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AUTH.NAME AUTHOR AFFILIATION
CURTIS,N.W. Pennsylvania Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
SCHWENCER,A. Licensing Branch 2

SUBJECT: Forwards addl info re containment vent & purge valve qualification.Purge valves marginally overstressed when closing from full open position against peak post-LOCA pressure.Mods needed to produce qualifiable valves.

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Pennsylvania Power [illegible]

[illegible]

[illegible] event [illegible] valve [illegible] overpressured when closed [illegible] full open position against high pressure. [illegible] needed to provide reliable valves.

[illegible] Correspondence

[illegible]

Pennsylvania Power & Light Company
Two North Ninth Street • Allentown, PA 18101 • 215 / 770-5151

Norman W. Curtis
Vice President-Engineering & Construction-Nuclear
215 / 770-5381

OCT 29 1982

Mr. A. Schwencer, Chief
Licensing Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
ADDITIONAL CONTAINMENT VENT AND PURGE
VALVE QUALIFICATION INFORMATION
ER 100450 FILE 841-2
PLA-1371

Docket No. 50-387

Dear Mr. Schwencer:

This letter is sent to provide additional information which was included as a commitment in our letter of 9/14/82 (PLA-1291). In that letter, PP&L committed to provide purge valve qualification documentation to the NRC by 10/30/82. PP&L has evaluated the purge valves and determined that some are marginally overstressed when closing from the full open position against peak post-LOCA pressure. Therefore modifications must be performed to produce qualifiable valves. PP&L will provide information on the modifications and qualification of affected valves by 1/1/84. This should allow NRC approval prior to implementation during the first refueling outage.

In the interim, PP&L will comply with license condition 5A by blocking purge supply and exhaust isolation valves to a maximum opening of 50 degrees. The attachment to this letter provides justification that the valves will not be overstressed if the maximum opening is 50 degrees.

As requested by M. Haughey, a sketch of the block mechanism is attached. The blocking method consists of adding a sleeve to the air cylinder of the valve operator such that the valve will not open further than 50°. This sleeve is secured in place by clamping to the stationary tie rods using two U-clamps. This allows for easy installation/removal, and requires no welding. Also, by placing the mechanical block in the air cyclinder position, the fail-close function of the valve provided by spring closure is not jeopardized. This blocking method has already been implemented for the inboard exhaust isolation valves as stated in our letter of 9/14/82 (PLA-1291).

PP&L requests your approval for operation with the purge supply and exhaust isolation valves blocked (as previously described) until the first refueling outage. Until such time that NRC approval is granted, PP&L will maintain its

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OCT 29 1982

present configuration as described in PLA-1291. We interpret Technical Specification 3.6.1.8 to mean this condition is only applicable in operating modes 1, 2, and 3, and that no blocking or maintaining valves closed is required in modes 4 and 5. We request your concurrence on this issue.

