Pacific Gas and Electric Company

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August 1, 2003

PG&E Letter DCL-03-092

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to NRC Request for Additional Information Regarding License Amendment Request 02-05, "Revision to Technical Specification Table 3.3.1-1, 'Reactor Trip System Instrumentation,' and Revised Reactor Coolant System Flow Measurement"

Dear Commissioners and Staff:

On April 22, 2003, the NRC staff identified additional information required to complete the evaluation associated with PG&E License Amendment Request (LAR) 02-05 for Diablo Canyon Power Plant (DCPP) Units 1 and 2.

LAR 02-05 proposes to revise the term "minimum measured flow per loop" to "measured loop flow" in the allowable value and nominal trip setpoint columns for the Reactor Coolant Flow-Low reactor trip function contained in Technical Specification 3.3.1 Table 3.3.1-1, "Reactor Trip System Instrumentation." In addition, LAR 02-05 proposes to allow an alternate method for the measurement of reactor coolant system (RCS) total volumetric flow rate through measurement of the elbow tap differential pressures on the RCS primary cold legs. LAR 02-05 was submitted by PG&E letter DCL-02-097, "License Amendment Request 02-05, Revision to Technical Specification Table 3.3.1-1, 'Reactor Trip System Instrumentation,' and Revised Reactor Coolant System Flow Measurement," dated August 27, 2002.

Previously, PG&E provided responses to NRC requests for additional information in PG&E letter DCL-03-056, "Response to NRC Request for Additional Information Regarding License Amendment Request 02-05, Revision to Technical Specification Table 3.3.1-1, 'Reactor Trip System Instrumentation,' and Revised Reactor Coolant System Flow Measurement," dated May 15, 2003, and PG&E letter DCL-03-079, "Response to NRC Request for Additional Information Regarding License Amendment Request 02-05, Revision to Technical Specification Table 3.3.1-1, 'Reactor Trip System Instrumentation,' and Revised Reactor Coolant System Flow Measurement," dated June 26, 2003.

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PG&E's response to the April 22, 2003, request for additional information is included in Enclosure 1.

The additional information does not affect the results of the safety evaluation or no significant hazards consideration determination previously transmitted in PG&E letter DCL-02-097.

If you have any questions regarding this response, please contact Stan Ketelsen at 805-545-4720.

Sincerely,

James R. Becker
Vice President - Diablo Canyon Operations and Station Director

kjs/4328
Enclosures

cc: Edgar Bailey, DHS
Thomas P. Gwynn
David L. Proulx
Diablo Distribution

cc/enc: Girija S. Shukla

PG&E Letter DCL-03-092

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

	)	Docket No. 50-275
In the Matter of	)	Facility Operating License
PACIFIC GAS AND ELECTRIC COMPANY	)	No. DPR-80
	)	
Diablo Canyon Power Plant	)	Docket No. 50-323
Units 1 and 2	)	Facility Operating License
	)	No. DPR-82

AFFIDAVIT

James R. Becker, of lawful age, first being duly sworn upon oath states that he is Vice President - Diablo Canyon Operations and Station Director of Pacific Gas and Electric Company; that he has executed this response to the NRC request for additional information on License Amendment Request 02-05 on behalf of said company with full power and authority to do so; that he is familiar with the content thereof; and that the facts stated therein are true and correct to the best of his knowledge, information, and belief.

James R. Becker
Vice President - Diablo Canyon Operations and Station Director

Subscribed and sworn to before me this 1st day of August 2003.

Notary Public
County of San Luis Obispo
State of California

SANDRA L. RECTOR
Commission # 1339380
Notary Public - California
San Luis Obispo County
My Comm. Expires Jan 12, 2006

PG&E Response to NRC Request for Additional Information Regarding License Amendment Request 02-05, "Revision to Technical Specification Table 3.3.1-1, 'Reactor Trip System Instrumentation,' and Revised Reactor Coolant System Flow Measurement"

Questions Received on April 22, 2003:

NRC Question 1

Provide justification that the kinetic energy effects between the hot leg and the cold leg have a negligible impact on the elbow tap flow measurement.

PG&E Response

The difference in the kinetic energy (KE) per unit mass between the reactor coolant system (RCS) hot leg and cold leg resistance temperature detectors (RTDs) has been calculated to be -0.00018 British thermal units (BTU) per pound mass for Diablo Canyon Power Plant (DCPP) Units 1 and 2. This difference is considered to be negligible and therefore the effects of KE can be ignored for the calculation of elbow tap flow using baseline RCS flow calorimetrics. The calculation of the difference in the KE per unit mass between the RCS hot leg and cold leg RTDs is contained in Enclosure 2.

