therefore, the CCP total system resistance $((P_d - P_{RCS})/Q_d^2)$ must not be greater than 1.004E-2 ft/gpm^2, where P_d is pump dischage pressure in feet, P_{RCS} is RCS pressure in feet, and Q_d is the total pump flow rate in gpm.

The SI pump minimum flow SR provides the absolute minimum injected flow assumed in the safety analyses. The maximum total system resistance defines the range of minimum flows (including the minimum flow SR), with respect to pump head, that is assumed in the safety analyses. Therefore, the safety injection pump total system resistance $((P_d - P_{RCS})/Q_d^2)$ must not be greater than 0.423E-2 ft/gpm^2, where P_d is pump discharge pressure in feet, P_{RCS} is RCS pressure in feet, and Q_d is the total pump flow rate in gpm.

The CCP maximum total pump flow SR ensures the maximum injection flow limit of 550 gpm is not exceeded. This value of flow is comprised of the total flow to the four branch lines of 469 gpm and a seal injection flow of 79 gpm plus 2 gpm for instrument uncertainties.

The SI pump maximum total pump flow SR ensures the maximum injection flow limit of 675 gpm is not exceeded. This value of flow includes a nominal 30 gpm of mini-flow.

The test procedure places requirements on instrument accuracy (20 inches of water column for the charging branch lines and 10 inches of water column for the SI branch lines) and setting tolerance (30 inches of water column for both the charging and SI branch lines) such that branch line flow imbalance remains within the assumptions of the safety analyses.

The maximum and minimum potential pump performance curves, in conjunction with the maximum and minimum flow SRs, the maximum total system resistance, and the test procedure requirements, ensure that the assumptions of the safety analyses remain valid.

The surveillance flow and differential pressure requirements are the Safety Analysis Limits and do not include instrument uncertainties. These instrument uncertainties will be accounted for in the surveillance test procedure to assure that the Safety Analysis Limits are met.