Very truly yours,

R J Shovlin for
N. W. Curtis
Vice President-Engineering & Construction-Nuclear

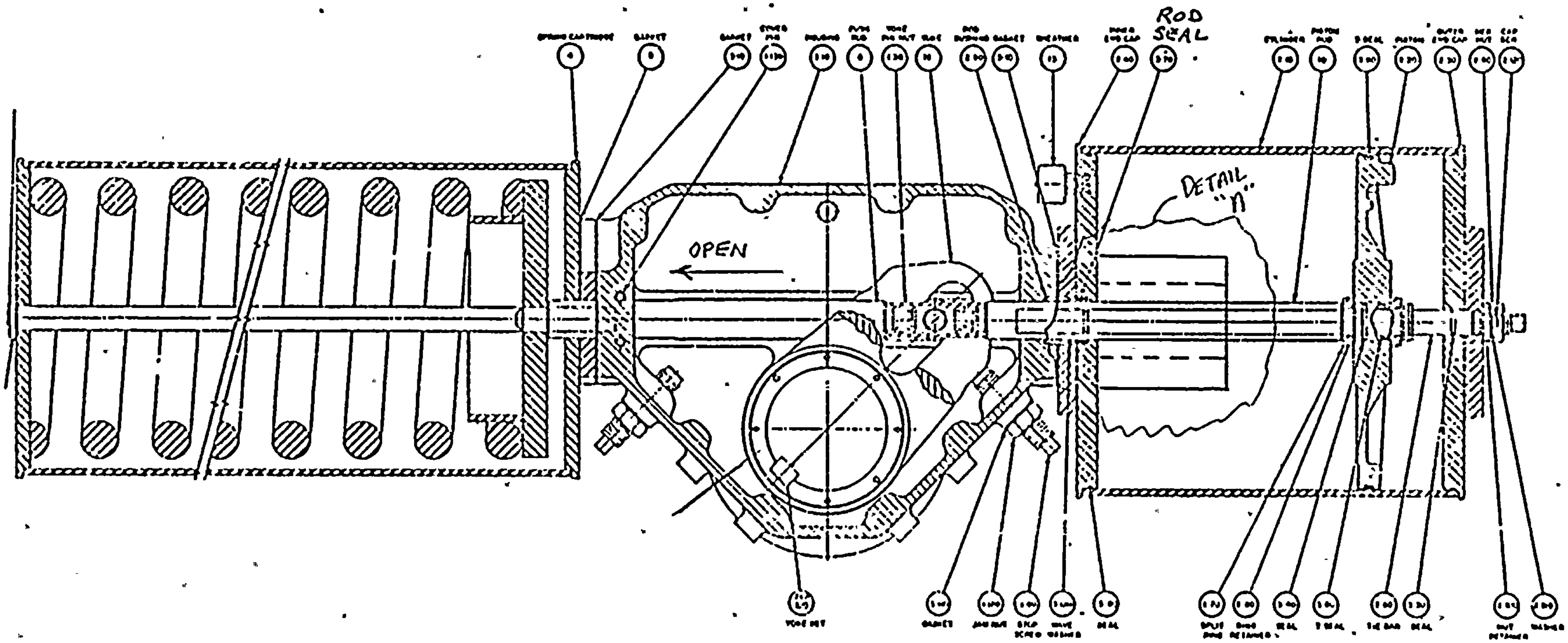
DPM/mks

Attachment

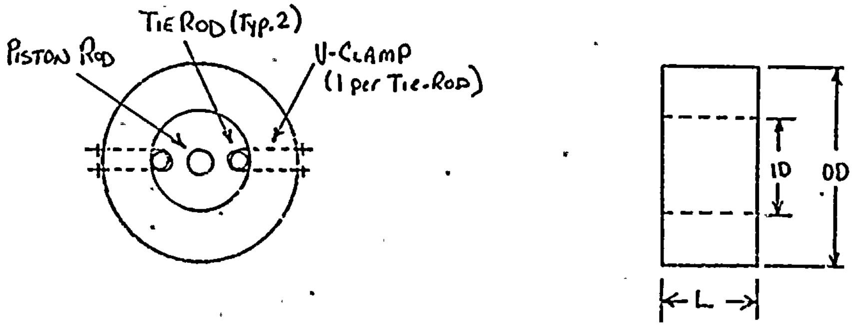
cc: G. Rhoades - NRC
R. L. Perch - NRC

Blocking Mechanism Details

Operator Assembly*



Detail "A" *



Dimensional Data

Valve Size	Operator Model	OD	ID	L
18"	T312 -SR3	6"	3.75"	4.43"
24"	T416 - SR3	6"	3.75"	5.725"

*Note: Not To Scale

PP&L CALCULATION COVER SHEET

CALC. NO. M[redacted]-003[redacted]0	SAFETY-RELATED ☒
FILE NO: 171, 289-P31	ASME III OR XI ☒
SUPERSEDED BY	OTHER QUALITY ☐
	NON QUALITY ☐

PROJECT SSES UNIT #1 ER/CTN NO. 100450

DESIGN ACTIVITY/PMR NUMBER N/A PAGE 1 OF 20

TITLE/DESCRIPTION CONTAINMENT PURGE VALVES - DETERMINATION OF BLOCKING ANGLE

STATEMENT OF PROBLEM DETERMINE A BLOCKING ANGLE FOR THE CONTAINMENT PURGE VALVES THAT WILL REDUCE THE STRESSES IN BOTH THE TOP DISC PINS AND THE BONNET BELOW THE CODE ALLOWABLES.

DESIGN BASIS (DC020.0 OR DC020.1) N/A

REFERENCES/FORMULAE

1) HENRY PRATT CO. ANALYSIS FOR 18" & 24" BUTTERFLY VALVES - FF110310
2) TELECON DATED 9/24/82 BETWEEN L. WEST (PP&L) & R. KAZA (PRATT) - ATTACHED

SUMMARY/CONCLUSIONS

THE 18" & 24" VALVES SHOULD BE BLOCKED TO AN ANGLE OF 50°. THIS ANGLE WILL REDUCE THE DISC PIN STRESS AND THE BONNET STRESS BELOW THE CODE ALLOWABLES. THIS ANGLE ALSO GIVES A SAFETY FACTOR OF 1.48 FOR THE 18" VALVES AND 1.19 FOR THE 24" VALVES

REV. NO.	DATE	PREPARED BY	REVIEWED/CHECKED BY	DATE	APPROVED BY	DATE
0	10/21/82	[signature]	[signature]	10/25/82	[signature]	10/25/82

INTRODUCTION

This analysis was performed in order to determine a blocking angle for the 18" and 24" containment vent and purge valves. The purpose for blocking the valves is to reduce the stresses in the top disc pins and the bonnet to a level that is below the code allowables. This analysis contains two calculations; one for the disc pin stresses and another for the bonnet stresses. The conclusions section defines the blocking angle that was determined as a result of both analyses.

