REVISIONS				
LTR	CALC	DATE	APPV	DATE
A	JSR	4/26/85	J Cory	4/29/85
B	JSR	10/17/85	J Cory	10/18/85

PMGM- 1648 1

POSI-SEAL INTERNATIONAL, INC.

North Stonington, CT 06359

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By D.C. RM Date NOV 22 1985

LOCA & SEISMIC ANALYSIS

CUSTOMER: Texas Utilities Generating Company

UNIT: Comanche Peak Steam Electric Station Units 1 & 2

P.O. NO.: CPF-12296-S

SPEC. NO.: 2323-SS-20

REPORT NO.: 34977SL-001

CALCULATED BY: John S. Rodgers

DATE: 1/25/85

APPROVED BY: John W. Cory #9093

DATE: Jan. 25, 1985

<u>REVISION A</u> - Changed Pages 5,6,7,15,19,20,21,41,42 44,47,48,53,56,C-2,C-4,C-6,C-8,C-10, D-2,E-1,E-3,E-4,E-6,E-7,E-9,E-10 and E-12.

Added Pages 42A and E-13 thru E-18 Revision A was made to incorporate Comments 1 thru 7,8a,9,10,12a and 13 of Texas Utilities letter TSG-8637, dated March 13, 1985.

<u>REVISION B</u> - Changed the Table of Contents, Pages 2,5,6,7,8,15,41,42,43,44,54,56,C-2, C-4 thru C-10, Appendix E and Enclosure (5).

Added Pages 8A, 42B and 48A-E and C-11 thru C-16.

Revision B was made to incorporate comments made by Mr. R. Manuenyan of Texas Utilities and to upgrade Enclosure (5).

TABLE OF CONTENTS

ENCLOSURE

(1) Valve Assembly Dwgs 14758-2 Rev. D
14759-2 Rev. C
(2) Posi-Seal Technical Bulletin No. 2, dated June 1982
(3) Derivation of Hydrodynamic Torque Curves
(4) Posi-Seal Technical Bulletin No. 1A, dated June 1982
(5) Comparison of Calculated Aerodynamic Torques with Test Data

REFERENCES

(a) DuPont Tefzel Catalog, A-95151, dated 1973
(b) "Flow of Fluids through Valves, Fittings and Pipe", Technical Paper No. 410, Crane
(c) "Formulas for Stress and Strain" by R. J. Roark, McGraw Hill, 4th Edition
(d) "Mechanical Vibrations" by Church, John Wiley & Sons
(e) "Advanced Strength of Materials" by Seeley & Smith, John Wiley & Sons
(f) "Eccentrically Loaded Joints", Machine Design, August 1967
(g) Texas Utilities Generating Company, TSG-7086, Mr. Fred Madden to Mr. Stites, dated Nov. 7, 1984
(h) TUSI Nuclear Power Plant, Instructure Response Spectra for Containment Building, FRB-5R, August, 1976
(i) TUGCO Dwg BRP-VA-1-RB-004, Rev. CP-1

SUMMARY

Due to the design of the Posi-Seal butterfly valve with the disc being asymmetrical, flow in the preferred direction tends to close the valve. In the nonpreferred direction the disc tends to stay in the open position until it reaches an angle of approximately 75 degrees open, then tends to close. See Figure 1 on Page 2 for an illustration of what direction is preferred.

For the subject valves, those inside containment are in the nonpreferred direction and those outside containment are in the preferred direction.

If a LOCA does occur the scenario given below describes what effect the large flows resulting from the LOCA will have on the subject valves.

A. <u>If all the subject valves are fully open</u>

Under normal flow conditions the subject valves would pass 2000 SCFM with an approximate pressure drop of .008 in. water.

If a LOCA were to occur the initial flow due to a LOCA will create an aerodynamic torque of such a magnitude that the valve inside containment will remain open.

For the valves outside containment the aerodynamic torque will override the actuators and cause the valves to partially close and damage the valve disc pins. Upon receiving the signal to close, the valves outside containment will close, however, due to the damage to the disc pins a tight shut off will not be obtained.

B. If the amount of valve opening for all the subject valves is restricted to 65 degrees.

Under normal flow conditions the subject valves would pass 2000 SCFM with an approximate ΔP of .03 in. water. The requirement of the specification requires a ΔP of .03 in. of water.

Once the LOCA occurs all the valves would override their actuators and tend to close a few degrees. Once the signal to close was received, the valves would fully close providing a proper shut off.

Preferred Direction

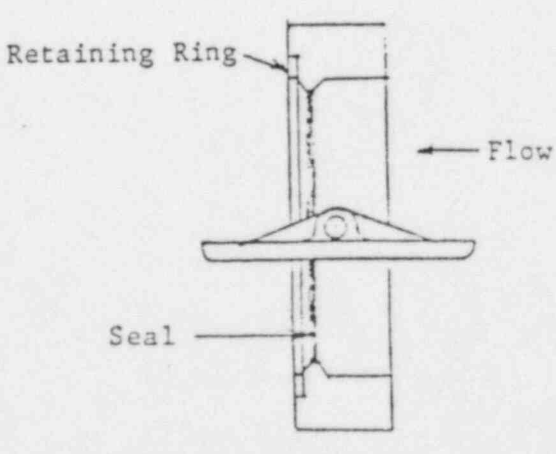


Figure 1

INTRODUCTION

The objective of this analysis is to show that the subject containment isolation valves can withstand a Loss of Coolant Accident (LOCA) as well as a seismic event and still maintain operability.

The escape of containment atmosphere during a LOCA will result in aerodynamic torques acting on the valve assembly if it is in the open position. These torques are a result of the disc acting like an airfoil wanting to rotate about the axis of the stem. This analysis will determine the magnitude of the aerodynamic torque and its effect on the operation of the valve assembly.

The seismic aspect of the analysis will consist of first determining the natural frequencies of the valve assembly. If any of these frequencies is less than 33 Hz then the maximum accelerations of the appropriate RRS curves will be used for the stress analysis. If not, then the ZPA will be used.

The stress analysis will be performed based on the accelerations statically acting at the CG of the actuator. Critical sections of the valve assembly such as bolting, neck, stem and disc pins will be analyzed. Seismic stresses will be combined with stresses due to the LOCA torque and the operating pressure.

All equations are either straight forward or from Reference (c) unless otherwise noted.

The valves to be qualified by this analysis are as follows:

PSI Item No.	Description	Tag No.
14758-2	18"-150 Cl. with Matryx 26072-SR80	CP1-VADPBC-09 CP1-VADPBC-10
14759-2	18"-150 Cl. with Matryx 26072-SR80	CP2-VADPBC-09 CP2-VADPBC-10

The assembly drawings of these valves are shown in Enclosure (1).

RESULTS

Maximum Torques Resulting from a LOCA and Closing Times

Tag No.	VADPBC-09	VADPBC-10
Valve	18"	18"
Class	150	150
Matryx Actuator Model	26072-SR80	26072-SR80
Location	Inside Containment	Outside Containment
Torques (in-lbs)		
Max Torque Resulting from a LOCA		
Valve opened to 90 degrees	15906 (1)	20609 (1)
Valve opened to 70 degrees	13350 (2)	12198 (2)
Valve opened to 65 degrees	11401 (2)	7677 (2)
Actuator Max Allowable Torque	28286	28286
Actuator Spring Beginning Torque	10400	10400
Actuator Spring Ending Torque	6420	6420
Closing Times (Sec)		
No Flow	1.65 (3)	1.65 (3)
Valve opened to 90 degrees	Will not close	.65 (1)
Valve opened to 70 degrees	.57 (2)	.65 (1)
Valve opened to 65 degrees	.57	.65
Required Closing Time	5	5

Notes (1) Piping upstream of valve VADPBC-09 breaks off, Case 3

(2) Piping upstream of elbow breaks off, Case 2

(3) See Page 54

LOCA AND SEISMIC STRESSES (PSI)

Tag No. & Item No.	Valve Opening	Actuator Bolt		Bracket Bolt		Bracket		Valve Neck		Stem		Disc Pin	
		Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow
CP1 & 2 VADPBC 10	90°	42328	94500	21523	94500	23458	41400	2923	26250	22023	52500	35790	21000
CP1 & 2 VADPBD 10	70°	36970	94500	20104	94500	19079	41400	2651	26250	14122	52500	21183	21000
CP1 & 2 VADPBC 09	70°	39640	94500	21382	94500	25270	41400	2918	26250	15233	52500	23184	21000
CP1 & 2 10	65°	34400	94500	1[illegible]478	94500	16844	41400	2577	26250	9954	52500	13332	21000
CP1 & 2 09	65°	38431	94500	21064	94500	24324	41400	2862	26250	13417	52500	19799	21000

Tag No. & Item No.	Valve Opening		
		Calc	Allow
CP1 & 2 VADPBC 10	90°	4856	24750
CP1 & 2 VADPBC 10	70°	5094	24750
CP1 & 2 VADPBC 09	70°	4948	24750
CP1 & 2 VADPBC 10	65°	6141	24750
CP1 & 2 VADPBC 09	65°	5792	24750

RECOMMENDATIONS AND CONCLUSIONS

Based on the results of this analysis Posi-Seal recommends that the amount of valve opening for all the subject valves be restricted to 65 degrees. This can be accomplished by bolting a stop to the internals of the Matryx piston cartridge which would limit the stroke of the actuator. See Figure 2 on Page 9.

The conclusion that the amount of valve opening be restricted to 65 degrees is based on:

1. The LOCA flow tending to close the valves irregardless of whether they are in the preferred direction or nonpreferred direction.

2. As a result of the flow assisting the closing, closing times will be less than those for no flow and will be less than the required closing time.

3. The yield strength of disc pin material per the ASME specification is 3.28 times greater than the allowable strength used based on the ASME Code.

4. The maximum torque of the actuator is 2.48 times the maximum torque calculated based on a LOCA flow with the valve at 65 degrees.

5. With the valves at 65 degrees the valves can still pass the required flow under normal conditions with the required pressure drop.

The ability of the Tefzel seals to provide a proper shut off is based on the following:

1. Posi-Seal's experience with Tefzel seals in applications where the velocities are comparable to those the subject valves will experience during a LOCA.

