Procedure No. 3.3
Attachment A
Page 1 of 1

PACIFIC GAS AND ELECTRIC COMPANY
DESIGN CALCULATION COVER SHEET

File No. : 140.061
Calculation No.: M-320

/_/ Preliminary /X/ Final

Project: Diablo Canyon Date : 1/9/91
Engineering Discipline: NECS-ME

Structure, System or Component:
Component Cooling Water System

Type or Purpose of Calculation: Max ΔP across air + motor operated valves in the CCW system.

No. of Sheets: ______

Computer Program Name :	/	Version :	/
PC Model :	/	Serial No. :	/
Hard Disk File Name (If Applicable) :	/	Date of Last File Change :	/
Floppy Diskette Control No. (If Applicable) :	/	Date of Last Validation :	/

	Signature	Discipline/Dept.	Date
PREPARER			
CHECKER			
	*Check Method:		
APPROVAL	Discipline Engineer (if required)		
GROUP SUPERVISOR			

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.

Jorge R. del Mazo
M.E. 17.006 3.31.00
Greg ? [illegible]

RECORDS OF REVISIONS

Revision Number	Date	Reasons for Revision	Rev. By	Checked By	*Check Method	Approval Engr.	Approval Grp. Supvr.
RMS INDEXED [illegible]	1/10/91	Revise Sh. 1,2,5,7,8	[illegible]	[signature]	B		[signature]
INDEXED 4	7/31/91	Revise Sh. 1,2,7,12 Add Sh. A, 2A	[illegible]	[signature]	B		[signature]
5	2.10.97	See Sheet i	[signature]	[signature]	B	—	4/7/97

*A - Alternate Calculation (Note added pages)
B - Detailed Check
C - Critical Point Check

Subject CCW Valves dP Maximum

Made By K.Smith-Ratchford Date 12/10/96 Checked By J. Schimmels Date 1-22-97

REVISION 5

PURPOSE: This calculation has been reviewed for impact on its conclusions as a result of the maximum allowable post-accident CCW supply temperature increase (Ref. 1). The intent of this calculation is to determine maximum dP across CCW system control valves.

EVALUATION OF IMPACT: The section of this calculation affected by the design bases temperature change is Section 3A "Valving in or Valving Out the Idle CCW Heat Exchanger When One CCW HX Is In-Service", which takes into consideration frictional losses in the piping between the pump discharge and outlet of the CCW heat exchanger. The temperatures used were:

after the CCW HX	132 F
before the CCW HX	188 F

As a result of the change in the maximum allowable peak CCW temperature to 140 F and more recent accident analyses evaluations on the CCW (refer to Calc M-305, Rev 9, App B), the maximum temperatures are:

before the CCW HX	~ 239 F
after the CCW HX	~ 140 F

The increase in temperatures would affect the density of the CCW (lowering the value by approx.2% from the value used in the calculation for frictional losses upstream of the CCW HX and less than 0.05% on the downstream). The lower density value will result in a slightly higher friction factor, and thus frictional losses; however, the impacts on frictional losses are negligible and the impacts on the upstream and downstream side of the HX almost completely cancel each other out when determining the overall differential pressure. (Reference Crane Technical Paper 410, Eqn: 3-5)

CONCLUSION: There is no impact on Sections 1 and 2, since they do not take into consideration frictional losses in determining dP. For section 3, it has been determined to that the change in CCW system maximum design bases temperature will have an insignificant impact on the calculated frictional losses, since the value used has significant margin over the value calculated. Thus, the value of 20 psid for the FCV-430 and 431 remains conservative.

References:
1) DCP M-49291
2) Calculation M-305, R9, App B

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76-68 1/81

PACIFIC GAS AND ELECTRIC COMPANY
DESIGN CALCULATION COVER SHEET

File No. 140.061

Calculation No. M-320

Project DIABLO CANYON UNIT 1 Date 3/23/83

Engineering Discipline M&NE

Structure, System, or Component CCW SYSTEM

Type of or Purpose of Design Calculations MAX ΔP ACROSS AIR OPERATED & MOTOR OPERATED VALVES

No. of Sheets 23 + 4 ATTS.

SAR Change Required ☐ Yes ☒ No
(Nuclear Projects only)

	Signature	Discipline/Dept.	Date
Preparer	C E Ward	M&NE	3/23/83
Checker	T H Hemelein	M&NE	3/30/83
Approval:			
Discipline Engineer *(If required)*	C E Ward	M&NE	6/13/83
Group Leader/Supervisor	Larry G. Tisdale	M&NE	6-14-83

Record of Revisions

Rev. No.	Date	Reason for Revision	Rev. by	Checked by	Approval Engr.	Approval GL/Supr.	Check Method
0	6-14-83	FINAL	CEW	THH		LGT	
1	8-14-85	ADD PP 3,17,18,19,20,21 · CHANGE pp. 1, 2. RENUMBER ONLY PP.	CEW	THH	CEW	LGT	
2	7/10/85	REVISE pp 2,13,16,7	CEW	BRS		MDerrick	D

RMS INDEXED

RMS INDEXED →

A = ALT. CALC.
C = CRITICAL CHECK
D = DETAILED CHECK

Pacific Gas and Electric Company
Engineering - Calculation Sheet
Project: Diablo Canyon Unit (X) 1 ( ) 2 ( ) 1&2

69-332 (11/88)
Engineering

CALC. NO. M-320
REV. NO. 4
SHEET NO. A OF 23

SUBJECT CCW Valves ΔP_{max}

MADE BY D. Howland DATE 6/17/91 CHECKED BY [signature] DATE 7/1/91

Rev. 4

This Rev. was done to update the required closing ΔP_{max} for valves in the CCW system. Two new pages, A and 2A, were added for clarification. The maximum ΔP for closing the RCP L.O. & reactor vessel support cooler, and the excess letdown heat exchanger return containment isolation valves were revised. Thermal expansion due to inadvertant heat loading, and back leakage through check valves was considered for the above valves. The revision 4 version of M-320 will be used as a basis for the 89-10 generic letter valve ΔP calculations.

Sheets 1, 2, 7, and 12 were revised.

Note: Calculation M-573 (Unit 2 equivalent of M-320) establishes that the results of M-320 are applicable to Unit 2 due to the similarities between the Unit 1 and Unit 2 CCW systems. Any changes to M-320 should be checked against the conclusions in M-575 for possible impacts.