NRC Question 2

What was the heat loss rate between the RCS hot legs and cold legs assumed in the RCS calorimetric calculations? What were the RCS makeup and letdown mass flow rates and the locations that were assumed in the calculations?

PG&E Response

The net heat loss between the RCS cold and hot leg RTDs on the core side that is currently used by PG&E in the RCS flow calorimetric calculations is 1.089 million BTU per hour for each loop. Individual charging flow energy, reactor vessel heat loss, pressurizer spray flow energy, control rod drive mechanism heat loss, and RCS piping heat loss terms are quantified in the heat loss calculation. The heat loss calculation is contained in PG&E Calculation N-196 Revision 0 which is attached in Enclosure 3. It is noted that the baseline flow calorimetrics that were performed in Cycles 1 and 2 for DCPP used an older value of 1.835 million BTU per hour instead of 1.089 million BTU per hour. This older value resulted in slightly lower (more conservative) RCS baseline flows for the elbow tap normalization.

The heat loss calculation considers a charging flow of 25,025 pounds mass per hour (50 gallons per minute at a temperature of 100 degrees Fahrenheit and a pressure of 2250 pounds per square inch absolute) that enters the RCS via the normal charging line. The charging flow is based on a letdown flow of 75 gpm, a reactor coolant pump seal return flow of 11 gpm, and a net RCP seal injection flow of 25 gpm.

Evaluation of Effect of Kinetic Energy Difference Between RCS Hot and Cold Leg RTDs on RCS Flow Calorimetric

With the kinetic energy term, the loop reactor coolant system (RCS) flow calorimetric equation becomes:

$M = Q/(\Delta h + \Delta(KE))$ [Equation 1]

M = loop mass flowrate (pounds mass (lb_m)/sec)

Q = net heat removal between hot and cold leg resistance temperature detectors (RTDs) (British thermal units (BTU)/sec)

Δh = enthalpy rise between cold leg and hot leg RTDs (a positive value) (BTU/lb_m)

$\Delta(KE)$ = increase in kinetic energy (KE) per unit mass between RCS cold leg and hot leg RTDs (BTU/lb_m)

Note that if $\Delta(KE)$ is negative, then it is conservative to ignore it.

The ratio between the KE at the hot leg and the KE at the cold leg is given by:

$(V_H/V_C)^2 = (\rho_C^2 d_C^4)/(\rho_H^2 d_H^4)$ [Equation 2]

where

$KE = V^2/(2x32.174)$ (foot pounds force/lb_m) [Equation 3]

$M = \rho_C V_C A_C = \rho_H V_H A_H$ (Equation 2 is derived from this conservation of mass equation)

M = loop mass flow rate (lb_m/second (sec))

ρ = water density (lb_m/cubic feet (ft^3))

V = water velocity (feet (ft)/sec)

A = flow area (square feet (ft^2))

d = pipe inside diameter (ft)

The RCS flow calorimetric is performed at (or near) 100 percent reactor thermal power. At full power, the following nominal conditions exist in the RCS cold and hot legs at Diablo Canyon Units 1 and 2.

RCS Cold Leg	RCS Hot Leg
d_C = 27.5" = 2.292 ft	d_H = 29" = 2.417 ft
$A_C = 4.1247\ ft^2$	$A_H = 4.5869\ ft^2$
T_C = 540 degrees Fahrenheit (F)	T_H = 604 F
P_C = 2300 pounds per square inch absolute (psia)	P_H = 2250 psia
$\rho_C = 47.526\ lb_m/ft^3$	$\rho_H = 42.817\ lb_m/ft^3$
$h_C = 534.79\ BTU/lb_m$	$h_H = 618.97\ BTU/lb_m$

Then Equation 2 gives:

$$(V_H/V_C)^2 = 0.9962$$

Because this ratio is less than 1.0, Δ (KE) is negative in Equation 1. Therefore, it is conservative to ignore this term in the RCS flow calorimetric calculation. The magnitude of this conservatism is quantified below.

The nominal volumetric flow rate at the RCS cold leg is 91,000 gallons per minute, which is 202.749 ft^3/sec.

The velocity at the RCS cold leg is given by:

$$(202.749\ ft^3/sec)/(4.1247\ ft^2) = 49.155\ ft/sec$$

Equation 3 gives the kinetic energy per unit mass at the RCS cold leg as:

$$(49.155)^2/(2x32.174) = 37.55\ ft\text{-}lb_f/lb_m = 0.04825\ BTU/lb_m$$

The kinetic energy per unit mass at the RCS hot leg is:

$$(0.04825 \times 0.9962) = 0.04807\ BTU/lb_m$$

The Δ (KE) term in Equation 1 is:

$$0.04807-0.04825 = -0.00018\ BTU/lb_m$$

The Δ (KE) term in Equation 1 is very small compared to the enthalpy rise between the cold leg and hot leg RTDs term (Δh) and thus the increase in KE per unit mass between the cold leg and hot leg RTDs can be ignored.