2. Radiation testing performed by DuPont as reported in Reference (a). For Posi-Seal's application we have rated the Tefzel seals to 3 X 10^8 rads.

3. The ability of Tefzel to withstand 340 degrees F. temperatures for a short period of time as also reported in Reference (a).

ALLOWABLE STRESSES

Per Paragraph 6.2 of Specification 2323-SS-20, which addresses seismics, the stress limit should be 90 percent of the yield strength unless otherwise set forth in the appropriate design standards and codes specified in the equipment specifications.

Posi-Seal used this criteria for the bolting and bracket stresses.

As for the parts subject to pressure, Section 3.7, 16.5 of the subject specification states that the stress limits for the upset, emergency and faulted conditions are the primary pressure rating corresponding to the pressure temperature classification as defined by ANSI B16.5. These pressures, however, cannot be translated into allowable stresses for the purpose of this report. It should also be noted that Paragraph NC-3500 of Section III of the ASME Boiler and Pressure Vessel Code, 1974 Edition, including the Winter of 1975 Addenda, only states that the valve shall be designed in accordance with ANSI B16.5.

As a consequence of the above, Posi-Seal decided to use 0.6 S for the allowable disc pin stress and 1.5 S for the remaining allowable stresses. S is the allowable stress for Class 2 and 3 components given in Appendix I, Tables 1-7.1, 2 and 3 of the Code. This decision was based on using the service limit Level A given in the present Code. The 0.6 factor was used for the disc pins since they are in pure shear. The 1.5 factor for the body, disc and stem was used since the stress of these components includes bending.

MATRYX ACTUATOR

Mechanical Stop

for

Restricting Valve Opening to 65°

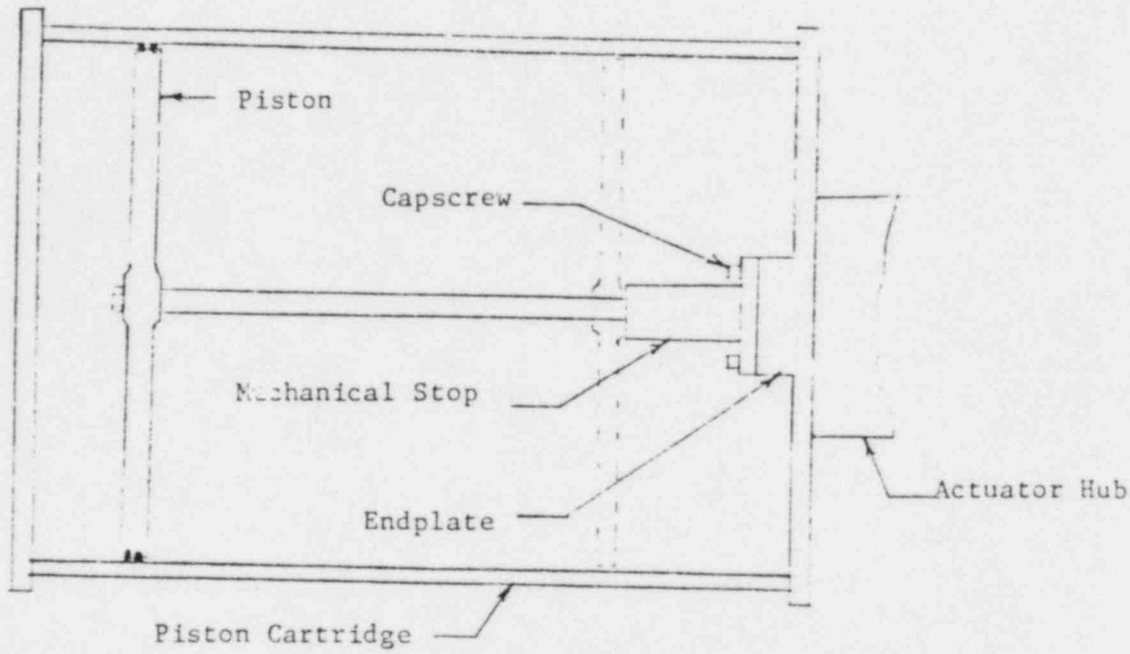


Figure 2

LOCA ANALYSIS

The purpose of this analysis is to determine what effects the aerodynamic torque resulting from a LOCA will have on a valve assembly. Since aerodynamic torque is dependent upon the flow conditions and the valve angle, computer programs are developed which:

1. Models the piping system
2. Determines the flow at various valve angles
3. Simulates the actuator as it strokes the valve from fully open to fully close.

MODELING THE PIPING SYSTEM

For this LOCA analysis three cases are investigated to determine which piping system results in the largest aerodynamic torques resulting from a LOCA.

The piping systems are:

Case 1 The piping breaks off downstream of Valve VADPBC-10

Case 2 The piping breaks off upstream of 90 degree bend inside containment and downstream of Valve VADPBC-10

Case 3 The piping breaks off upstream of Valve VADPBC-9 and downstream of Valve VADPBC-10

Shown in Appendix A are schematics of the piping systems with each system broken down into the individual components with its corresponding resistance factor. These factors are inputted into the computer program either as a K value, as a length of pipe, a change in pipe diameter, or as a valve C_v. The K values are obtained from Reference (b), the C_v values from Posi-Seal Technical Bulletin No. 2, Enclosure (2).

Thus, with the piping system modeled, and with the upstream and downstream conditions known, the flow conditions can be determined.

Determination of Flow Conditions

Derivation of equations

Bernoulli's Equation

$$Z_1 + \frac{144\ P_1}{\rho_1} + \frac{V_1^{\ 2}}{2g} = Z_2 + \frac{144\ P_2}{\rho_2} + \frac{V_2^{\ 2}}{2g} + h_L$$

Since the flow investigated will either be steam or air the height terms (Z_1, Z_2) can be ignored.

$$\frac{144\ P_1}{\rho_1} + \frac{V_1^{\ 2}}{2g} = \frac{144\ P_2}{\rho_2} + \frac{V_2^{\ 2}}{2g}$$

where P = Pressure PSIG

ρ = Density lb/ft^3

V = Velocity ft/sec

g = Gravitational constant = 32.2 ft/sec^2

h_L = Head Loss

Since the piping systems are relatively short the flow is assumed to be adiabatic.

$$\rho_2 = \rho_1 \left(\frac{P'_2}{P_1'}\right)^{1/K_1}$$ per Ref. (b)

$$T_2 = T_1 \left(\frac{P_2'}{P_1'}\right)^{\frac{K_1-1}{K_1}}$$

where K_1 = Ratio of specific heats

P' = Pressure PSIA

T = Absolute temperature °R

Flow equations

In pipe

$$Q = \frac{694.3\,P'\,V\,D^2}{T}$$

where Q = Flow SCFH

D = Diameter in^2

In valve

$$Q = 1360\,C_V\,P_1'\,Y\sqrt{\frac{X}{GTZ}}$$ per Encl. (2)

where C_V = Valve coefficient

$X = \Delta P/P'$

ΔP = Pressure drop across valve PSI

$$Y = 1 - \frac{X}{3F_K\,X_T}$$

F_K = Ratio of specific heat factors

X_T = Rated pressure drop ratio factor

G = Specific gravity

Z = Compressibility factor

For choke flow in valve

$$Q = 907.1\,C_V\,P_1'\sqrt{\frac{F_K\,X_T}{G\,T\,Z}}$$ per Encl. (2)

ΔP choked $= F_K\,X_T\,P_1'$

Sonic Velocity Equation

$$V_S = \sqrt{\frac{4637 K_1 P'}{\rho}} \qquad \text{per Ref. (b)}$$

Determination of the flow conditions will be performed as follows:

1. Calculate density at the end condition

$$\rho_{N+1} = \left(\frac{P'_{N+1}}{P'_N}\right) \rho_1$$

2. Calculate initial velocity based on beginning and end conditions.

$$V(1) = \sqrt{\frac{\left(\frac{P_{N+1}}{\rho_{N+1}} - \frac{P_1}{\rho_1}\right) 288g}{\left(1 - \left(\frac{D_1}{D_{N+1}}\right)^4 - K\right)}}$$

where $K = K(1) + K(2) + \ldots + K(N+1)$

3. Using the initial velocity V(1), calculate ΔP for all the stations as shown below

For I = 1 to N

$\rho = \rho(I)$

$\rho(I+1) = \rho$

$V(I+1) = D(I)^2 \, V(I) \, \rho(I) \Big/ D(I+1)^2 \Big/ \rho(I+1)$

$P(I) = P(I) - 14.7$

$$P(I+1) = \rho(I+1)\left(\frac{P(I)}{\rho(I)} + \frac{V(I)^2}{9274}(1 - K(I)\right) - \frac{V(I+1)^2}{9274}$$

$P(I) = P(I) + 14.7 \qquad P(I+1) = P(I+1) + 14.7$

$$\rho(I+1) = \rho(I)\left(\frac{P(I+1)}{P(I)}\right)^{1/K_1}$$

If $\left|\rho(I+1) - \rho\right| > .0005$ then $\rho = \rho - .0005$

and recalculate P(I+1)

Note: This is done since $\rho(I+1)$ is a function of P(I+1) and vice versa.

$$T(I+1) = T(I)\left(\frac{P(I+1)}{P(I)}\right)^{(K_1-1)/K_1}$$

For determining the ΔP across the valves, the equation for Q given on the preceding page is used. Solving for ΔP from this equation results in a cubic equation with the smallest root being equal to the actual drop across the valve.

4. With the final pressure P(N+1) calculated, this pressure is compared to the final pressure given. For this particular study the final pressure is atmospheric.

   If the calculate pressure is less than the given final pressure then the initial velocity is decreased and Step 3 is repeated. The initial velocity is increased if the calculated final pressure is greater than the given final pressure.

5. Steps 3 and 4 are repeated until the calculated final pressure approximately equals the given final pressure.

6. If sonic velocity is encountered at any of the stations the initial velocity is decreased until Step 5 is achieved or until the calculated sonic velocity approximately equals the actual sonic velocity.

   If the latter is the case then the given final pressure is assumed and the pressures at the stations between the outlet and the station at which sonic flow occurs are determined by using the equation given in Step 3 in reverse order and using the flow, Q, based on the sonic velocity.