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

DIABLO CANYON PROJECT
CALCULATION SHEET

SHEET NO. 1 OF 23.
CALC. NO. M-320
REV. NO. 4 34

SUBJECT CCW VALVES ΔP max

MADE BY CE Ward DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

Δ CE Ward 7/1/83
Δ D. Hoffland 1/9/91
Δ D. Hoffland 6/26/91
Δ [illegible] 7/11/83
Δ SNZ 1/9/91
Δ SNZ 7/1/91

PROBLEM: TO DETERMINE THE MAXIMUM ΔP AIR OPERATED & MOTOR OPERATED VALVES IN THE CCW SYSTEM MUST OPEN AGAINST AND CLOSE AGAINST. (1)

ASSUMPTIONS:

1. CCW SURGE TANK IS VENTED TO ATMOSPHERE.
2. CCW SURGE TANK IS @ LOW LEVEL.
3. Isolated lines inside containment ARE @ RV LIFT PRESSURE DUE TO THERMAL EXPANSION OF FLUID IN THE PIPE. (4)
4. SOURCES OF MAKE-UP WATER TO CCW SYSTEM ARE AT HIGH LEVEL (OVERFLOW), EXCEPT RAW WATER RESERVOIR (SEE SECTION 3 A i)
5. PUMPS WHICH TRANSFER WATER TO CCW SYSTEM ARE AT SHUTOFF HEAD
6. MAX ΔP FOR VALVES IN CCW SYSTEM, EXCEPT ISOLATION VALVES FOR CONTAINMENT (SEE ASSUMPTION 3) IS DUE TO CCW Ps SHUTOFF HEAD, AND CCW Hx DISCHARGE VALVES FCV-430 & 431 (SEE ASSUMPTION 9) (1) (4)
7. MAKE-UP WATER FLOW FROM RAW WATER STORAGE RESERVOIRS TO CCW SURGE TANK IS GRAVITY FED.
8. RETURN HEADER PIPING IS AT STATIC PRESSURE DUE TO THE SURGE TANK FOR CONSIDERATION OF ISOLATED PIPING INSIDE CONTAINMENT.
9. (1) OPERATION OF CCW Hx DISCHARGE VALVES, FCV-430 & FCV-431, CAN BE EITHER AGAINST SHUT-OFF HEAD OF CCW Ps OR AGAINST PRESSURE DIFFERENTIAL ASSOCIATED WITH VALVING IN OR OUT THE SECOND CCW Hx W/ ONE CCW Hx IN SERVICE.

12465

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

DIABLO CANYON PROJECT
CALCULATION SHEET

SHEET NO. 2 OF 23
CALC. NO. M-320
REV. NO. 1 2 3 4

SUBJECT CCW VALVES ΔP max

MADE BY CE Ward DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

△1 CEWard 7/1/83
△2 CEWard 7/16/84

△1 [illegible] 7/18/83
△2 GNS 7/20/84
△3 [illegible] 1/9/91
△4 [illegible] 7/11/94

REFERENCES:
△3 D Howland 1/9/91
△4 D. Howland 6/26/91

1. P&ID 102014, REV 11
2. DC-CeG3213-37-1
3. MEMO FROM TNCRAWFORD TO ECCONDELL, 3/9/83, CRON 14430
4. PG&E DWG 53093, REV 15, SHEET 57
5. PG&E DWG 101938, REV 1
6. P&ID 102016, REV 10
7. PG&E DWG 438038, REV 6 ; 7a PG&E DWG 500090, REV 13
8. PG&E DWG 438039, REV 4
9. DC-663062-39-1
△2 10. DC-663062-22-1
11. MW KELLOGG DWG 19322, REV B
12. MW KELLOGG DWG 19323, REV B
13. MW KELLOGG DWG 19320, REV B
14. MW KELLOGG DWG 19321, REV B
15. MW KELLOGG DWG 1927, REV NOT GIVEN, 10/5/72
16. MW KELLOGG DWG 1443, REV A
△1 17. PG&E DWG 438148, REV 6

CONCLUSIONS: SEE NEXT PAGE FOR ADDITIONAL REFERENCES

1. MAX ΔP FOR ALL VALVES IN CCW SYSTEM, EXCLUDING MAKEUP VALVES, LCV 69 & LCV 70 & CONTAINMENT ISOLATION VALVES, IS 81 psid △3
△1 & FCV-430 & FCV-431 WHEN VALVING IN OR OUT A SECOND CCW HX W/ ONE IN SERVICE
2. MAX ΔP FOR CCW SYSTEM MAKEUP VALVES LCV 69 & LCV-70 IS 380 ft (OR 165 psid)

~~3. i) MAX ΔP FOR closed CONTAINMENT ISOLATION VALVES (ie. TO OPEN THE VALVES) IS:~~ △4
~~a) FOR RCP L.O. & REACTOR VESSEL SUPPORT CLRS = 124 psid (INCLUDES INLET VALVE TO CONTAINMENT)~~
~~b) FOR RCP THERMAL BARRIERS = 245 psid~~
~~c) FOR EXCESS LETDOWN HX = 123 psid~~

12465

SUBJECT CCW Valves ΔPmax

MADE BY D. Howland DATE 6/26/91 CHECKED BY [signature] DATE 7/11/91

3. i) Maximum ΔP for closed containment isolation valves (i.e. to open the valves) is:

a) For RCP L.O. + reactor vessel support coolers = 124 psid (FCV-363, FCV-749) (excluding inlet valve to containment)

b) For RCP thermal barriers = 2458 psid (FCV-357, 755)

c) For excess letdown hx = 123 psid (FCV-361)

d) The inlet valve for RCP L.O. + reactor vessel support cooler = 81 psid* (FCV-356) 4

*A higher opening ΔP of 124 psid could occur if the CCW pumps are all shut down with the relief valves lifted in the lines downstream of FCV-356. The maximum credible ΔP is still 81 psid since there are always a minimum of 2 CCW pumps operating and there is no reason to open FCV-356 if the CCW pumps are not operating.

ii) Maximum ΔP for open containment isolation valves (i.e. to close the valves) is:

a) To close the RCP L.O. + reactor vessel support coolers = 124 psid (FCV-363, FCV-749)

b) To close the RCP thermal barriers = 2458 psid (FCV-357, 755)

c) To close the excess letdown heat exchanger = 123 psid (FCV-361)

d) To close the inlet valve for RCP L.O. + reactor vessel support cooler = 81 psid (FCV-356)

SUBJECT CCW VALVES ΔPmax

MADE BY ΔCEWard DATE 7/1/83 CHECKED BY Δ [illegible] DATE 7/18/83 JOB NO. 15320

1 CONCLUSIONS (CONT'D):

4. MAX ΔP FOR FCV-430 & FCV 431, WHEN VALVING IN OR OUT THE SECOND CCW Hx W/ ONE ALREADY IN SERVICE, IS 20 psid

1 REFERENCES (CONT'D):

18. CALCULATION M-299, REV 0
19. CALCULATION M-390, REV 0
20. VENDOR PRINT DC-663212-26-1
21. CALCULATION M-305, REV 2
22. CRANE TECHNICAL PAPER #410, 19th PRINTING, 1980
23. PG&E DWG 449316, REV 1