PP&L Form 2454 (9-79)
Cat. # 973401

Dept. NPE - MECH
Date 2/22 1982
Designed by LJW
~~Approved~~ Checked by GEA

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT CONTAINMENT PURGE VALVES - DETERMINATION OF BLOCKING ANGLE

ER No. ______

Sht. No. 3 of 20

M-CAC-003 Rev.0

DISC PIN CALCULATION

PURPOSE

The purpose of this calculation is to determine and justify a blocking angle for the containment purge and vent valves. The criteria that will determine the blocking angle is the top disc pin shear stress level. The analysis done by the Henry Pratt Co. shows that under a LOCA condition the top disc pin stress levels are above the allowables, therefore, the valve must be blocked in order to reduce the stress levels in these disc pins.

ANALYSIS

All of the equations and numerical values used in this calculation were obtained from the Pratt analysis. The following equations define the shear stress for the top disc pins.

$$S(15) = \frac{T_8 - 1/2\, U_5}{2 N_1 R_5 D_3^2 (.785)} \qquad (1)$$

where:

$$U_5 = U_4 + W_2\, g_x\, U_3\, R_5 \qquad (1a)$$

$$U_4 = (.785)(2R_4)^2 P_0\, U_3\, R_5 \qquad (1b)$$

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Date 9/23 1982

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CALCULATION SHEET

PROJECT Containment Purge Valves - Determination of Pinning Angle

ER No.

Sht. No. 4 of 20

M-CAC-003 Rev.0

The variable definitions and values are listed below:

Variable	Definition	Value 18" Valve	Value 24" Valve
S(15)	Shear Stress for Top Disc Pins	To Be Determined	
T_8	Max. Required Operating Torque	2321 in-lb	64426 in-lbs
N_1	Number of Top Disc Pins	2	2
R_5	Shaft Radius	1.125 in	1.5 in
D_3	Disc Pin Diameter	.685 in	.935 in
R_4	Disc Radius	7.85 in	10.85 in
U_3	Shaft Bearing Coefficient of Friction	.25	.25
W_2	Banjo Weight	188 lbs	356 lbs
g_x	Seismic Acceleration Constant	5	5
D_4	Thrust Collar OD	3.125 in	4 in
D_2	Shaft Dia $(2 \cdot R_5)$	2.25 in	3.0 in
P_0	Actual Shut-Off Pressure	21.4 lb/in²	21.4 lb/in²

TABLE I

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PROJECT Containment - Purge Valves - Determination of Blocking Angle

ER No.
Sht. No. 5 of 20

M-CAC-003 (Rev. 0)

The first part of this calculation is to use Eqs. 1, 1a, 1b and the values in Table I and calculate the disc pin stress. Verify that the stress calculated agrees with the value given in the Pratt analysis.

The next step is to calculate a range of torque values for a given range of stress levels. This can be done by rearranging Eq. 1 and solving for T_B. Once a limiting torque condition is selected, a blocking angle can be read off of Figs. 1 or 2. An alternate method for determining the blocking angle would be to interpolate a torque value from the data in the Pratt analysis. The most conservative value should be used.

Note: Although $T_B = T_D - T_B - T_H$, this calculation uses $T_B = T_D$. This will provide a more conservative approach and asure that the disc pin stresses do not exceed the code allowable of 12,000 psi.

The data for Figs. 1 & 2 was obtained from the test results given in the Pratt analysis. This data relates the torque values to valve angles under a LOCA condition. Therefore, both methods for determining the blocking angle (interpolation or Figs. 1 & 2) are based upon test results.

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Cat. #973401

Dept. NPE - Mech

Date 7/21 · 1982

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~~Approved~~ Checked by J ZA

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT Containment Purge Valves - Determination of Blocking Angle

ER No.

Sht. No. 6 of 20

M-CAL-002 Rev 0

RESULTS - 18" VALVE

$U_4 = (.785)(4)(7.85\,in)^2(21.4\,lb/in^2)(.25)(1.125\,in)$

$U_4 = 1164.596$ in-lbs

$U_5 = 1164.596$ in-lbs $+ (188\,lbs)(5)(.25)(1.125\,in)$

$U_5 = 1428.971$ in-lbs

$$S(15) = \frac{23211\ \text{in-lbs} - \tfrac{1}{2}(1428.971\ \text{in-lbs})}{2(2)(1.125\,in)(.685\,in)^2(.785)}$$

$S(15) = 13572.252\ lb/in^2$ ∴ this agrees with the Prior Analysis

Rearranging Eq. 1 & combining constants yields;