7. If choke flow is encountered in any of the valves then the same approach is taken as given in Step 6.

8. To determine the flow conditions for the various valve angles, the C_V of the valve closing is determined for the angle of interest and Steps 1 thru 7 are repeated.

The above is formulated into the computer program "FLOW-GAS."

SIMULATION OF THE ACTUATOR STROKING THE VALVE CLOSE

In order to simulate the closing of the valve, an equation which describes the torques acting on the valve stem has to be defined. This equation is given below:

$$T_{TTO} = T_{flow} + T_{air} + T_{spring} + T_{packing\ and\ seal} + T_{bearing}$$

Where T_{TTO} = The net torque tending to open the valve (equals zero when the valve starts to close).

T_{flow} = The torque due to aerodynamic flow caused by the LOCA can act in either direction depending on flow direction and valve angle.

T_{air} = The torque exert by the actuator as a result of the air acting on the actuator piston tending to open the valve acts in the positive direction.

T_{spring} = The torque exerted by the actuator spring tending to close the valve acts in the negative direction.

$T_{packing\ \&\ seal}$ = Torque of the packing and the seal resisting the closing motion of the valve. The seal torque does not take affect until the disc begins to seal which occurs at approximately 3 degrees from fully closed. Resists the motion of the actuator. Positive when valve closes, negative when the valve opens. B

$T_{bearing}$ = Torque due to the ΔP acting across the valve which forces the stem/disc assembly into the bearings. Resists the motion of the actuator. Positive when valve closes, negative when the valve opens.

Derivation of Torque Equations

Aerodynamic Torque (T_{flow})

Since Posi-Seal has only determined hydrodynamic torques for water based on testing, see Encl. (3), a way to determining aerodynamic torques for air and steam from those for water has to be derived.

The resultant drag and lift forces acting on the disc are as follows:

$$F_D = C_D \rho \frac{V^2 A}{2} \quad \text{Resultant Drag Force}$$

$$F_L = C_L \rho \frac{V^2 A}{2} \quad \text{Resultant Lift Force}$$

The resultant torque is the resultant force times the length from ℄ of stem to the location of the resultant force.

$$\therefore T_D = C_D L_P \rho \frac{V^2 A}{2} \quad \text{Resultant Drag Torque}$$

$$T_L = C_L L_L \rho \frac{V^2 A}{2} \quad \text{Resultant Lift Torque}$$

$$T_{D,L} = C_{D,L} L_{D,L} \rho \frac{V^2 A}{2}$$

Where V = Velocity

A = Surface Area

ρ = Density of Fluid

C_D, C_L = Drag and Lift Coefficients (Dependent upon shape and orientation of disc)

L_D, L_L = Length ℄ stem to resultant lift and drag forces

D,L = Combined Subscript

NOTE: $C_{D,L}$ and $L_{D,L}$ are the same for the same size and class valve, assuming the same angular position, regardless of fluid, flow, media or temperature.

$$\therefore \frac{T\ \text{fluid}}{T\ \text{water}} \approx \frac{\rho\ \text{fluid}\ V^2\ \text{fluid}}{\rho\ \text{water}\ V^2\ \text{water}}$$

$$T_{4F} = \rho_F \frac{T_{4W}\ V_F^{\ 2}}{62.4\ V_W^{\ 2}}$$

Where W = Water

F = Fluid

ρ water = 62.4 lbs/ft^3

V_F = Calculated in the determination of the flow conditions

$$V_W = .00223\ \frac{Q}{A} = .00223\ \frac{C_V}{A}\ \sqrt{\Delta P}$$

T_{4W} = Disc Hydrodynamic Torque per PSI ΔP (function of valve angle)

T_{4F} = Disc Aerodynamic Torque per PSI ΔP

The total aerodynamic torque equals

$$T_F = \rho_F\ \frac{T_{4W}\ V_F^{\ 2}}{62.4\ V_W^{\ 2}}\ \Delta P$$

Since $\rho_F = \frac{144\ P_1}{R\ T_1}$ $R_{Air} = 53.34$

$R_{Steam} = 85.76$

$$V_F = \frac{Q\ T_1}{127300\ P_1 A}$$

$$V_W = \frac{.00223\ C_v \sqrt{\Delta P}}{A}$$

$$\text{Then } T_F = \frac{144\ P_1}{R\ T_1} \left(\frac{T_{4W}}{62.4}\right) \left(\frac{\frac{Q\ T_1}{127300\ P_1 A}}{\frac{.00223\ C_v \sqrt{\Delta P}}{A}}\right)^2 \Delta P$$

$$T_{Air} = .04326\ T_{4W}\ \frac{T_1}{P_1} \left(\frac{Q}{203.6\ C_v}\right)^2$$

$$T_{Steam} = .0269\ T_{4W}\ \frac{T_1}{P_1} \left(\frac{Q}{203.6\ C_v}\right)^2$$

Values for C_v and T_{4W} can be found in Enclosures (2) and (4) respectively for various valve angles.

For critical flow the equations can be simplified to:

$$T_{Air} = .441\ T_{4W}\ \frac{F_K\ X_T\ P_1}{G\ Z}$$

$$T_{Steam} = .274\ T_{4W}\ \frac{F_K\ X_T\ P_1}{G\ Z}$$

The above aerodynamic torque equations have also been incorporated into "FLOW-GAS" computer program such that the torque resulting from a LOCA can be determined for every 10° of valve closure.

Since Posi-Seal has not performed any aerodynamic flow testing, the validity of these equations is determined by comparison to test data given in an ISA transaction. See Enclosure (5)

In performing the LOCA analysis it is assumed that the valves close individually. This assumption is made for two reasons. The first is for ease of analysis. The second reason being, this is considered to be more conservative since if both valves close simultaneously, the resistance in the system will be greater; consequently, the flow will be less and the aerodynamic torque will be less.

Pneumatic Torque (T_{air})

$$T_{air} = \frac{A\ R\ P1}{C2}$$

Where A = Area of piston

D_c = Cubic Displacement

$A = \frac{D_c}{2R}$

P = Working Pressure of Actuator

$A = \frac{1728}{2R} V \left(\frac{14.7}{P+14.7}\right)$

V = Specific Volume - SCF

R = Radius of Scotch Yoke (See Figure 4)

$P1$ = Pressure of the air in the piston cylinder

$= \frac{P1\ (V-\Delta V)}{V}$

$P1$ = Previous pressure (See Note Below)

ΔV = Change in Volume

$= \frac{dt * Q}{3600}$

dt = Change in Time

Q = Flow thru solenoid valve or quick exhaust

$$= \frac{963\ C_{vs}\ F_{LS}\ P1 \sqrt{1-.25\ (F_L)^2}}{\sqrt{GT}}$$

$C_{vs} = C_v$ of solenoid valve or quick exhaust

F_{LS} = Rated liquid pressure recovery factor of a solenoid valve or quick exhaust = .9

G = Specific Gravity of Air = 1

T = Temperature ° Rankine

$Q = 774.2\ C_v\ P1 / \sqrt{T}$

$C2$ = Equation describing the advantage of the Scotch yoke as a function of angle.

NOTE: In order to take the effect of the building atmospheric pressure into consideration the initial pressure for P_1 is equal to the working pressure of the actuator minus the building atmospheric pressure.

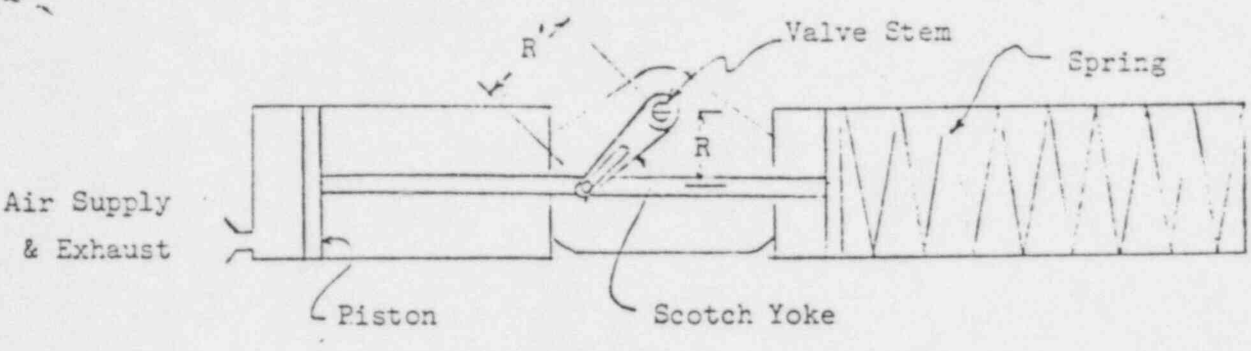
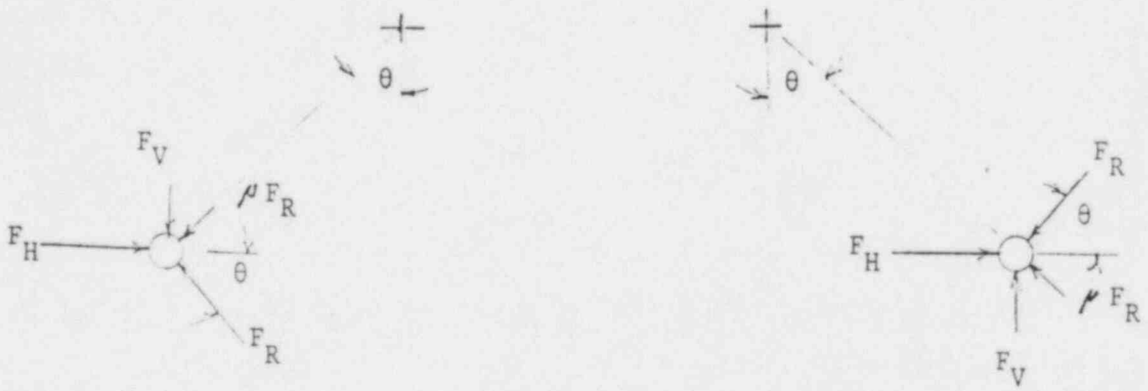