Therefore, the effects of KE can be ignored for the RCS flow calorimetric calculations.

PG&E Calculation N-196 Revision 0

PACIFIC GAS AND ELECTRIC COMPANY
NUCLEAR POWER GENERATION
IDAP CF3.ID4
ATTACHMENT 7.1

TITLE: CALCULATION COVER SHEET

PACIFIC GAS AND ELECTRIC COMPANY
CALCULATION COVER SHEET

File No. :
Calculation No.: N-196

☐ Preliminary ☒ Final

Project: RCS NET HEAT INPUT FOR CALORIMETRIC FLOW Date : 10-31-95
Department/ Group: NSSS/REACTOR ENGINEERING

Structure, System or Component:
RCS (UNITS 1 & 2)

Type or Purpose of Calculation: TO UPDATE THE NET HEAT INPUT FOR THE RCS FLOW CALORIMETRIC (STP R-26) USING THE LATEST DATA OBTAINED FROM WESTINGHOUSE
No. of Sheets: 5 (NOT INCLUDING THIS COVER SHEET)

	Signature	Discipline/Dept.	Date
PREPARER:	William [signature]	REACTOR ENGIN./NSSS	10-?-95
CHECKER :	Douglas N. Poland	Reactor Engr./NSSS	10-28-95
APPROVAL:	[signature] Supervisor	Reactor Eng./NSSS	10-31-95

RMS
INDEXED

For civil calculation, enter the registered engineer's stamp or seal and expiration date of certificate or authority in this space.

For other calculation, enter the registered engineer's full name and registration number, or stamp, or seal in this space.

Larry Lester Cossette
#1327

RECORDS OF REVISIONS

Revision Number	Date	Reasons for Revision	Prepared By	Checked By	Approval Regis. Engr.	Approval Supvr.

PACIFIC GAS AND ELECTRIC CO.
Nuclear Power Generation
Nuclear Technical Services
Reactor Engineering

ENGINEERING CALCULATIONS

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PG&E

ENGINEERING CALCULATIONS

I. Purpose

The purpose of this calculation file is to revise the Reactor Coolant System (RCS) net heat input for the RCS flow calorimetric (STP R-26) using the latest RCS net heat input data obtained from Westinghouse [1]. The new heat addition terms will result in slightly lower calorimetric powers and flows. This calculation file applies to both DCPP units.

II. RCS Net Heat Input For Flow Calorimetric

A. Definition

STP R-26 determines the RCS volumetric flowrate at the elbow taps in the crossover piping. This is accomplished by performing an energy balance across the reactor vessel between the cold leg and hot leg RTDs. For each loop, the flow calorimetric equations are:

$$W_{HL} = Q_{calp,L}/(h_H - h_C)_L \quad \text{(EQN. 1)}$$

$$GPM_L = v_{CL} \times W_{HL}/8.02083 \quad \text{(EQN. 2)}$$

$$Q_{calp,L} = Q_{core,L} - \Delta_L \quad \text{(EQN. 3)}$$

$$Q_{core,L} = Q_{SG,L} - NPHA_L \quad \text{(EQN. 4)}$$

where

$Q_{core,L}$ = core power going to loop "L" (BTU/hr)

Δ_L = the net heat addition between the hot and cold leg RTDs on the core side divided by 4 (BTU/hr)

$NPHA_L$ = 12.24 x 10^6 BTU/hr = total NPHA divided by 4 [1]

W_{HL} = the RCS loop mass flowrate at the hot leg RTDs determined by the flow calorimetric (lb_m/hr)

h_H = hot leg enthalpy in loop "L" (BTU/lb_m)

h_C = cold leg enthalpy in loop "L" (BTU/lb_m)

v_C = cold leg specific volume (ft^3/lb_m)

GPM_L = volumetric flowrate at elbow taps (GPM)

We are interested in calculating Δ_L.

Prepared By: HB Date: 10/13/95 Doc. No. N-196, Rev. 0
Reviewed By: QWP Date: 10-23-95

B. Control Volume Equation and Simplifying Approximations

The selected control volume will enclose the reactor vessel and will include: the RCS piping between the reactor vessel and the hot leg RTDs and between the reactor vessel and the cold leg RTDs. Normal charging and the pressurizer spray line cross the boundary of this control volume. However, letdown and the pressurizer surge line do not [2, 3]. Then the energy input terms are given by core power, the four cold legs, and normal charging. The energy output terms are given by the four hot legs, normal pressurizer spray line, and the radiative and convective heat losses from: the reactor vessel, control rod drive mechanisms, and piping (within control volume).