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

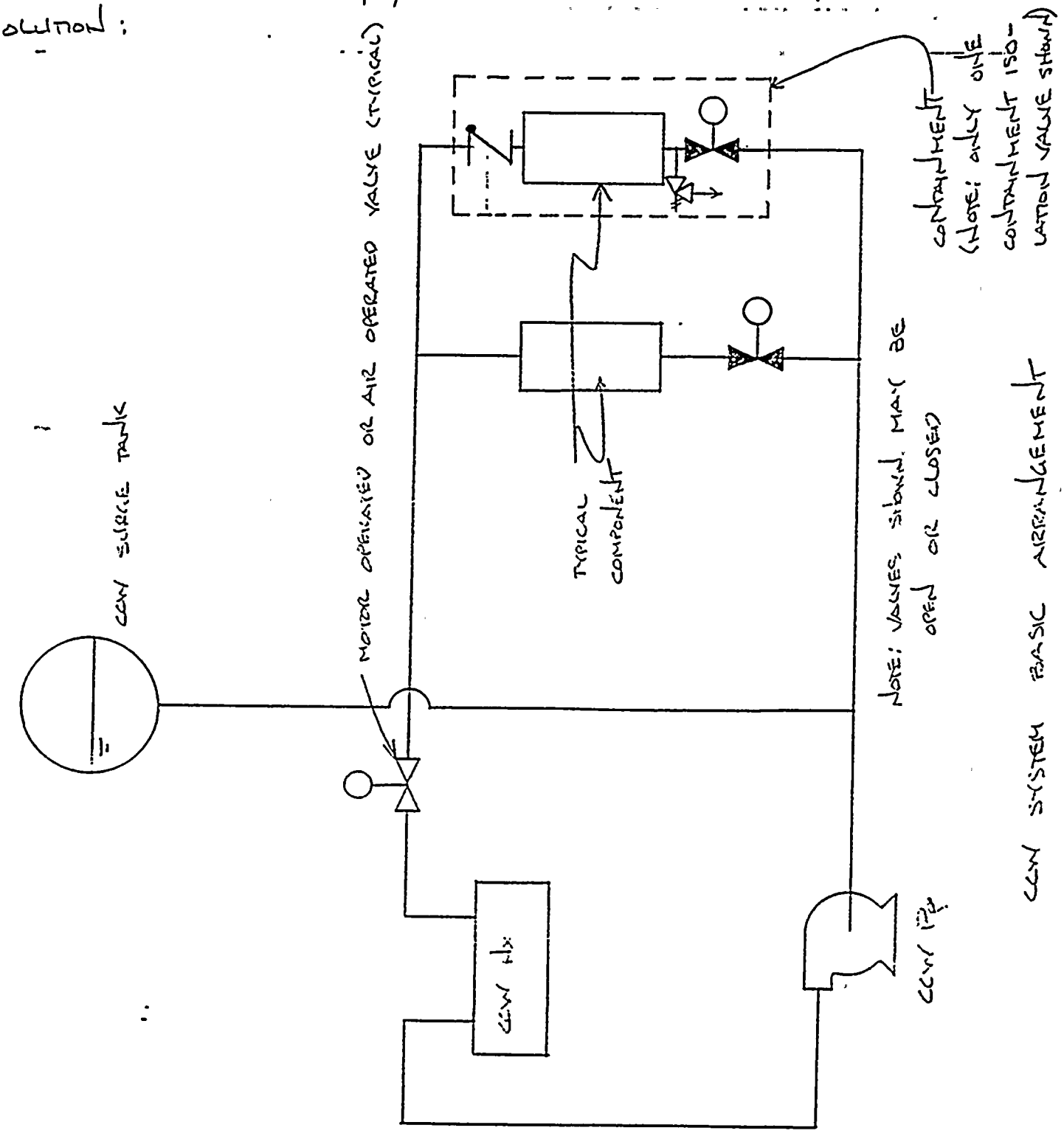
DIABLO CANYON PROJECT
CALCULATION SHEET

SHEET NO. 4 OF 23
CALC. NO. M-320
REV. NO. 0

SUBJECT CCW VALVES ΔP max

MADE BY CE Ward DATE 3/23/87 CHECKED BY [illegible] DATE 3/30/87 JOB NO. 15320

Solution:



SUBJECT CCW VALVES ΔP_{max}

MADE BY CE Ward DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

Δ Maitland 1/7/91 Δ3 SNS 1/19/91

1. VALVES OUTSIDE CONTAINMENT (EXCLUDING SURGE TANK MAKE-UP WATER VALVES AND CONTAINMENT ISOLATION VALVES) Δ3

AS SHOWN IN THE 1 BASIC ARRANGEMENT DRAWING, CCW SURGE TANK STATIC HEAD IS TRANSMITTED TO BOTH SIDES OF ALL VALVES OUTSIDE CONTAINMENT - WHETHER THESE VALVES ARE OPEN OR CLOSED.

HENCE, THE MAXIMUM ΔP ACROSS THESE VALVES IS DETERMINED AS FOLLOWS:

i) PRESSURE @ PUMP DISCHARGE, P_{PPd} IS GIVEN BY THE FOLLOWING (ASSUMING PUMPS ARE @ SHUT-OFF HEAD):

$$P_{PPd} + Z_{PPd} = P_{PPs} + Z_{PPs} + TDH_{SO} \quad \text{(ENERGY EQ'N)}$$

WHERE Z_{PPd} = ELEVATION @ PUMP DISCHARGE

Z_{PPs} = ELEVATION @ PUMP SUCTION

P_{PPs} = SUCTION PRESSURE @ PUMP

TDH_{SO} = PUMP SHUT-OFF HEAD

P_{PPs} = ELEVATION OF SURGE TANK WATER LEVEL, Z_{ST}, LESS THE ELEVATION @ PP SUCTION, Z_{PPs}

SO, $P_{ppd} = z_{st} - z_{pps} + z_{pps} - TDH_{so} - z_{ppd}$

OR $P_{ppd} = TDH_{so} + z_{st} - z_{ppd}$

ii) @ ANY VALVE, MAX ΔP IS DUE TO SHUT-OFF HEAD OF PUMP. (BY ASSUMPTION)

AT THE UPSTREAM SIDE OF THE VALVE, THE PRESSURE, P_{V_1}, IS GIVEN BY

$$P_{V_1} + z_{V_1} = P_{ppd} + z_{ppd} \quad \text{(ENERGY EQ'N)}$$

SUBSTITUTING FOR P_{ppd} YIELDS

$$P_{V_1} + z_{V_1} = TDH_{so} + (z_{st} - z_{ppd}) + (z_{ppd})$$

OR $P_{V_1} = TDH_{so} + z_{st} - z_{V_1}$

AT THE DOWNSTREAM SIDE OF THE VALVE, THE PRESSURE, P_{V_2}, IS GIVEN BY

$$P_{V_2} + z_{V_2} = P_{pps} + z_{pps} \quad \text{(ENERGY EQ'N)}$$

$z_{V_2} = z_{V_1}$

$P_{pps} = z_{st} - z_{pps}$ (FROM PART 1, i)

SO $P_{V_2} + z_{V_1} = z_{st} - z_{pps} + z_{pps}$

△2 CEWard 7/16/84 △ D. Haviland 1/4/91 △ D. Haviland 6/26/91 △4 SNS 7/20/84 △3 DRL 1/9/91 △4 JDL 7/11/91

OR $P_{V2} = z_{st} - z_{V1}$

iii) ΔP_{max} ACROSS THE VALVE IS GIVEN BY

$$\Delta P_{max} = P_{V1} - P_{V2} = TDH_{so} + z_{st} - z_{V1} - (z_{st} - z_{V1})$$

OR $\boxed{\Delta P_{max} = TDH_{so}}$

PER REFERENCE 2, TDH_{so} = 180 ft OR 81 psi

△4 2. Valves inside containment (+ containment isolation valves)

a. Open valves that are closing will be exposed to $\Delta P_{max} = TDH_{so}$ = 186 ft or 81 psi except for the following:

1) RCP L.O. & reactor vessel support coolers ΔP_{max} = 124 psid (due to back leakage from the RCP thermal barrier check valve pressurizing the piping to relief valve lift pressure minus the static head from the surge tank).