Figure 4

Forces acting on Scotch Yoke Pin



Beginning of Air Stroke

End of Air Stroke

Figure 5

Summing forces in the horizontal direction

$$F_H - \cos|\theta|\ F_R - \mu \sin|\theta|\ F_R = 0 \qquad \text{For } \theta = -90° \text{ to } +90°$$

$$F_R = F_H / (\cos\theta + \mu \sin|\theta|) \qquad \cos\theta = \cos|\theta|$$

F_R = Resultant Force

F_H = Horizontal Force

$$T_R = F_R R' = \frac{F_R R}{\cos\theta} = \text{Resultant Torque}$$

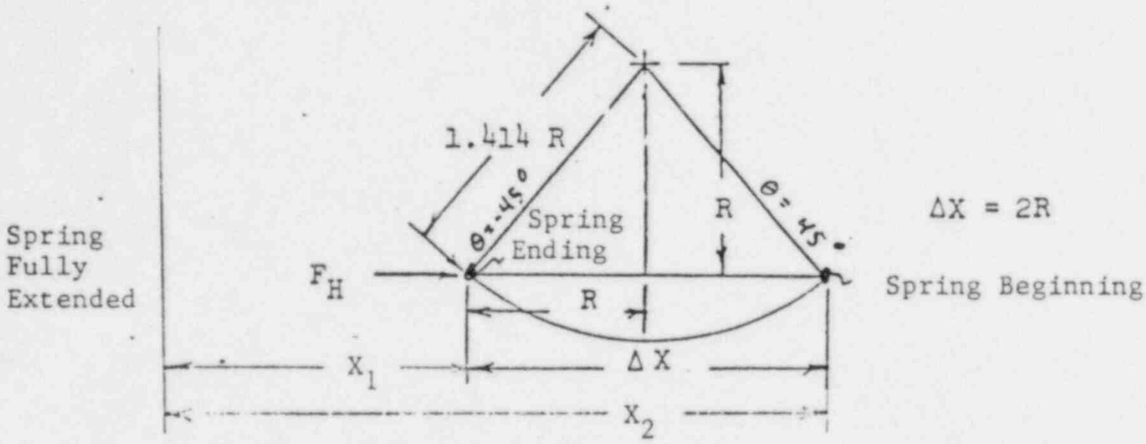
$$\therefore \quad T_R = \frac{T}{\cos\theta\,(\cos\theta + \mu \sin|\theta|)}$$

$$C2 = \cos\theta\,(\cos\theta + \mu \sin|\theta|)$$

Spring Torque (T_{spring})

$$T_{spring} = \frac{K\ X2\ R}{C}$$

Figure 6



A

K = Springrate

$$= \frac{\Delta F}{\Delta X} = \frac{T_{spring\ beginning}}{1.414\ (1.414)R} - \frac{T_{spring\ ending}}{\Delta X}$$

$$K = \frac{T_{spring\ beginning} - T_{spring\ ending}}{4R^2}$$

$$X2 = X_1 + R\ (1 + \tan\theta)$$

$$X_1 = \frac{T_{spring\ ending}\ \ C2\ @\ \theta = -45}{KR}$$

$$X_1 = \frac{.571\ T_{spring\ ending}}{KR}$$

$$X2 = \frac{.571\ T_{spring\ ending}}{KR} + R\ (1 + \tan\theta)$$

Bearing Torque ($T_{bearing}$)

$$T_{bearing} = \frac{\pi \mu P D^2\ d}{8}$$

where μ = Coefficient of friction

= .059 for bronze bearings

D = Disc gage diameter

d = Stem diameter

The torque equations are formulated into the computer program "FLOW-CL". This program calculates the various torques acting on the valve and the amount of valve closure as time is incremented until which time the valve is fully closed. In order to determine the aerodynamic torque for angles other than the ten degree increments calculated by "FLOW-GAS" the values for the densities, pressure drops and velocities are taken from "FLOW-GAS", interpolated to correspond to the angle of interest and then the aerodynamic torques are calculated based on those values. The reason for calculating aerodynamic torque in this manner is that density, pressure drop and velocity are more linear between the ten degree increments than is the aerodynamic torque. However, for the case where there is a bend upstream of the valve the torque is inputted directly. The program used for this is "FLOW-CL1".

SEISMIC ANALYSIS

A. NATURAL FREQUENCIES:

LATERAL - Disc/Stem (By Rayleigh's Method)

The natural frequency is calculated for the worse case, that being the valve open where the disc is not supported by the seat.

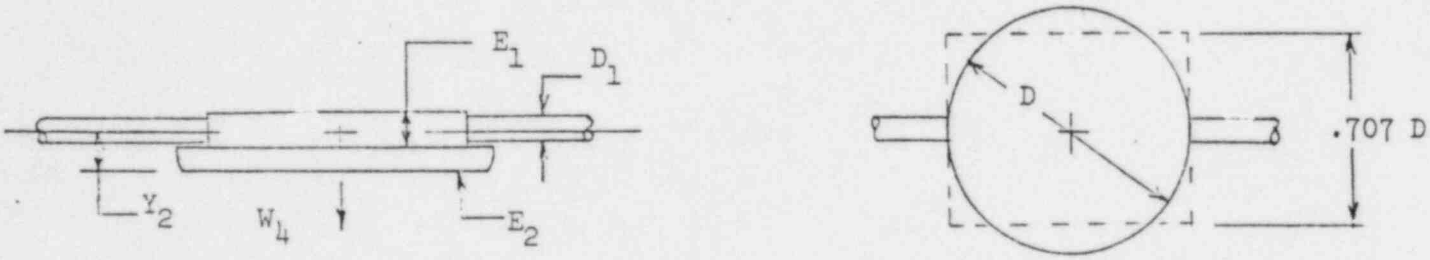
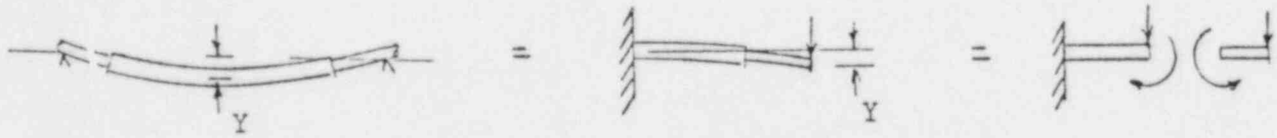


Figure 7

$$N_C = 3.125\sqrt{\frac{1}{Y}}\ \text{Hz}$$

NATURAL FREQUENCY Per Ref. (d)

Figure 8



$$Y_D = \frac{\frac{W_4}{2}\left[\frac{D}{2}\right]^3}{3\ EI_D} + \frac{M\left[\frac{D}{2}\right]^2}{2\ EI_D} = \frac{W_4\ D^3}{48\ EI_D} + \frac{W_4\left[\frac{L_1}{3} + L_2\right] D^2}{16\ EI_D}$$ Deflection of Disc

$$\theta_D = \frac{\frac{W_4}{2}\left[\frac{D}{2}\right]^2}{2\ EI_D} + \frac{M\ \frac{D}{2}}{EI_D} = \frac{W_4\ D^2}{16\ EI_D} + \frac{W_4\left[\frac{L_1}{3} + L_2\right] D}{4\ EI_D}$$ Slope at end of Disc

$$Y_S = \frac{\frac{W_4}{2}\left[\frac{L_1}{3} + L_2\right]^3}{3\ EI_S} = \frac{W_4\left[\frac{L_1}{3} + L_2\right]^3}{6\ EI_S}$$ Deflection of Stem

$$Y = \frac{W_4}{E}\left[\frac{D^3}{48\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right] D^2}{16\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right] D^2}{16\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right]^2 D}{4\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right]^3}{6\, I_S}\right]$$

$$Y = \frac{W_4}{E}\left[\frac{D^3}{48\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right] D^2}{8\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right]^2 D}{4\, I_D} + \frac{\left[\frac{L_1}{3} + L_2\right]^3}{6\, I_S}\right]$$

$$I_S = \frac{\pi D_1^4}{64} \quad \text{Moment of Inertia of Stem (in}^4\text{)}$$

$$I_D = \frac{.707\, D E_2^3}{12} + .707\, D E_2\left[\frac{E_2}{2} - \bar{Y}\right]^2 + \frac{\pi E_1^4}{64} + \frac{\pi E_1^2\left[Y_2 - \bar{Y}\right]^2}{4} \quad \text{Moment of Inertia of Disc (in}^4\text{)}$$

$$\bar{Y} = \frac{.3535\, D E_2^2 + .7854\, E_1^2 Y_2}{.707\, D E_2 + .7854\, E_1^2} \quad \text{Distance to Neutral Axis (in)}$$

WHERE: W_4 = DISC WEIGHT (LBS.)

D_1 = STEM DIA. (IN.)

D = DISC GAGE DIA. (IN.)

L_1 = EFFECTIVE BRG. LENGTH (IN.) See Page 46 for equation

L_2 = THRUST WASHER THICKNESS (IN.)