$T_8 = [S(15)]\, 2 N_1 R_5 D_3^2 (.785) + \tfrac{1}{2} V_5$

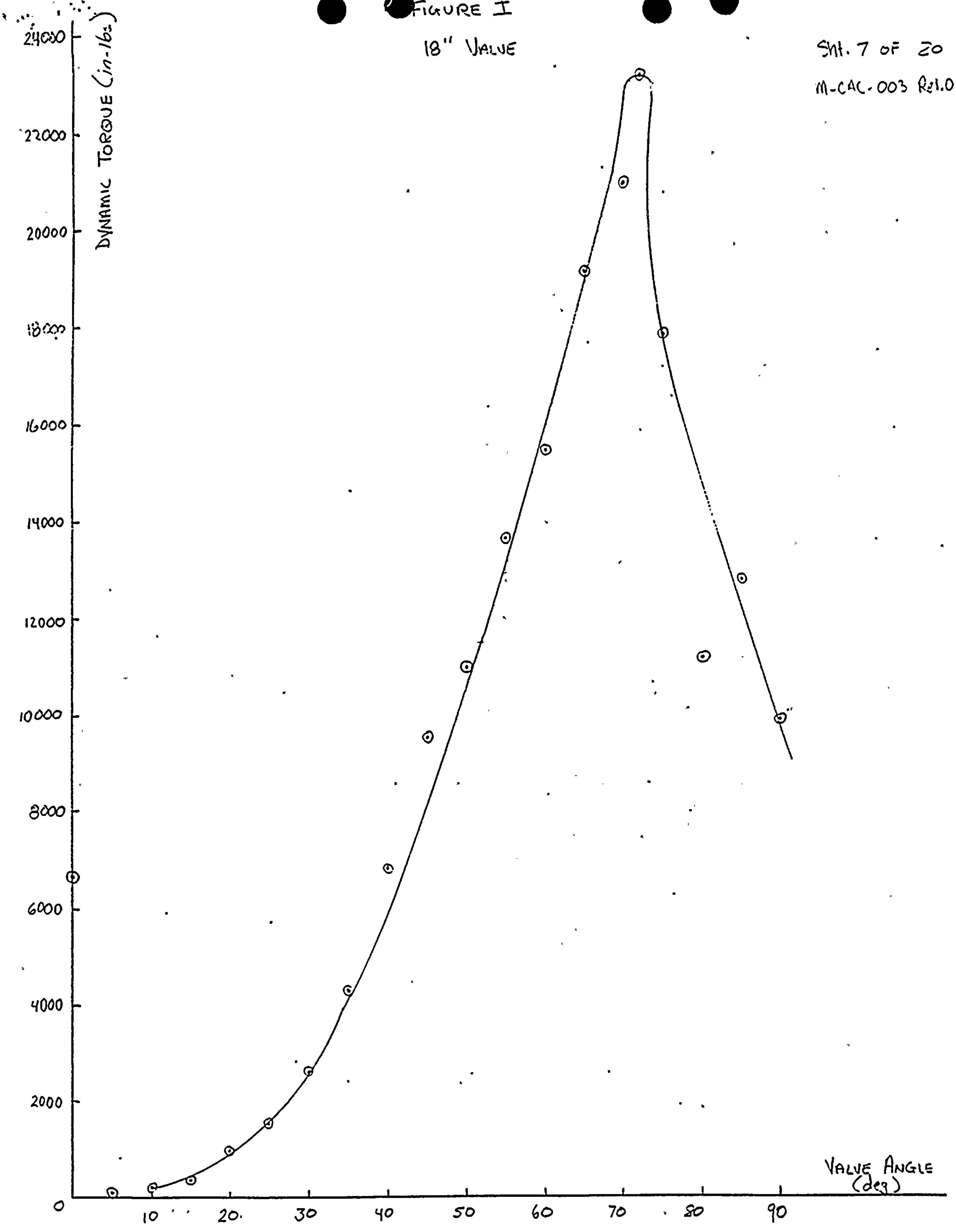
$T_8 = [S(15)](2)(2)(1.125\,in)(.685\,in)^2(.785) + \tfrac{1}{2}(1428.971\ \text{in-lbs})$

$T_8 = [S(15)](1.658) + 714.486$ in-lbs

Disc Pin Stress S(15)	Torque T8	Blocking Angle (from Fig 1)	Blocking Angle (interpolation)
13500	23097	—	—
13000	22268	69°	71.2°
12500	21439	68.5°	70.4°
→ 12000	20610	67°	69.0°
11500	19781	66°	66.6°
11000	18952	65°	64.6°
10500	18123	63.5°	63.5°
10000	17294	62°	62.4°
9500	16465	61°	61.3°
5962	10600	50°	—
→ 6208	11007	—	50

FIGURE I

18" VALVE



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CALCULATION SHEET

PROJECT Containment Purge Valves - Determination of Rocking Angle

ER No.