△4

1) RCP thermal barrier isolation valves ΔP_{max} = 2458 psid (due to thermal barrier rupture pressurizing the piping to relief valve lift pressure minus the static head from the surge tank)

2) Excess letdown heat exchanger isolation valve ΔP_{max} = 123 psid (due to excess letdown heat exchanger tube rupture pressurizing the piping to relief valve lift pressure minus the static head from the surge tank)

b. CLOSED VALVES THAT ARE OPENING

AS SHOWN IN THE BASIC ARRANGEMENT DRAWING, PIPING INTO CONTAINMENT WHICH HAS AIR OR MOTOR OPERATED ISOLATION CAPABILITY

SUBJECT CCW VALVES - ΔP max

MADE BY CEWard DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

Δ2 DHowland 1/4/90 SMB 1/9/91 Δ2

HAS A CHECK VALVE UPSTREAM OF THE COMPONENT SERVED.

As a result, when these valves are closed, the piping upstream of the valve has the potential to go to the pressure of the relief valve (protecting the upstream piping). This would be due to thermal expansion if a heat load were applied to the component.

Δ3

THE AFFECTED PIPING & ASSOCIATED ISOLATION VALVES SERVE THE FOLLOWING COMPONENTS

1) REACTOR COOLENT PUMP (RCP) L.O. COOLERS & REACTOR VESSEL SUPPORT COOLERS (RVSC)

2) RCP THERMAL BARRIERS

3) EXCESS LETDOWN Hx

THE RV'S PROTECTING THESE LINES, AND THEIR SETPOINTS, ARE LISTED BELOW (REF 1 & 3)

COMPONENT	RV NUMBER	RV SETPOINT (psid/ft)
RCP L.O. & RVSC	RV-51	150 / 347
RCP THERM. BAR.	RV-41, 42, 43, 44	2485 / 5740
EXCESS LTDN Hx	RV-52	150 / 347

SUBJECT CCW VALVES

MADE BY CEWard DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

THE ΔP_{max} FOR THIS CASE IS DETERMINED AS FOLLOWS

i) THE PRESSURE ON THE UPSTREAM SIDE OF ANY ISOLATION VALVE, P_{V1}, IS GIVEN BY

$$P_{V1} + Z_{V1} = P_{rv} + Z_{rv} \quad \text{(ENERGY EQ'N)}$$

WHERE P_{rv} = LIFT PRESSURE OF RV

Z_{rv} = ELEVATION OF RV

OR $$P_{V1} = P_{rv} + Z_{rv} - Z_{V1}$$

ii) THE PRESSURE ON THE DOWNSTREAM SIDE OF THIS VALVE, P_{V2}, IS GIVEN BY

$$P_{V2} + Z_{V2} = P_{pps} + Z_{pps} \quad \text{(ENERGY EQ'N)}$$

SEE NOTE BELOW

$$Z_{V2} = Z_{V1}$$

$$P_{pps} = Z_{st} - Z_{pps} \quad \text{(FROM SECTION 1 i OF THIS CALCULATION)}$$

NOTE: THIS NEGLECTS FRICTION LOSSES & VELOCITY HEAD, LOWERING, P_{V2}. SEE DISCUSSION OF RESULTS, SECTION 4.

SO $P_{V2} = z_{st} - z_{pps} + z_{pps} - z_{V1}$

OR $P_{V2} = z_{st} - z_{V1}$

iii) MAX ΔP IS GIVEN BY

$$\Delta P_{max} = P_{V1} - P_{V2} = P_{rv} + z_{rv} - z_{V1} - (z_{st} - z_{V1})$$

OR $$\Delta P_{max} = P_{rv} + z_{rv} - z_{st}$$

iv) ELEVATION OF RV's

RV NO.	ELEVATION (ABSOLUTE)	REFERENCE
RV-41	107'-5"	19322, REV B
RV-42	109' (APPROX)	19323, REV B
RV-43	108'-8"	19320, REV B
RV-44	104'-8"	19321, REV B
RV-51	109'-4"	1927, REV NOT GIVEN, 10/5/72
RV-52	106'-10"	1443, REV A

NOTE: REFERENCES ARE M.W. KELLOGG DWGS

v) ELEVATION OF WATER LEVEL IN CCW SURGE TANK

PER REF 4 #5, THE ABSOLUTE ELEVATION OF WATER IN THE CCW SURGE TANK (@ LOW LEVEL) IS GIVEN BY:

$$Z_{st} = 171' - 2" - 5" = 170.75 \text{ ft} \cong 171 \text{ ft}$$

NOTE: -5" IS SETPOINT OF LOW LEVEL SWITCH

vi) BASED ON RV LIFT PRESSURE, P_{rv}, Z_{st}, & Z_{rv}, ΔP_{max} (EQ'N IN SECTION 2iii) IS TABULATED AS GIVEN BELOW

RV No	P_{rv} (ft)	Z_{rv} (ft) NOTE 3	Z_{st} (ft)	ΔP_{max} (ft)	ΔP_{max} (psi)
RV-41 NOTE 1	5740	108	171	5677 NOTE 1	2458 NOTE 1
RV-42 NOTE 1	5740	109	171	5678 NOTE 1	2458 NOTE 1
RV-43 NOTE 1	5740	109	171	5678 NOTE 1	2458 NOTE 1
RV-44 NOTE 1	5740	105	171	5674 NOTE 1	2456 NOTE 1
RV-51 NOTE 2	347	110	171	286 NOTE 2	124 NOTE 2
RV-52	347	107	171	283	123

SEE NEXT PAGE FOR NOTES

SUBJECT CCW VALVES - ΔP_{max}

MADE BY CE Ward DATE 3/23/83 CHECKED BY [illegible] DATE 3/30/83 JOB NO. 15320

A D. Howland 7/11/91 JR 7/11/91 A

NOTES: 1. RV-41, 42, 43, & 44 ALL DISCHARGE INTO A COMMON LINE (@ THE CONTAINMENT ISOLATION VALVE). HENCE THE MAXIMUM ΔP_{max} FOR THE 4 RV'S MUST BE CONSIDERED FOR ACTUATOR SIZING

2. IF RV-51 LIFTS, INLET VALVE TO CONTAINMENT, FCV 356 PER REF 1, WILL ALSO HAVE MAX ΔP AS SHOWN, W/ HIGHER PRESSURE DOWNSTREAM OF VALVE. THIS ΔP_{max} IS WITH THE CCW PPS NOT RUNNING. IF CCW PUMPS ARE RUNNING, ΔP WOULD DECREASE, SINCE THE SUPPLY LINE WOULD BE PRESSURIZED. (see page 2A)