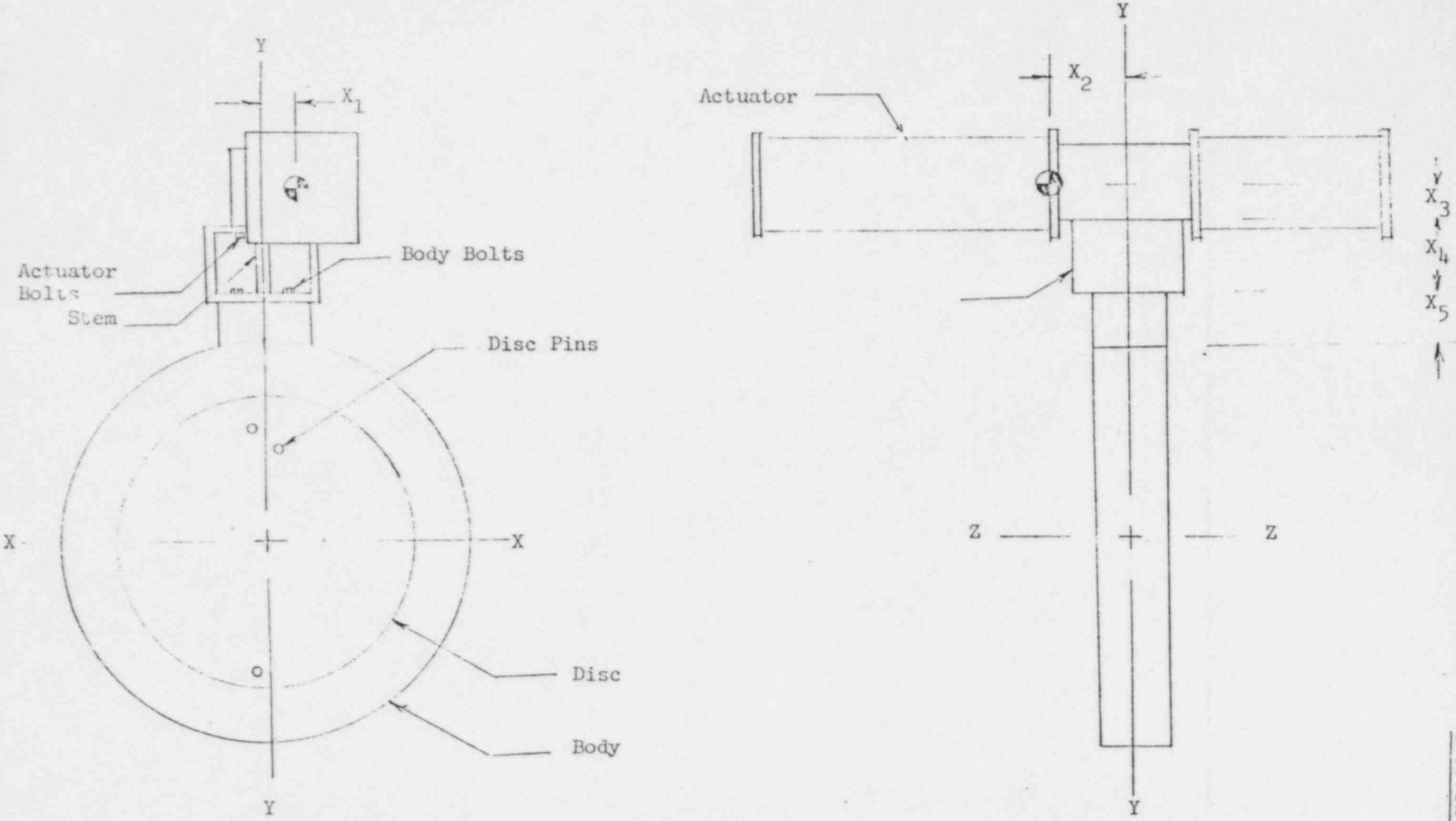
E_1 = WIDTH SMALL DIA. BACK OF DISC (IN.)

E_2 = WIDTH LARGE DIA. OF DISC (IN.)

Y_2 = DIST. ℄ STEM TO FRONT FACE OF DISC (IN.)

NATURAL FREQUENCY ANALYSIS - VALVE/ACTUATOR ASSEMBLY

The natural frequency in the longitudinal direction is that of the actuator rocking about the top of the valve neck in the direction parallel to the pipeline. The transverse natural frequency is that of the actuator rocking about the top of the valve neck in the direction perpendicular to the pipeline.