Sht. No. 8 of 20

M-CAC-003 Rev. 0

RESULTS - 24" VALVE

$$U_4 = (.785)(4)(10.84 in)^2(21.4\ lb/in^2)(.25)(1.5 in)$$

$$U_4 = 2960.965\ in\text{-}lbs$$

$$U_5 = 2960.965\ in\text{-}lbs + (356\ lbs)(5)(.25)(1.5\ in)$$

$$U_5 = 3628.465\ in\text{-}lbs$$

$$S(15) = \frac{64426\ in\text{-}lbs - 1/2(3628.465\ in\text{-}lbs)}{2(2)(1.5 in)(.935 in)^2(.785)}$$

$S(15) = 15205.89\ lb/in^2$ ∴ this is in close agreement with the Pio - Analysis

Rearranging Eq. 1 and combining constants yields;

$$T_8 = [S(15)]\ 2N_1 R_5 D_3^2 (.785) + 1/2\ U_5$$

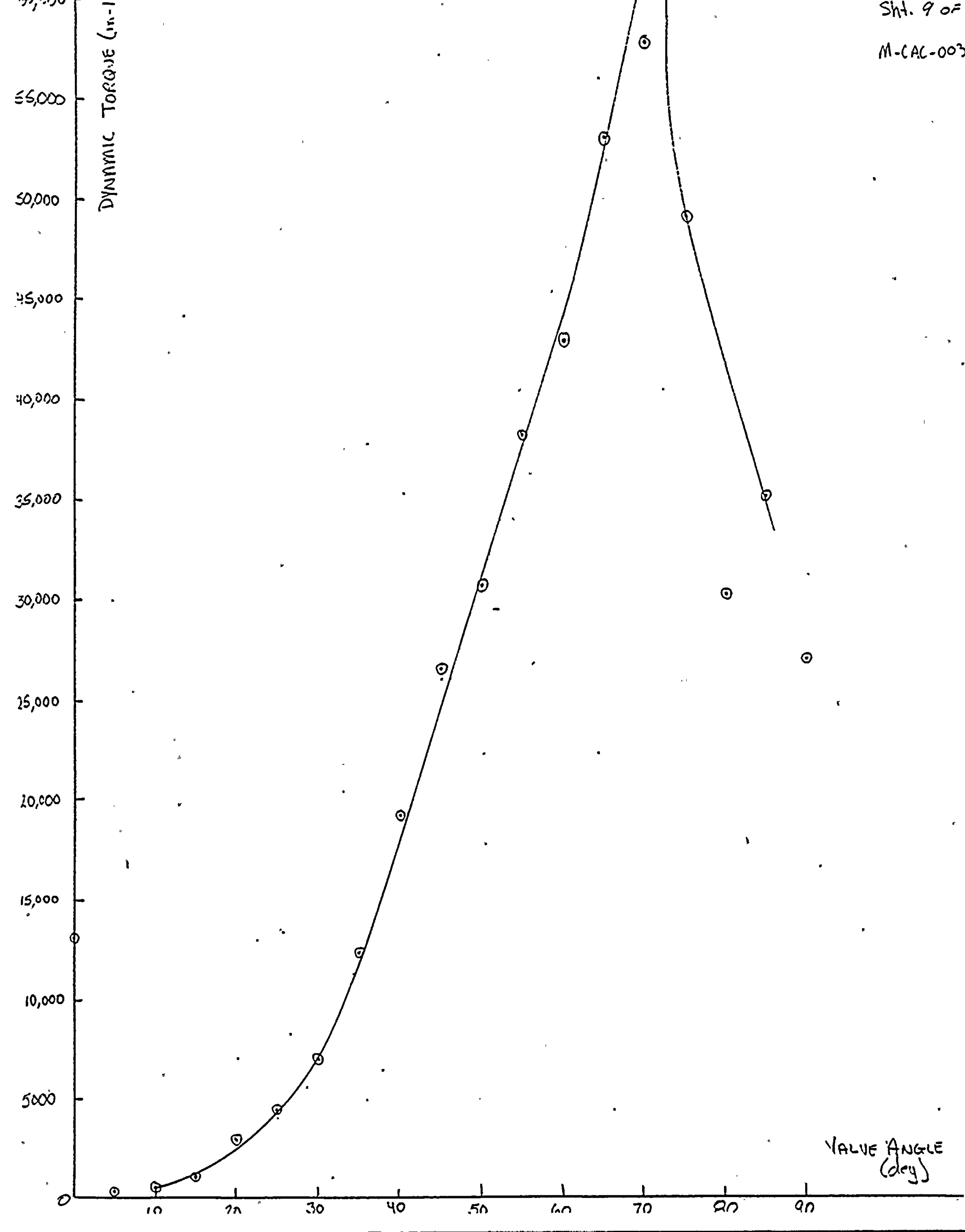
$$= [S(15)](2)(2)(1.5 in)(.935 in)^2(.785) + 1/2(3628.465)$$