3. ALL RV VALVES ROUNDED UP, WHICH INCREASES ΔP_{max}

3. MAKE-UP WATER VALVES

A. THE PRIMARY SOURCES OF MAKE-UP TO THE CCW SYSTEM ARE AS FOLLOWS, PER REF 6

1. RAW WATER RESERVOIR (ESSENTIALLY GRAVITY FED)
2. CONDENSATE STORAGE TANK (THROUGH THE MAKE-UP WATER TRANSFER PUMPS)
3. PRIMARY WATER STORAGE TANK (THROUGH THE PRIMARY WATER MAKE-UP PUMPS)

i) WATER FROM SOURCE 1 ABOVE IS NOT PUMPED. THE ELEVATION OF WATER IN THE RAW WATER RESEVOIR IS 308' (REF 6, SHEET 1 & REF 17)

ii) MAX ELEVATION IN THE CONDENSATE STORAGE TANK (CST), SOURCE 2, IS 115' + 45'-9" = 160'-9" (REF 7 & 8). THIS ELEVATION

IS TO THE CST OVERFLOW. SHUTOFF HEAD OF THE MAKE-UP WATER TRANSFER PPS IS 390 ft (REF 9)

iii) MAX WATER LEVEL IN PRIMARY WATER STORAGE TANK (PWST), SOURCE 3, IS 152'-6" (REF 7A) THIS ELEVATION IS TO TH PWST OVERFLOW. SHUTOFF HEAD △2 OF THE PRIMARY WATER MAKE-UP PUMPS IS 275 ft (REF 10)

B. AN EQUATION FOR ΔP_{max} ACROSS THE CCW SYSTEM MAKE-UP WATER VALVES, LCV-69 & LCV-70 (REF 1), IS DEVELOPED BELOW.

i) PRESSURE UPSTREAM OF VALVE, P_{V1}

a) $P_{V1} + Z_{V1} = P_{ppd} + Z_{ppd}$ (ENERGY EQ'N)

WHERE P_{ppd} = DISCHARGE PRESSURE OF TRANSFER PUMP

Z_{ppd} = ELEVATION OF TRANSFER PUMP DISCHARGE

b) ACROSS TRANSFER PP, THE ENERGY EQ'N YIELDS:

$$P_{ppd} + Z_{ppd} = P_{pps} + Z_{pps} + TDH_{sa}$$

WHERE P_{PPS} = SUCTION PRESSURE OF TRANSFER PP

Z_{PPS} = ELEVATION OF TRANSFER PP SUCTION

TDH_{SO} = TRANSFER P_P SHUT-OFF HEAD

c) FROM STORAGE TANK TO TRANSFER PP SUCTION, THE ENERGY EQ'N YIELDS:

$$Z_{stw} = P_{PPS} + Z_{PPS}$$

WHERE Z_{stw} = ELEVATION OF LIQUID SURFACE IN STORAGE TANK

e) SUBSTITUTING EQ'N IN c) INTO EQ'N IN b) YIELDS

$$P_{ppd} + Z_{ppd} = Z_{stw} + TDH_{so}$$

e) SUBSTITUTING EQ'N IN e) INTO EQ'N IN a) YIELDS

$$P_{V1} + Z_{V1} = Z_{stw} + TDH_{so}$$

OR $$P_{V1} = Z_{stw} + TDH_{so} - Z_{V1}$$

ii) PRESSURE DOWNSTREAM OF VALVE, P_{V2}

$$P_{V2} + Z_{V2} = Z_{st} \quad \text{(ENERGY EQN)}$$

$$Z_{V2} = Z_{V1}$$

SO $$P_{V2} = Z_{st} - Z_{V1}$$

WHERE Z_{st} = SURGE TANK WATER LEVEL (FROM BEFORE)

iii) ΔP_{max} ACROSS THE VALVES IS GIVEN BY:

$$\Delta P_{max} = P_{V1} - P_{V2} = Z_{stw} + TDH_{so} - Z_{V1} - (Z_{st} - Z_{V1})$$

OR

$$\boxed{\Delta P_{max} = Z_{stw} + TDH_{so} - Z_{st}}$$

SUBJECT CCW VALVES - ΔP_{max}

MADE BY CEWard DATE 3/23/83 CHECKED BY [illegible] DATE 3/24/83 JOB NO. 15320

△2 CEWard 7/16/84 △2 STS/ 7/20/84

C. APPLYING THE ΔP_{max} EQ'N FROM PART B TO THE 3 SOURCES OF WATER YIELDS:

i) RAW WATER RESEVOIR (ASSUMED TO BE GRAVITY FEED)

$\Delta P_{max} = 308' + 0 - 171' = 137$ ft

ii) CONDENSATE STORAGE TANK (MAKE-UP WATER TRANSFER Pps)

$\Delta P_{max} = 160.75' + 390' - 171' = 380$ ft

SEE NOTE BELOW

iii) PRIMARY WATER STORAGE TANK (PRIMARY WATER TRANSFER PUMPS)

△2 $\Delta P_{max} = 152'-6'' + 275' - 171' = 256.5$ ft

∴ HENCE, THE MAX ΔP WHICH LCV 69 & LCV 70 HAVE TO OPEN AGAINST IS 380 ft

SEE NOTE BELOW

NOTE: 380 ft IS BASED ON A VERY SIMPLIFIED ANALYSIS, I.E. CONSIDERING SHUT-OFF HEAD OF MAKE-UP WATER TRANSFER Pps. THIS VALUE SHOULD ONLY BE USED FOR CONSIDERING OPENING OF LCV'S AND FOR NO OTHER PURPOSE.

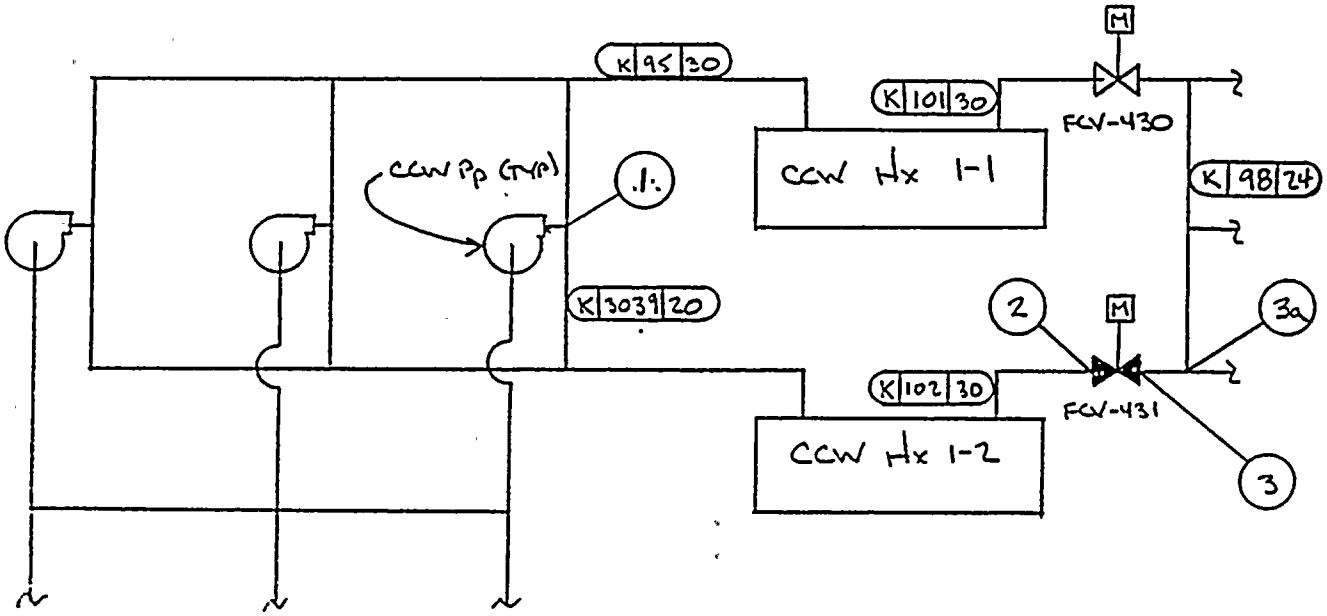
SUBJECT CCW VALVES - ΔP_{min}

MADE BY CEWard DATE 6/30/83 CHECKED BY TMK DATE 7/18/83 JOB NO. 15320

3A VALVING IN OR VALVING OUT THE IDLE CCW Hx WHEN ONE CCW Hx IS IN SERVICE

(BASED ON REF 1)