An energy balance over the control volume yields the following equation.

$$Q_{core} + w_{CH}h_{CH} + (w_C h_C)_1 + (w_C h_C)_2 + (w_C h_C)_3 + (w_C h_C)_4$$
$$= Q_{RV} + Q_{spray} + Q_{CRDM} + Q_{piping} + (w_H h_H)_1 + (w_H h_H)_2$$
$$+ (w_H h_H)_3 + (w_H h_H)_4 \qquad \text{(EQN. 5)}$$

where the subscript "CH" refers to charging flow.

To simplify this calculation, we will assume perfect symmetry between the four cold legs and between the four hot legs, i.e., assume the following:

$$w_{C1} = w_{C2} = w_{C3} = w_{C4} = w_C$$

$$w_{H1} = w_{H2} = w_{H3} = w_{H4} = w_H$$

$$h_{C1} = h_{C2} = h_{C3} = h_{C4} = h_C$$

$$h_{H1} = h_{H2} = h_{H3} = h_{H4} = h_H$$

$$w_H = w_C + w_{CH}/4$$

Then Equation 5 can be written as

$$Q_{core} - Q_{RV} - Q_{spray} - Q_{CRDM} - Q_{piping} = 4w_H h_H - 4(w_H - w_{CH}/4)h_C - w_{CH}h_{CH}$$

(EQN. 6)

Define $Q_C = w_{CH}h_C$. Also, from Equation 1, $Q_{core} = w_H(h_H - h_C)$. Then we can solve for Δ_L.

$$\Delta_1 = Q_{core}/4 - Q_{loop}$$

$$= Q_C/4 - Q_{CH}/4 + Q_{RV}/4 + Q_{spray}/4 + Q_{CRDM}/4 + Q_{piping}/4 \quad \text{(EQN. 7)}$$

C. Solution of Equation For Net Heat Input

In Equation 7, Q_C is calculated from $w_{CH}h_C$. Q_{CH}, Q_{RV}, Q_{spray}, and Q_{CRDM} are taken directly from Reference 1. Q_{piping} for the control volume will be approximated by taking half of the total piping losses given in Reference 1.

The charging flow to use in the above control volume equation (call it "Charging") is the portion of the total charging flow which goes into the RCS via the normal charging line. The total measured charging flow (including seal injection) is 86 gpm and the normal letdown flow (not including seal return) is 75 gpm [1]. Since 75 gpm is leaving the RCS, 75 gpm must be entering the RCS via the charging and RCP seal injection. Call "Seal Injection" the portion of the RCP seal injection flow which goes into the RCS. Then

"Charging" + "Seal Injection" = 75 gpm

Also, the total flow leaving the CVCS (86 gpm) must equal the total flow returning to the CVCS. Therefore,

"Letdown" + "Seal Return" = 86 gpm

Since "Letdown" = 75 gpm, then "Seal Return" = 86-75 = 11 gpm. For each RCP, the seal injection flow is 9 gpm [1]. Then the total RCP seal injection flow is 4x9 = 36 gpm. Then

"Seal Injection" = 36 -11 = 25 gpm

and

"Charging" = 75 - "Seal Injection" = 75 - 25 = 50 gpm

Therefore, w_{CH} = (50 gpm)(62.4 lb_m/ft^3)(8.0208333) = 25025 lb_m/hr. The charging water density corresponds to 100 °F and 2250 psia. And h_C = 534.84 BTU/lb_m at 540 °F and 2250 psia. Then Q_C = (25025 lb_m/hr)(534.84 BTU/lb_m) = 13.38 MBTU/hr.

Prepared By: HB Date: 10/3/95 Doc. No. N-196, Rev. 0
Reviewed By: ONP Date: 10-28-95 Page No. 4 Of 5

Next, we have from Reference 1:

Q_{CH} = 11.72 MBTU/hr

Q_{RV} = 0.23 MBTU/hr

$Q_{[illegible]}$ = 0.41 MBTU/hr

Q_{CRDM} = 1.98 MBTU/hr

$Q_{[illegible]}$ = 0.15/2 = 0.075 MBTU/hr

Then Equation 7 gives

$$(13.38 - 11.72 + .23 + .41 + 1.98 + .075)/4 = \underline{1.089\ MBTU/hr}$$

III. Summary

The appropriate net heat input value to use in converting core power to "loop" power in the STP R-26 flow calorimetric is approximately 1.089 MBTU/hr for each loop.

IV. References

(1) Westinghouse Letter PGE-95-572, "Revised RCS Net Heat Input Calculation", J.C. Hoebel to M.J. Angus, 9/13/95, PG&E Chron. No. 227922.

(2) DCPP OVID 106707, Rev. 29, Unit 1.

(3) DCPP OVID 107707, Rev. 26, Unit 2.