$$T_8 = [S(15)](4.118) + 1814.233\ in\text{-}lbs$$

Disc Pin Stress S(15)	Torque (T_8)	Blocking Angle (From Fig 2)	Blocking Angle (interpolation)
15000	63584	71°	71.8°
14000	59466	69°	71.3
13500	57407	68°	69.6°
13000	55348	66.5°	67.3°
12500	53289	65.5°	65.1°
→ 12000	51230	64.5°	64.0°
11500	49171	63°	63.0°
11000	47112	62°	62.0°
10500	45053	61°	61.0°
10000	42994	59°	60.0°
→ 7160	31300	50°	—
7023	30723	—	50°

FIGURE II

24" VALVE



Date 9/24/82
11:15 am

TELEPHONE CALL

Subject CONTAINMENT PURGE / VENT VALVES Route

Caller L. WEST of PP&L - NPE

To RAU KAZA of HENRY PRATT

File No. 172-03, 289-P31

The questions I had for Rau are listed below followed by his responses.

Questions:

1) What does the variable P_o stand for and what is it's value?

2) Define the variable T_8 and the reason why its value is not part of the chart shown on page 7 of the valve analysis.

3) If a LOCA were to occur while the valve was closing, would the torques/flows shown on the computer sheet (pg. 7) still be valid?

Responses:

1) P_o is called the shut-off pressure and is the pressure differentic across the valve when in the closed position. Its value is 21.4 psia.

2) $T_8 = T_D - T_B - T_H$. When doing the stress analysis (for conservitism purposes) $T_8 = T_D$. Since T_8 is only several hundred in-lbs larger than T_D, the discrepency was not corrected. The error is a

Date 9/24/82
11:15 am

TELEPHONE CALL

Subject CONTAINMENT PURGE / VENT VALVES
Route

Caller L. WEST of FP&L - NPE

To RAU KAZA of HENRY PRATT

File No.

sponses:

3) YES. The chart would still be valid if such a condition occured. The torques & flows are dependant upon the upstream pressure and the valve angle.

Leonard J. West, Jr.

PP&L Form 2454 (9-79)
Cat. # 973401

Dept. NPE-MECH
Date 10/21 19 82
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~~Approved by~~ Checked JEG

PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT CONTAINMENT PURGE VALVES - DETERIMINATION OF BLOCKING ANGLE

ER No.

M-CAC-003 Rev 0

BONNET ANALYSIS

Purpose

The purpose of this calculation is to determine and justify a blocking angle for the containment vent & purge valves. The criteria that will determine the blocking angle is the combined stresses in the bonnet. The analysis done by the Henry Pratt Co. shows that under a LOCA condition the stress levels in the bonnet are above the code allowables, therefore, the valve must be blocked in order to reduce the stress levels in the valve bonnet.

Analysis

All of the equations and numerical values used in this calculation were obtained from the Pratt analysis. The following equations define the stresses in the bonnet.

For the 18" valves:

$$S(60) = \frac{S(61) + S(62)}{2} + \frac{\left((S(61)+S(62))^2 + 4(S(63)+S(64))^2\right)^{1/2}}{2} \qquad (2a)$$

where:

(2b) $$S(61) = \frac{F_z + W_4 q_z}{B_5}$$

$$S(63) = \frac{(F_x^2+F_y^2)^{1/2} + W_4 (q_x^2+q_y^2)^{1/2}}{B_5} \qquad (2d)$$

(2c) $$S(62) = \frac{\overline{M}_x B_8}{I_1} + \frac{\overline{M}_y B_9}{I_2}$$

$$S(64) = \frac{T C_o}{K_o} \qquad (2e)$$

PP&L Form 2454 (9-79)
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Dept. NPE-MECH	PENNSYLVANIA POWER & LIGHT COMPANY CALCULATION SHEET	ER No.
Date 10/21 1982		
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~~Approved~~ Checked by JEQ		M-CAL-003 Rev 0

For the 24" valves:

$$S(S1) = \frac{S(S2) + S(S3)}{2} + \frac{\left((S(S2) + S(S3))^2 + 4(S(S4) + S(S5))^2 \right)^{1/2}}{2} \qquad (3a)$$

where:

(3b) $$S(S2) = \frac{F_z + W_4 g_z}{B_5}$$

$$S(S4) = \frac{(F_x^2 + F_y^2)^{1/2} + W_4 (g_x^2 + g_y^2)^{1/2}}{B_5} \qquad (3d)$$

(3c) $$S(S3) = \frac{\overline{\overline{M}}_x B_8}{I_1} + \frac{\overline{\overline{M}}_y B_9}{I_2}$$

$$S(S5) = \frac{T \cdot C_0}{K_0} \qquad (3e)$$

The variable definitions and values are listed on the following page in Table II.