THE FIGURE BELOW SHOWS THE ARRANGEMENT UNDER CONSIDERATION, NOTE: EITHER HEAT EXCHANGER CAN BE CONSIDERED WITH A SIMILAR RESULT.



$$\Delta P_{valve} = P_2 - P_3 \qquad \text{(EQ'N 1)}$$

CONSIDER ENERGY EQ'NS. (NEGLECTING VELOCITY HEAD, WHICH IS SMALL; $V = 0.408Q/d^2 = 0.408(6567)/(19.25)^2 = 7.2$; $V^2/2g = 0.8$ ft)

$$P_2 + Z_2 = P_1 + Z_1 \qquad \text{(EQ'N 2)}$$

↑ SEE pr 19 FOR FLOW

$$P_1 + Z_1 = P_{3a} + Z_{3a} + h_{L1-3} \qquad \text{(EQ'N 3)}$$

NOTE $h_{L3a-3} = 0$, SO $h_{L1-3} = h_{L1-2}$

$$P_3 + Z_3 = P_3 + Z_{3a} \qquad \text{(EQ'N 4)}$$

1

P = STATIC PRESSURE
z = ELEVATION
h_L = HEAD LOSS

SUBSTITUTING EQ'N 4 INTO EQ'N 3,

$$P_1 + z_1 = P_3 + z_3 + h_{L_{1-3}} \quad \text{(EQ'N 5)}$$

SUBSTITUTING EQ'N 2 INTO EQ'N 5,

$$P_2 + z_2 = P_3 + z_3 + h_{L_{1-3}} \quad \text{(EQ'N 6)}$$

REARRANGING EQ'N 6,

$$P_2 - P_3 = z_3 - z_2 + h_{L_{1-3}}$$

PER REF , $z_3 = z_2$, HENCE

$$\boxed{P_2 - P_3 = h_{L_{1-3}}}$$

$h_{L_{1-3}}$ INCLUDES BOTH PIPING LOSSES & ΔP THRU CCW Hx.

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

DIABLO CANYON PROJECT
CALCULATION SHEET

SHEET NO. 19 OF 23
CALC. NO. M-320
REV. NO. 1

SUBJECT CCW VALVES - ΔP

MADE BY ⚠ CEWard DATE 6/30/83 CHECKED BY ⚠ JWL DATE 7/14/83 JOB NO. 15320

1

TO FIND FRICTION LOSSES, CONSIDER OPERATING MODE WITH HIGHEST CCW Hx ΔP. FROM REF 18 & 19, THE HIGHEST FLOW OCCURS DUE TO LOSS OF AIR (CAUSING AIR OPERATED VALVES TO GO TO THEIR FAILURE POSITION), WITH 3 CCW PPS IN OPERATION.
PER REF 19, 19,700 gpm IS LOSS OF AIR FLOW, HENCE FRICTION LOSSES WILL BE HIGHEST FOR THIS MODE.
PER REF 20, CCW Hx ΔP = 12 psid FOR 19700 gpm.
FOR SIMPLICITY, ASSUME 19,700 gpm FLOWS FROM POINT 1 TO POINT 3a, EXCEPT FOR LINE 3039, WHERE FLOW = (⅓)19700 = 6567 gpm. THIS IS CONSERVATIVE SINCE FLOW IN LINE 98 IS LESS THAN 19700.

PIPE FRICTION LOSSES ARE SUMMARIZED ON THE NEXT PAGE. SUMMARIZED BELOW ARE PARAMETERS & EQUATIONS USED TO FIND FRICTION LOSSES.

1. MAX CCW BEFORE CCW Hx: TEMPERATURE = 100°F (REF 21, p 20)

$\mu = 0.33$ Cp (REF 22, p A-3)

$\rho = 60.4 \frac{lb}{ft^3}$ (REF 22, p. A-6)

2. MAX CCW AFTER CCW Hx: TEMPERATURE = 132°F (REF 21, p 20)

$\mu = 0.50$ Cp (REF 22, p A-3)

$\rho = 61.5 \frac{lb}{ft^3}$ (REF 22, p. A-6)

$Re = \frac{50.60 Q}{d\mu}$ (REF 22, p 3-2)

$h_L = KV^2/2g$ (REF 22, p 3-2), $V = 0.408 Q/d^2$ (REF 22, p 3-2)

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

DIABLO CANYON PROJECT
CALCULATION SHEET

SHEET NO. 20 OF 23
CALC. NO: M-320
REV. NO. Δ1

JECT CCW VALVES - ΔPmin

MADE BY Δ CEWard DATE 6/30/83 CHECKED BY Δ [illegible] DATE 7/18/83 JOB NO. 15320

PRESSURE DROP DATA SHEET

LINE NUMBER	K-3039	K-95	K-101	K-98	
PIPE SIZE (inches)	20	30	30	24	
PIPE ID (inches)	19.25	29.25	29.25	23.25	
PIPE LENGTH (ft) (NOTE 2)	10	114	14	10	
FLOW (gpm)	6567	19,700	19,700	19,700	
N_{Re}	3.2×10^6	6.2×10^6	4.2×10^6	5.3×10^6	
f	0.012	0.0115	0.0115	0.012	
K_{PIPE} (= fL/D)	0.07	0.51	0.07	0.06	
VELOCITY (ft/sec)	7.2	9.4	9.4	14.9	
f_T =	0.012	0.011	0.011	0.012	
FITTINGS					
QUANTITY / TOTAL "K"					
ELBOWS (NOTE 5)					
a) 90° ($K = 14 f_T$)		4/0.62	1/0.15		
b) 45° ($K = 11 f_T$)	1/0.13	4/0.48			
TEES (NOTE 5)					
a) BRANCH ($K = 60 f_T$)	1/0.72		1/0.66	1/0.72	
b) RUN ($K = 20 f_T$)				1/0.24	
VALVES (NOTE 5)					
a) BUTTERFLY ($K = 25 f_T$)	1/0.30	1/0.28	1/0.28	2/0.60	
b) CHECK ($K = 100 f_T$)	1/1.2				
OTHER					
TOTAL "K"	2.42	1.89	1.16	1.62	
h_L (ft)	2.0	2.6	1.6	5.6	

NOTES:
1. K VALUES PER REF 22, UNLESS NOTED.
2. f PER REF 22, P. A-25
3. NEGLECT SMALL TEE'S.
4. VALUES OF f_T PER REF 23, P. A-26 OR A-25
5. PIPING ARRANGEMENT PER REF 23

12465

SUBJECT CCW VALVES - MAX DP

MADE BY [illegible] DATE 6/12/97 CHECKED BY [illegible] DATE 7/14/13 JOB NO. 15320

1

FROM THE PRESSURE DROP DATA SHEET

$h_{L_{PIPE}} = 2.10 + 2.0 + 1.6 + 5.6 = 11.8$ ft

$h_{L_{Hx}} = 12$ psid (ASSUMING VENDOR DATA INCLUDES LOSS @ INLET & OUTLET)

SO,

$$\Delta P_{valve} = 12 \text{ psi} + \frac{11.8}{2.31} = 17.1 \text{ psid}$$

FOR CONSERVATISM, SAY - $\Delta P_{valve} = 20$ psid

4. DISCUSSION OF RESULTS

i) THE RESULTS FOR PART 1 OF THIS CALC ARE CONSERVATIVE, IN GENERAL, SINCE IT IS NOT VERY LIKELY THAT ANY VALVES IN THE SYSTEM WILL SEE PUMP SHUT-OFF HEAD.