PICTORAL MODEL OF VALVE ASSEMBLY

Figure 9

34977SL-001

VALVE NECK AND FLANGE DIMENSIONS

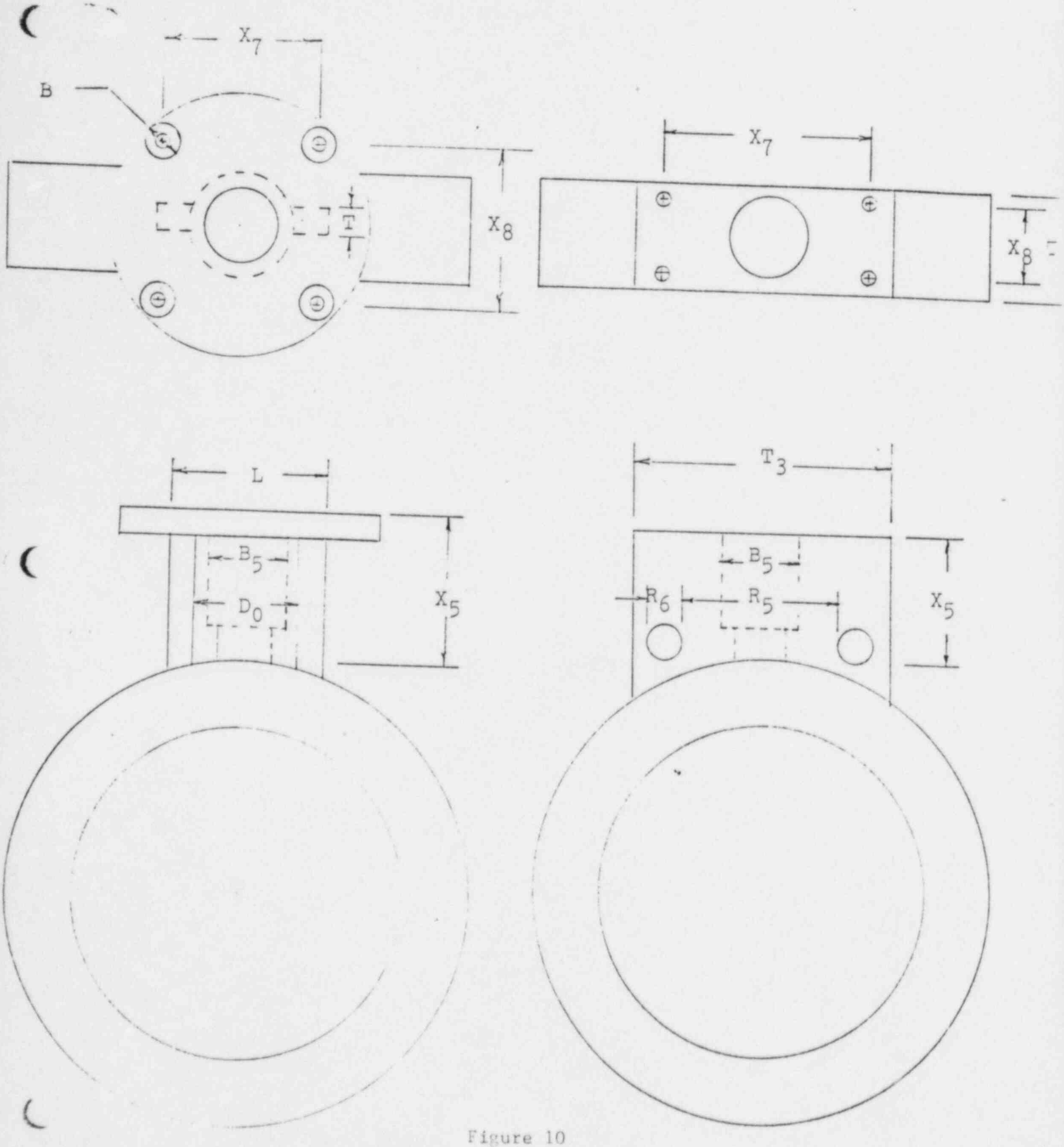


Figure 10

ACTUATOR MOUNTING BRACKET DIMENSIONS

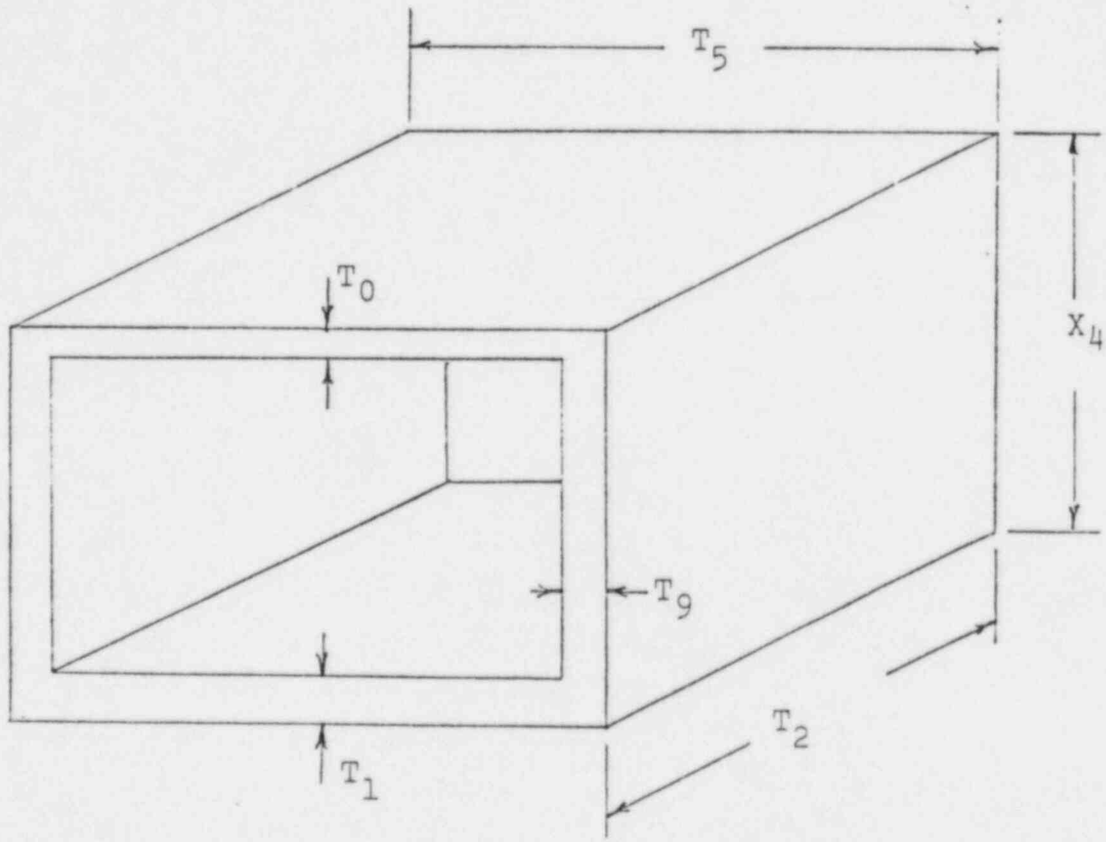


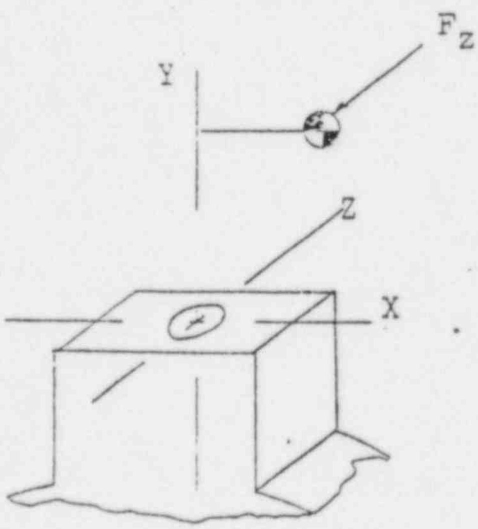
Figure 11

LONGITUDINAL (Z) NATURAL FREQUENCY

DETERMINATION OF LONGITUDINAL SPRINGRATE

Springrate of the Neck

Springrate of the neck due to the shear in the Z direction



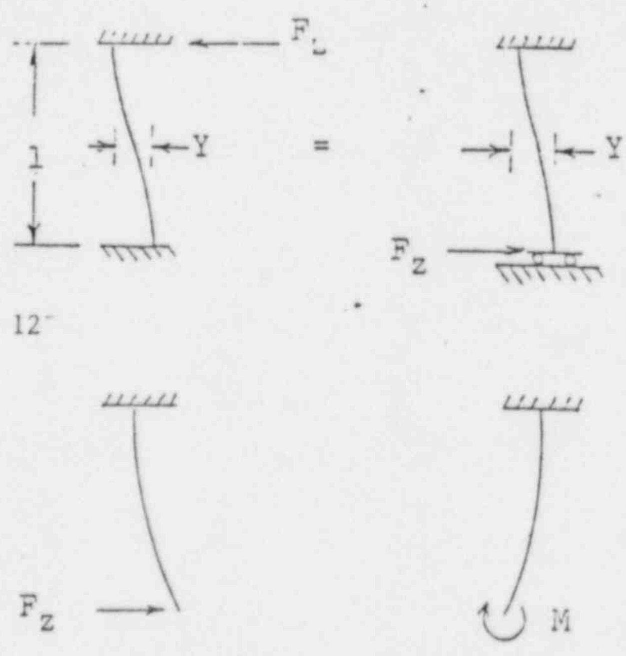


Figure 12

$Y_F = \dfrac{F_z\, l^3}{3\, EI_x}$ $\qquad$ $Y_M = \dfrac{M\, l^2}{2\, EI_x}$

$\theta_F = \dfrac{F_z\, l^2}{2\, EI_x}$ $\qquad$ $\theta_M = \dfrac{M\, l}{E\, I_x}$

$Y = Y_F + Y_M$ $\qquad$ $Y = \dfrac{F_z\, l^3}{3\, EI_x} + \dfrac{M\, l^2}{2\, EI_x}$

$\theta = \theta_F + \theta_M$ $\qquad$ $\theta = \dfrac{F_z\, l^2}{2\, EI_x} + \dfrac{M\, l}{EI_x} = 0$

$$M = -\frac{F_z\, l}{2}$$

LONGITUDINAL SPRINGRATE OF NECK

$$Y = \frac{F_z\, l^3}{3\, EI_x} - \frac{F_z\, l^3}{4\, EI_x} \qquad Y = \frac{F_z\, l^3}{12\, EI_x}$$

$$K = \frac{F_z}{Y} = \frac{12\, EI_x}{l^3}$$

Circular Cross Section

$$I_x = \frac{\pi}{64}(D_0^4 - B_5^4)$$

Rectangular Cross Section

$$I_x = \frac{T_3\, T_4^3}{12} - \frac{\pi}{64} B_5^4$$

With Gussets

$$I_x = I_x + \frac{(L - D_0)T^3}{12}$$

For the Neck $l = X_5$

$$\therefore \boxed{K_{NF_z} = \frac{12\, EI_x}{X_5^3}}$$

Springrate of the neck due to the moment about the X - axis

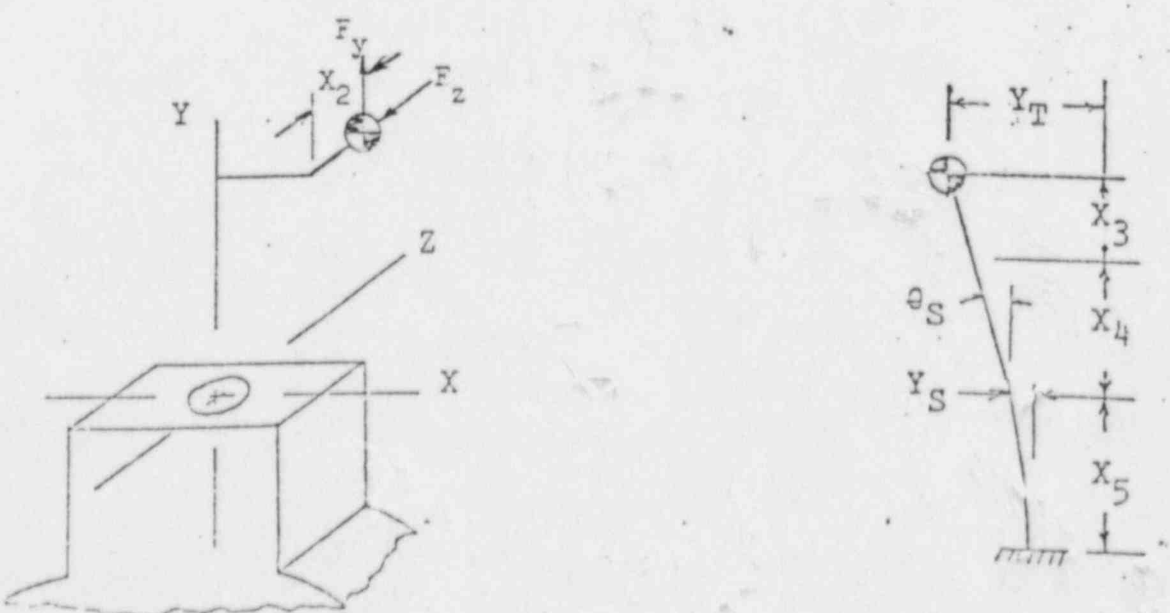


Figure 13

LONGITUDINAL SPRINGRATE OF NECK

$Y_T = Y_S + \theta_S (X_3 + X_4)$ $\qquad Y_S = Y_F + Y_M$

$\theta_S = \theta_F + \theta_M$

$Y_F = \frac{F_z X_5^3}{3 EI_x}$ $\qquad Y_M = \frac{M X_5^2}{2 EI_x}$ $\quad M = F_z (X_3 + X_4) + F_y X_2$

$F_y = F_z \quad Y_M = \frac{F_z (X_2 + X_3 + X_4) X_5^2}{2 EI_x}$

$\theta_F = \frac{F_z X_5^2}{2 EI_x}$ $\qquad \theta_F (X_3 + X_4) = \frac{F_z (X_3 + X_4) X_5^2}{2 EI_x}$

$\theta_M = \frac{M X_5}{EI_x} = \frac{F_z (X_2 + X_3 + X_4) X_5}{EI_x}$

$\theta_M (X_3 + X_4) = \frac{F_z (X_3 + X_4)(X_2 + X_3 + X_4) X_5}{EI_x}$

$$Y_T = F_z \left[\frac{X_5^3/3 + (X_3 + X_4) X_5^2/2 + (X_2 + X_3 + X_4) X_5^2/2}{EI_x} + \frac{(X_3 + X_4)(X_2 + X_3 + X_4) X_5}{EI_x} \right]$$

$K = \frac{F_z}{Y_T}$

$$K_{NM_x} = \frac{EI_x}{X_5^3/3 + (X_3 + X_4) X_5^2/2 + (X_2 + X_3 + X_4) X_5^2/2 + (X_3 + X_4)(X_2 + X_3 + X_4) X_5}$$

$K_{N_z} = \frac{K_{NF_z} \; K_{NM_x}}{K_{NF_z} + K_{NM_x}}$

LONGITUDINAL SPRINGRATE OF BRACKET

Springrate of Bracket

Springrate due to twisting of the bottom plates of bracket per Seely and Smith, Page 271, Ref. (e).

$$\phi = \frac{1}{B\,b\,h^3}\left[\frac{T}{G}\right] \qquad \text{where } B = .333 = \frac{1}{3} \text{ for } b \gg h$$

G = Shear Modulus

Looking at one side of bracket

Assume the width of the bracket that resists the twist of the plate is the distance between the bolts.

$\therefore b = X_8$

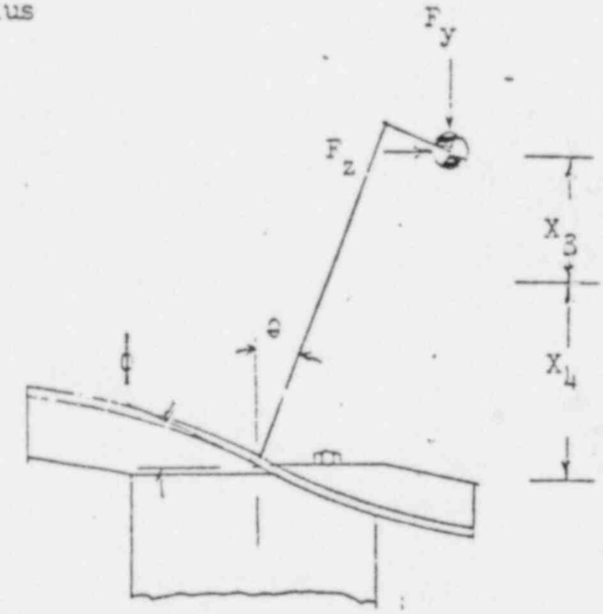


Figure 14

$G = 12X10^6 \quad h = T_1 \qquad\qquad T = M_x = \frac{F_z}{2}(X_4 - T_1 + X_3) + \frac{F_y}{2} X_2$

$$F_y = F_z \qquad \phi = \frac{3}{X_8\,T_1^3}\left[\frac{F_z\,(X_4 - T_1 + X_3 + X_2)}{2\,(12 \text{ X } 10^6)}\right] = \frac{F_z\,(X_4 - T_1 + X_3 + X_2}{X_8\,(4.\text{X } 10^6)\,T_1^3}$$