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CALCULATION SHEET

PROJECT CONTAINMENT PURGE VALVES - DETERMINATION OF BLOCKING ANGLE

ER No.

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TABLE II

Variable	Definition	Value 18" Valve	Value 24" Valve
T_8, T	Maximum required operating torque	23211 in-lbs	64426 in-lbs
W_4	Bonnet & Adapter plate assembly weight	66 lbs	74 lbs
g_x	Seismic Acceleration Constant - x axis	5	5
g_y	" - y axis	5	5
g_z	" - z axis	5	5
B_5	Bonnet body cross sectional area	9.69 in^2	16.5 in^2
B_8	Dist. to outer fiber of bonnet from shaft on x axis	4.5 in	6.5 in
B_9	Dist. to outer fiber of bonnet from shaft on y axis	3.0 in	4.5 in
I_1	Bonnet body moment of inertia about x axis	157.63 in^4	398.4 in^4
I_2	" y axis	22.57 in^4	91.27 in^4
F_x	Seismic force due to seismic acceleration acting on operator extended mass - x axis	1710 lb	2650 lb
F_y	" - y axis	1710 lb	2650 lb
F_z	" - z axis	1710 lb	2650 lb
$\bar{\bar{M}}_x$	Operator extended mass seismic bending moment about the x axis - base of operator	27488 in-lbs	44728 in-lbs
$\bar{\bar{M}}_y$	" y axis - base of operator	26376 in-lbs	40515 in-lbs
C_0	Torsional Constant for non-circular cross section	1.3	1.53
K_0	Function of Cross Section	2.25 in^4	4.86 in^4

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CALCULATION SHEET

PROJECT CONTAINMENT PURGE VALVES - DETERMINATION OF BLOCKING ANGLE

ER No.

11-CAL-003 Rev 0

The first step in this calculation is to use the values given in Table II and verify that the stress calculated agrees with the values given in the Pratt analysis

The next step is to calculate a range of torque values for a given range of stress levels. This can be done by rearranging Eq. 2a (or 3a) and solve for T_8 (or T). Once a limiting torque condition is selected, a blocking angle can be read off of Figs. 1 or 2. An alternate method for determining the blocking angle would be to interpolate a torque value from the data in the Pratt analysis. The most conservative value should be used.

Note: Although $T_8 (T) = T_D - T_B - T_H$, this calculation uses $T_8 = T_D$. This will provide a more conservative approach and assure that the bonnet stresses do not exceed the code allowable of 13,700 psi.

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Date 10/21 19 82

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PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT CONTAINMENT PURGE VALVES- DETERMINATION OF BLOCKING ANGLE

ER No. ______

M-CAC-003 Rev.0

RESULTS - 18" VALVE

$$S(61) = \frac{1710\text{ lb} + (66\text{ lb})(5)}{9.69\text{ in}^2} = 210.53\text{ lb/in}^2$$

$$S(62) = \frac{(27488\text{ in-lbs})(4.5\text{ in})}{157.63\text{ in}^4} + \frac{(26376\text{ in-lbs})(3.0\text{ in})}{22.57\text{ in}^4} = 4290.62\text{ lb/in}^2$$

$$S(63) = \frac{(1710\text{ lb}^2 + 1710\text{ lb}^2)^{1/2} + (66\text{ lbs})(\varepsilon^2 + 5^2)^{1/2}}{9.69\text{ in}^2} = 297.73\text{ lb/in}^2$$

$$S(64) = \frac{(23211\text{ in-lbs})(1.3\text{ in})}{2.25} = 13410.80\text{ lb/in}^2$$

The combined stress is -

$$S(60) = \frac{210.53 + 4290.62}{2} + \frac{\left((210.53 + 4290.62)^2 + 4(297.73 + 13410.8)^2\right)^{1/2}}{2}$$

$= 16142.62$ psi $\therefore$ this agrees with the Pratt Analysis

Rearranging equations (2a) and (2e) and combining constants yields:

$$T = \left\{\left[\frac{\left[2\left(S(60) - \frac{S(61) + S(62)}{2}\right)\right]^2 - \left(S(61) + S(62)\right)^2}{4}\right]^{1/2} - S(63)\right\}\frac{K_o}{C_o}$$

$$T = \left\{\left[\frac{\left[2\left(S(60) - 2250.58\right)\right]^2 - 20260351}{4}\right]^{1/2} - 297.73\right\}1.73 \qquad (2f)$$

PP&L Form 2454 (9-79)
Cat. # 973401

Dept. NFE - Mech
Date 10/21 19 82
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PENNSYLVANIA POWER & LIGHT COMPANY
CALCULATION SHEET

PROJECT Containment Purge Valves– Determination of Blocking Angle

ER No.
Sht. No. 17 of 20
M-CAC-003 Rev 0

Equation (2f) relates the torque value to the bonnet stresses. The chart below shows this relationship for a range of stress values. The blocking angle was obtained in the same manner as for the disc pins; using Fig. 1 and by interpolation.