FOR THE INDIVIDUAL COMPONENTS TO SEE SHUT-OFF HEAD, ALL OTHER COMPONENTS WOULD HAVE TO BE ISOLATED, WHICH IS VERY IMPROBABLE.

ii) SHOULD THE CCW HX BE ISOLATED BY ITS DISCHARGE MOV, THE CCW PUMPS WILL GO ON RECIRCULATION (REF 1), HENCE PUMPS WILL NOT BE QUITE @ SHUT-OFF HEAD. FOR THESE VALVES TO SEE FULL SHUT-OFF HEAD, THE RECIRCULATION VALVES WOULD HAVE TO FAIL TO OPEN (THIS WOULD BE SECOND FAILURE, ASSUMING THAT THE CCW HX DISCHARGE VALVE CLOSURE IS THE FIRST).

THE RESULTS IN PART 2 OF THIS CALC ARE CONSERVATIVE SINCE RETURN LINE PRESSURES, IN GENERAL, WILL BE ABOVE THE STATIC HEAD OF THE SURGE TANK. THIS ASSUMPTION INCREASES THE ΔP ACROSS THE VALVES IN QUESTION. SEE NOTE 2 ON PAGE 11 FOR AN ADDITIONAL COMMENT.

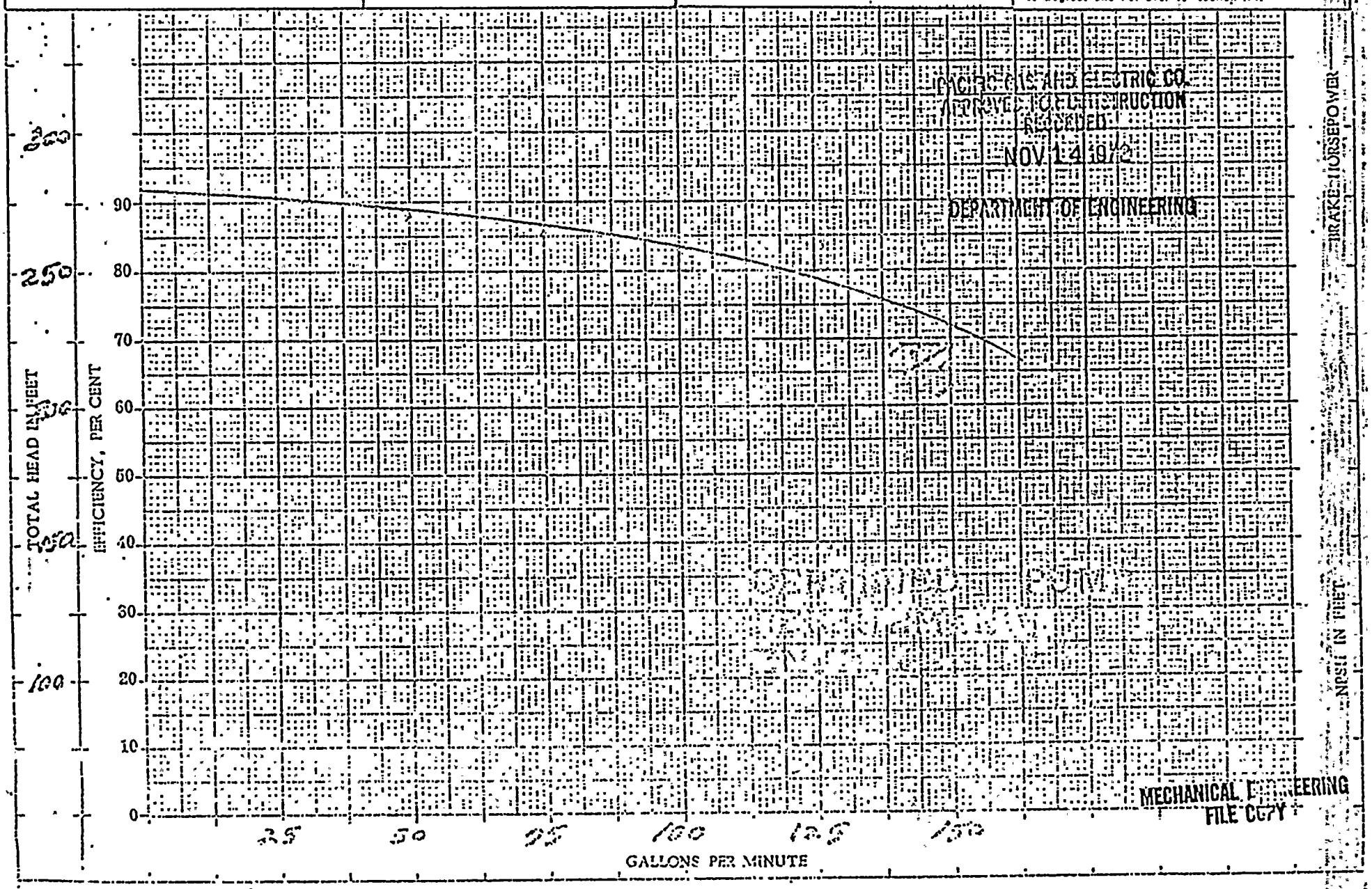
iii) THE RESULTS IN PART 3 ARE CONSERVATIVE SINCE IT IS UNLIKELY THAT THE MAKE-UP WATER PUMPS CONSIDERED WOULD BE