$\theta = \phi\, d \quad$ where d is assumed to be $= \frac{T_5 - 2T_9 - X_7}{2}$

$$\theta = \frac{F_z\,(X_4 - T_1 + X_3 + X_2)\,(T_5 - 2T_9 - X_7)}{X_8 \quad 16 \text{ X } 10^6 \quad T_1^3}$$

LONGITUDINAL SPRINGRATE OF BRACKET

$$Y = \theta (X_4 - T_1 + X_3) \qquad \text{Tan } \theta = \theta \text{ for small angles}$$

$$Y = \frac{F_z (X_4 - T_1 + X_3)(X_4 - T_1 + X_3 + X_2)(T_5 - 2T_9 - X_7)}{X_8 \;\; 16 \times 10^6 \;\; T_1^{\,3}}$$

$$K_{\frac{BBM}{2}x} = \frac{X_8 \;\; T_1^{\,3} \;\; 16 \times 10^6}{(X_4 - T_1 + X_3)(X_4 - T_1 + X_3 + X_2)(T_5 - 2T_9 - X_7)}$$

Since the springrate of the bottom plate for one half of the bracket is based on half the force acting on it, the springrate of all of the bottom plate equals

$$K_{BBM_x} = \frac{X_8 \;\; T_1^{\,3} \;\; 16 \times 10^6}{(X_4 - T_1 + X_3)(X_4 - T_1 + X_3 + X_2)(T_5 - 2T_9 - X_7)}$$

Springrate due to the twisting of the top pla.e of the bracket

$b = X_6$ - DBC of Actuator

$$\boxed{K_{BTM_x} = \frac{X_6 \; T_0^{\,3} \;\; 16 \times 10^6}{X_3 (X_3 + X_2)(T_5 - 2T_9 - X_6)}}$$

$$K_{BM_x} = \frac{K_{BBM_x} \;\; K_{BTM_x}}{K_{BBM_x} + K_{BTM_x}}$$

LONGITUDINAL SPRINGRATE OF BRACKET

Springrate of the bracket due to the shear in the Z direction per Page 29 $K_{Shear} = \frac{12\ EI_x}{l^3}$

$$K_{BF_z} = \frac{12\ EI_x}{X_4 - T_1 - T_0} \qquad I_x = (2)\ \frac{T_9\ T_2^{\ 3}}{12}$$

$$K_{BF_z} = \frac{12\ E\ T_9\ T_2^{\ 3}}{6\ (X_4 - T_1 - T_0)^3}$$

$$\boxed{K_{BF_z} = \frac{60 \times 10^6\ T_9\ T_2^{\ 3}}{(X_4 - T_1\ T_0)^3}}$$

Springrate of the bracket due to the bending of the side plates

$$Y_T = Y_S + \theta_S\ (X_3 + T_0)$$

$$Y_S = Y_F + Y_M \qquad \theta_S = \theta_F + \theta_M$$

$$Y_F = \frac{F_z\ (X_4 - T_0 - T_1)^3}{3\ EI_x}$$

$$Y_M = \frac{M_x\ (X_4 - T_0 - T_1)^2}{2\ EI_x}$$

$$M_x = F_z\ (X_3 + T_0) + F_y\ X_2$$

$$F_y = F_z$$

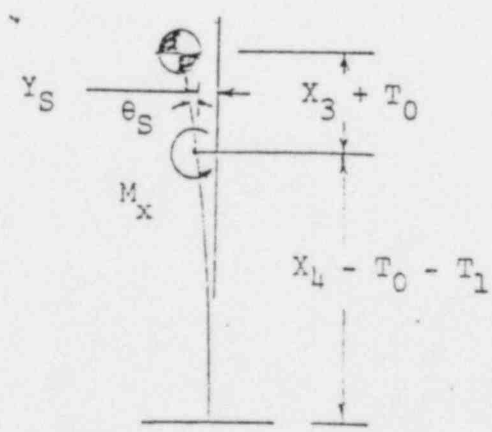


Figure 15

LONGITUDINAL SPRINGRATE OF BRACKET

$$Y_M = \frac{F_z (X_3 + T_0 + X_2)(X_4 - T_0 - T_1)^2}{2 EI_x}$$

$$\theta_F = \frac{F_z (X_4 - T_0 - T_1)^2}{2 EI_x}$$

$$\theta_F (X_3 + T_0) = \frac{F_z (X_3 + T_0)(X_4 - T_0 - T_1)}{2 EI_x}$$

$$\theta_M = \frac{M(X_4 - T_0 - T_1)}{EI} = \frac{F_z (X_3 + T_0 + X_2)(X_4 - T_0 - T_1)}{EI_x}$$

$$\theta_M (X_3 + T_0) = \frac{F_z (X_3 + T_0)(X_3 + T_0 + X_2)(X_4 - T_0 - T_1)^2}{EI}$$

$$Y_T = F_z \left[\frac{(X_4-T_0-T_1)^3}{3 EI_x} + \frac{(X_4-T_0-T_1)^2}{2 EI_x}\,\underline{(X_3+T_0)} + \frac{(X_4-T_0-T_1)^2 (X_3+T_0+X_2)}{2 EI_x} + \frac{(X_4-T_0-T_1)(X_3+T_0)(X_3+T_0+X_2)}{EI_x}\right]$$

$$\boxed{K_{BSM_x} = \frac{F_z}{Y_T} = \frac{EI_x}{(X_4-T_0-T_1)^3/3 + (X_4-T_0-T_1)^2(X_3+T_0)/2 + (X_4-T_0-T_1)^2(X_3+T_0+X_2)/2 + (X_4-T_0-T_1)(X_3+T_0)(X_3+T_0+X_2)}}$$

$$I_x = \frac{(2)T_9 T_2^3}{12} = \frac{T_9 T_2^3}{6}$$

$$K_{BS_z} = \frac{K_{BF_z} K_{BSM_x}}{K_{BF_z} + K_{BSM_x}}$$

$$K_{B_z} = \frac{K_{BM_x} K_{BS_z}}{K_{BM_x} + K_{BS_z}}$$

$$K_{z1} = \frac{K_{B_z} K_{N_z}}{K_{B_z} + K_{N_z}}$$

SPRINGRATE OF VALVE NECK FLANGE

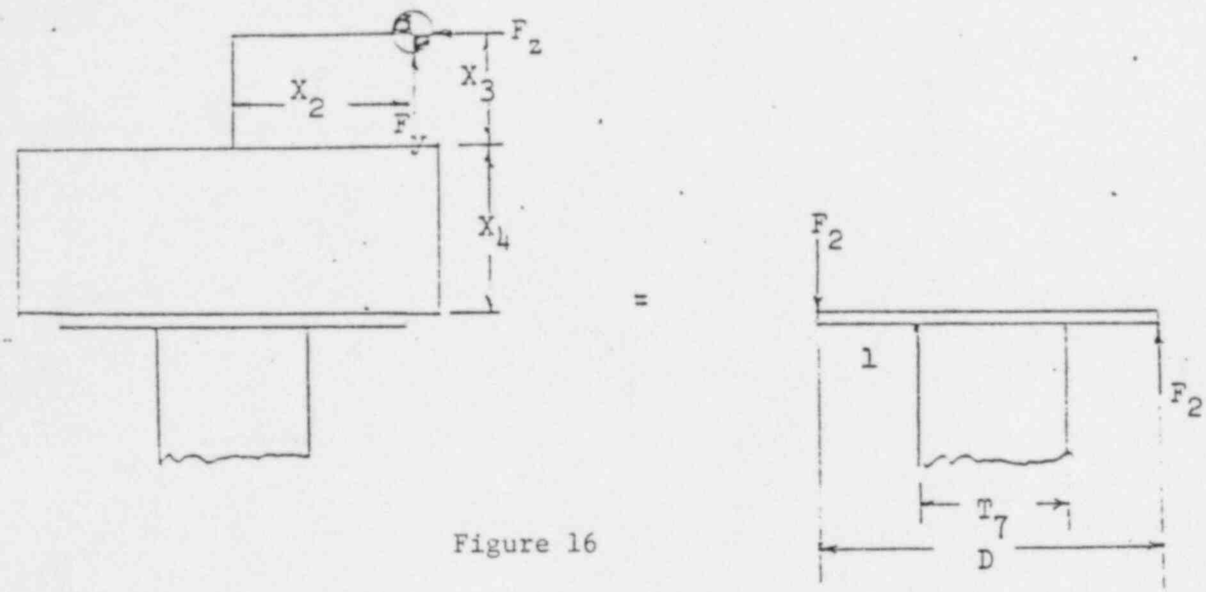


Figure 16

Case 22
Roark Ref. (e)