Bonnet Stress (psi)	Torque (in-lb)	Blocking Angle (from Fig. 1)	Blocking Angle (interpolation)
15000	21195.1	68.5°	70.2°
14500	20315.7	67.0°	68.2°
14000	19435.0	65.5°	65.6°
→ 13700	18906.0	65.0°	64.6°
13500	18553.0	64.0°	64.1°
13000	17669.3	63.0°	62.9°
12000	15895.9	60.0°	60.6°
11500	15005.5	58.0°	58.7°
11000	14112.1	56.5	56.1°
10500	13215.1	55.0°	54.1°
10000	12313.6	53.0°	52.4°
9056	10600.0	50.0°	—
→ 9278	11007.0	—	50.0°

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PENNSYLVANIA POWER & LIGHT COMPANY
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PROJECT CONTAINMENT PURGE VALVES - DETERMINATION OF BLOCKING ANGLE

ER No.

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RESULTS - 24" Value

$$S(S2) = \frac{2650\ lb + (74\ lb)(5)}{16.5\ in^2} = 183.03\ lb/in^2$$

$$S(S3) = \frac{(44728\ in\text{-}lb)(6.5\ in)}{398.4\ in^4} + \frac{(40515\ in\text{-}lb)(4.5\ in)}{91.27\ in^4} = 2727.31\ lb/in^2$$

$$S(S4): \frac{(2650\ lb^2 + 2650\ lb^2)^{1/2} + (74\ lb)(5^2 + 5^2)^{1/2}}{16.5\ in^2} = 258.84\ lb/in^2$$

$$S(S5) = \frac{(64426\ in\text{-}lb)(1.53\ in)}{4.86\ in^4} = 20282.26\ lb/in^2$$

The combined stress in the bonnet is -

$$S(S1) = \frac{183.03 + 2727.31}{2} + \frac{((183.03 + 2727.31)^2 + 4(258.84 + 20282.26)^2)^{1/2}}{2}$$

$= 22047.75$ psi $\therefore$ this agrees with the Pratt Analysis

Rearranging Eqs. (3a) and (3e) and combining constants yields:

$$T = \left\{ \left[\frac{\left[2\left(S(S1) - \frac{S(S2) + S(S3)}{2}\right)\right]^2 - (S(S2) + S(S3))^2}{4} \right]^{1/2} - S(S4) \right\} \frac{K_o}{C_o}$$

$$T = \left\{ \left[\left[2\left(S(S1) - 1455.17\right)\right]^2 - 8470078.9 \right]^{1/2} - 258.84 \right\} 3.18 \qquad (3f)$$

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Equation (3f) relates the torque value to the bonnet stresses. The chart below shows this relationship for a range of stress levels. The blocking angle was obtained in the same manner as for the disc pins; using Fig. 2 and by interpolation.

Bonnet Stress (psi)	Torque (in-lb)	Blocking Angle (from Fig 2)	Blocking Angle (from Fig 1)
15000	42000.2	58°	59.0°
14500	40400.5	57°	57.3°
14000	38800.2	55.5°	55.6°
→ 13700	37839.5	55°	54.7°
13500	37198.9	54.5°	54.3°
13000	35596.6	53°	53.2°
12500	33993.3	52°	52.2°
12000	32388.6	50.5°	51.1°
→ 11500	30782.5	49.5°	50.0°
11000	29174.6	48°	48.1°
10500	27564.8	47°	46.1°
10000	25952.5	46°	44.5°

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CONCLUSIONS

This analysis has shown that the governing criteria in determining the blocking angle is the bonnet stress. The allowable stress level for the bonnet is 13,700 psi per ASME Codes. If the 18" valves are blocked to 65° and the 24" valves are blocked to 55°, the stresses in both the disc pins and the bonnet are at or below the code allowables.

In order to add some additional conservatism into this analysis, it is recommended that the 18" and 24" valves are blocked to a position of 50°. The actual stresses and factors of safety are listed below.

18" Valve - Blocked to 50° Open

Actual Disc Pin Stress = 6208 psi ∴ Safety Factor = 1.93

Actual Bonnet Stress = 9278 psi ∴ Safety Factor = 1.48

24" Valve - Blocked to 50° Open

Actual Disc Pin Stress = 7160 psi ∴ Safety Factor = 1.68

Actual Bonnet Stress = 11500 psi ∴ Safety Factor = 1.19

[illegible]