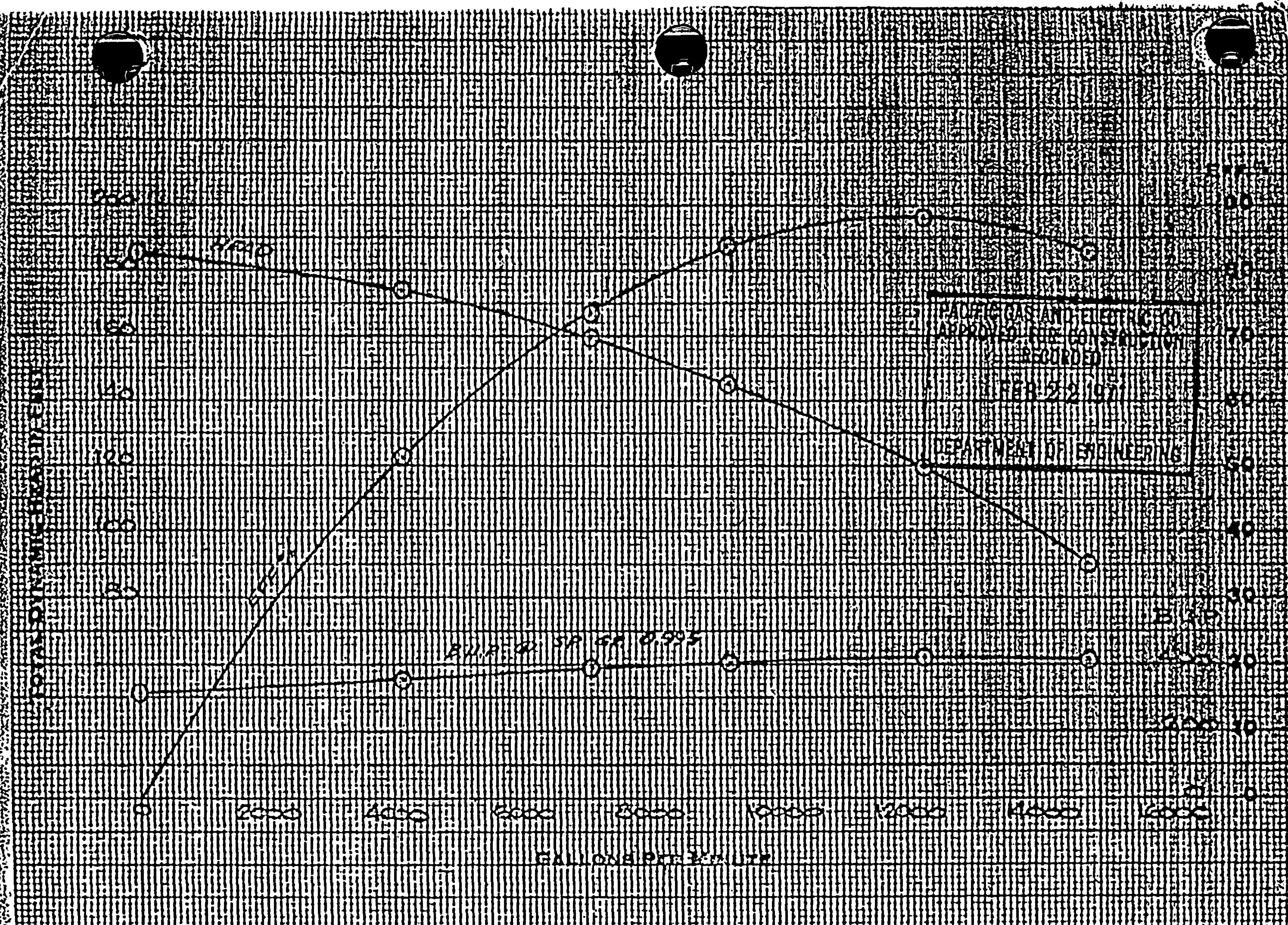
OPERATING & NOT SUPPLYING ANY OTHER USERS (HENCE GOING TO SHUT-OFF HEAD). ALSO, BOTH THE MAKE-UP WATER TRANSFER PUMPS & PRIMARY WATER MAKE-UP PUMPS HAVE CONTINUOUS FLOW RECIRCULATION LINES. (REF 6), HENCE, THESE PUMPS WILL ALWAYS OPERATE WITH A TDH LESS THAN SHUT-OFF HEAD.

iv) THE LEVEL OF THE SURGE TANK ONLY ENTERS INTO CALCULATION OF ΔPmax FOR SECTIONS 3 & 4 (ISOLATED VALVES IN CONTAINMENT & MAKE-UP WATER VALVES). ASSUMING LOW LEVEL IN THE SURGE TANK IS CONSERVATIVE, SINCE IT LOWERS THE DOWNSTREAM PRESSURE OF THE SUBJECT VALVES, INCREASING ΔPmax.

PG-663VB PRIMARY WATER TRANSFER PP 5-1 C-4052

CUSTOMER Pacific Gas & Elec	DESIGN CONDITIONS	Ingersoll-Rand	CURVE 15AVM3A 6.75
PROPOSAL NO. 66-31677 ITEM 4	GPM 150 EFF		PUMP 1½ VM-15
SPECIAL NOTES 0572-8035 0572-8036	T. H. (FT.) 222 BHP SG.		Curves are approximate. Pump is guaranteed for one set of conditions. Capacity, head and efficiency guarantees are based on shop test and when handling clear, cold, fresh water at a temperature of not over 85 degrees and not over 15' suction lift.
	RPM 3550 DRIVER M HP 15	DRAWN BY DATE	





MECHANICAL ENGINEERING

DC-663213-37-1

PACIFIC GAS & ELECTRIC COMPONENT COOLING WATER UNIT Nº 1 PUMP Nº 290291	CHARACTERISTIC CURVE SHEET BINGHAM PUMP DIVISION BINGHAM-WILLAMETTE COMPANY PORTLAND, OREGON & SHREVEPORT, LA.	IMPELLER MAX. DIA. 21	16 × 20 × 21 HSL PUMP		
		MIN. DIA.	DIA. IMPELLER 19 11/16	IMPELLER PATT. 1613 HBL-3	1190 R.P.M.
		EYE AREA 208 SQ. IN.	N.P.S.H. REQUIRED	REFERENCE	CURVE NO. 29019

C-181

MEMORANDUM

C14430

TO ECONNELL / CEWARD

LOCATION 45/10/D25

TN CRAWFORD / FJ CUCCO

DATE MAR 9 19 83

JOB NO. 1520

SUBJECT SETTINGS OF CCW RELIEF VALVES

FILE

A LIST OF RELIEF VALVES IN THE COMPONENT COOLING WATER SYSTEM AND THEIR CURRENT FIELD SETTINGS FOR UNIT 1 OF DIABLO CANYON IS ATTACHED. THESE SETTINGS WERE VERIFIED BY G.C. PERSONNEL AS BEING THE ACTUAL SETTINGS FROM THE G.C. TEST SHEETS (FORM E-22) VALID AS OF JANUARY 1983.

L. H. Cl

NO RESPONSE REQ'D

AJF

0043 (10-81)

SYS 14 RELIEF VALVE SETTINGS
AS VERIFIED BY G.C. 12/82 & 1/83

TAG #	SETTING	TAG #	SETTING
RV 41	2485 PSIG	RV 189	70 PSIG
RV 42	2485 PSIG	RV 191	50 PSID
RV 43	2485 PSIG	RV 192	70 PSID
RV 44	2485 PSIG	RV 194	50 PSID
RV 45	30 PSIG	RV 302	50 PSID
RV 46	70 PSID	RV 303	50 PSID
RV 47	70 PSID	RV 304	70 PSIG
RV 49	50 PSID	RV 305	70 PSIG
RV 51	150 PSIG	RV 307	50 PSID
RV 52	150 PSIG	RV 309	50 PSID
RV 55	50 PSID	RV 311	50 PSID
RV 186	50 PSID	RV 313	50 PSID
RV 187	50 PSID		
RV 188	50 PSID		

PSIG = POUNDS PER SQUARE INCH GAUGE

PSID = POUNDS PER SQUARE INCH DIFFERENTIAL