$T_7 = T_4$ or D_0

$$\Sigma M_1 = F_y\left(X_2 + \frac{D}{2}\right) + F_z\left(X_3 + X_4\right) - F_2 D$$

$$F_y = F_z$$

$$F_2 = \frac{F_z\left(X_2 + D/2 + X_3 + X_4\right)}{D}$$

$$y = f(F_z) = F_z C$$

$$\frac{y}{D/2} = \frac{X}{(X_3 + X_4)} \qquad X = \frac{2y\,(X_3 + X_4)}{D}$$

$$X = \frac{2\,(X_3 + X_4)\,Fz\,(X_2 + D/2 + X_3 + X_4)}{D^2}\;C$$

$$K_{FL} = \frac{F}{X}\;\frac{D^2}{2(X_3 + X_4)\,(X_2 + D/2 + X_3 + X_4)\;C}$$

$$K_{FL} = \frac{2.3 D^2\, T_6^{\,3}\, E}{(X_3+X_4)(X_2+D/2+X_3+X_4)}\left[\frac{4.33\,D^2 + 2.33\,T_7^{\,2}}{11D^4 - 2.33\,T_7^{\,4} - 8.67 D^2\,T_7^{\,2} - 26.8\,D^2\,T_7^{\,2}\,\ln(D/T_7) - 17.3\,D^2\,T_7^{\,2}\,(\ln(D/T_7))^2}\right]$$

$$K_z = \frac{K_{Z1}\;K_{FL}}{K_{Z1} + K_{FL}}$$

LONGITUDINAL (Z) NATURAL FREQUENCY

$$M = \frac{W_4 + W_5}{386}$$

Where W_4 = Weight of Actuator

W_5 = Weight of Bracket

$$fn_z = \frac{1}{2\pi}\sqrt{\frac{K_z}{M}} \quad H_z$$

TRANSVERSE (X) NATURAL FREQUENCY

DETERMINATION OF TRANSVERSE SPRINGRATE

Springrate of Neck

Springrate of the neck due to the shear in the X direction

$$K_{NF_x} = \frac{12\ EI_z}{{X_5}^3}$$

$$I_z = \frac{\pi}{64}\left({D_0}^4 - {B_5}^4\right) \quad \text{Circular}$$

$$I_z = \frac{T_4\ {T_3}^3}{12} - \frac{\pi}{64}{B_5}^4 \quad \text{Rectangular}$$

$$I_z = I_z + T\frac{(L-D_0)^3}{6} + 2(L - D_0)T\frac{(L + D_0)}{4}$$

with Gusset

Springrate of the neck due to the moment about the Z - Axis

$$K_{NM_z} = \frac{EI_z}{{X_5}^3/3 + (X_3 + X_4)\ {X_5}^2/2 + (X_1 + X_3 + X_4)\ {X_5}^2/2 + (X_3 + X_4)\ (X_1 + X_3 + X_4)\ X_5}$$

$$K_{N_x} = \frac{K_{NF_x}\ K_{NM_z}}{K_{NF_x} + K_{NM_z}}$$

TRANSVERSE SPRINGRATE OF BRACKET

SPRINGRATE OF BRACKET

Springrate due to the moment about the Z - axis acting on the bottom plate at the bracket

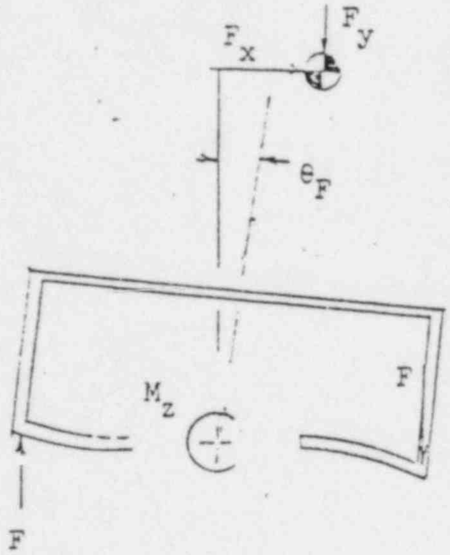


Figure 17

$$Y = \theta_F\,(X_4 - T_1 + X_3)$$

$$F = \frac{M_z}{T_5 - T_9} \qquad M_z = F_x(X_4 - T_1 + X_3) + F_y\,X_1$$

$$F_y = F_x$$

$$F = \frac{F_x\,(X_4 - T_1 + X_3 + X_1)}{T_5 - T_9}$$

$$\theta_F = \frac{F\,l^2}{2\,EI} = \frac{F\left[(T_5 - 2T_9 - X_7)/2\right]^2}{2\,EI_z}$$

$$\theta_F = \frac{F_x\,(X_4 - T_1 + X_3 + X_1)\left[(T_5 - 2T_9 - X_7)/2\right]^2}{2EI_z\,(T_5 - T_9)}$$

$$Y = \frac{F_x\,(X_4 - T_1 + X_3)\,(X_4 - T_1 + X_3 + X_1)\,(T_5 - 2T_9 - X_7)^2}{8\,EI_z\,(T_5 - T_9)}$$

$$K_{BBM_z} = \frac{8\,EI_z\,(T_5 - T_9)}{(X_4 - T_1 + X_3)\,(X_1 + X_4 - T_1 + X_3)\,(T_5 - 2T_9 - X_7)^2} \qquad I_z = \frac{T_1^{\,3}\,T_2}{12}$$

TRANSVERSE SPRINGRATE OF BRACKET

$$K_{BBM_z} = \frac{20 \times 10^6 \; T_2 \, T_1^{\;3} \, (T_5 - T_9)}{(X_4 - T_1 + X_3)\,(X_4 - T_1 + X_3 + X_1)\,(T_5 - 2T_9 - X_7)^2}$$

Springrate due to the moment about the Z - axis acting on the top plate of the bracket

$$K_{BTM_z} = \frac{20 \times 10^6 \; T_2 \, T_0^{\;3} \, (T_5 - T_9)}{X_3 \, (X_3 + X_1)\,(T_5 - 2T_9 - X_6)^2}$$

$$K_{BM_z} = \frac{K_{BBM_z} \; K_{BTM_z}}{K_{BBM_z} + K_{BTM_z}}$$

Springrate of the bracket due to the shear in the X - direction.

$K_{BF_x} = K_{BF_z}$ except $I_z = \dfrac{T_9^{\;3} \, T_2}{6}$

$$K_{BF_x} = \frac{60 \times 10^6 \; T_2 \, T_9^{\;3}}{(X_4 - T_1 - T_0)^3}$$

TRANSVERSE SPRINGRATE OF BRACKET

Springrate of the bracket due to the bending of the side plates.

$K_{BSM_z} = K_{BSM_x}$ except $I_z = \frac{T_9^3 T_2}{6} + 2T_9 T_2 \frac{(T_5 - T_9)^2}{2}$ & Substitute X_1 for X_2

$$K_{BSM_z} = \frac{EI_z}{(X_4-T_0-T_1)^3/3 + (X_4-T_0-T_1)^2(X_3+T_0)/2 + (X_4-T_0-T_1)^2(X_3+T_0+X_1)/2 + (X_4-T_0-T_1)(X_3+T_0)(X_3+T_0+X_1)}$$

$$K_{BS_x} = \frac{K_{BF_x} K_{BSM_z}}{K_{BF_x} + K_{BSM_z}}$$

$$K_{B_x} = \frac{K_{BM_z} K_{BS_x}}{K_{BM_z} + K_{BS_x}}$$

$$K_{x1} = \frac{K_{B_x} K_{N_x}}{K_{B_x} + K_{N_x}}$$

Springrate of valve neck flange

$T_7 = T_4$ or D_0

$$K_{FT} = \frac{2.3\ D^2 T_6^3\ E}{(X_3+X_4)(X_1-\frac{D}{2}+X_3+X_4)}$$

[See Page 35 for expression inside brackets]

$$K_x = \frac{K_{X1}\ K_{FT}}{K_{X1} + K_{FT}}$$

$$fn_x = \frac{1}{2\pi}\sqrt{\frac{K_x}{M}}\quad H_z$$

1. ACTUATOR/BRACKET BOLTING.

LOCA STRESSES -

$S_{Sox} = \frac{1.414T}{N_1 A_1 X_6}$ WHERE: T= LOCA TORQUE (in LBS).
N_1= NO. OF ACTUATOR BOLTS
A_1= TENSILE STRESS AREA OF ACTUATOR BOLTS (IN^2)

$S_{SOZ} = S_{SOX}$ $X_6 = D_{BC}$ OF ACTUATOR BOLTS (IN.)

$OL_{T,V}$ = Occasional Load (Transverse, Vertical)
G_1= Transverse Seismic Acceleration
G_2= Vertical Seismic Acceleration
G_3= Longitudinal Seismic Acceleration
W_1= Actuator Weight
W_2= Bracket Weight

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$Fy = W_1 * G_2 + OL_V$ $M_Z = FyX_1$ $M_X = FyX_2$

$F_X = \left[\frac{4}{X_6 N_1} \cos\frac{\pi}{N_1}\right] M_X$ MAXIMUM BOLT LOAD (LBS.) Per Ref (f)

$F_Z = \left[\frac{4}{X_6 N_1} \cos\frac{\pi}{N_1}\right] M_Z$

$F_T = \frac{Fy}{N_1} + F_X + F_Z$ (LBS) TOTAL TENSILE LOAD ON BOLT

$S_{Ty} = \frac{F_T}{A_1}$ (PSI) TENSILE STRESS

B. TRANSVERSE DIRECTION (F_X)

$F_X = W_1 * G_1 + OL_T$ $Ty = F_X X_2$ $M_Z = F_X X_3$

$S_{SSX} = \frac{1.414Ty}{N_1 A_1 X_6} + \frac{Fx}{N_1 A_1}$ (PSI) SHEAR STRESS

$F_{RZ} = \left[\frac{4}{X_6 N_1} \cos\frac{\pi}{N_1}\right] M_Z$ MAXIMUM BOLT LOAD (LBS.)

$S_{TZ} = \frac{F_{RZ}}{A_1}$ (PSI) TENSILE STRESS

C. LONGITUDINAL DIRECTION (F_Z)

$F_Z = W_1 * G_3$ $Ty = F_Z X_1$ $Mx = F_Z X_3$

$S_{SSZ} = \frac{1.414Ty}{N_1 A_1 X_6} + \frac{F_Z}{N_1 A_1}$

$F_{RX} = \left[\frac{4}{X_6 N_1} \cos\frac{\pi}{N_1}\right] M_X$ MAXIMUM BOLT LOAD (LBS.)

$S_{TX} = \frac{F_{RX}}{A_1}$ (PSI) TENSILE STRESS

ROOT SUM SQUARE STRESSES:

$$S_{SS} = \sqrt{(S_{SOX} + S_{SSX})^2 + (S_{SOZ} + S_{SSZ})^2}$$

$$S_{TS} = \sqrt{S_{Ty}^2 + S_{TZ}^2 + S_{TX}^2} \text{ (PSI) TENSILE}$$

MAXIMUM STRESS: MAX. STRESS THEORY

$$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^2}$$

BRACKET

LOCA STRESSES -

$S_B = \frac{Mc}{I_x}$ $F = T/T_5$ $M = X_4 T/T_5$

$I_x = \frac{T_9 T_2^3}{12}$ $c = \frac{T_2}{2}$

$S_B = \frac{6\ X_4\ T}{T_5 T_9 T_2^2}$ TENSILE (PSI)

S_{SSO} SHEAR (PSI) See Page 42A

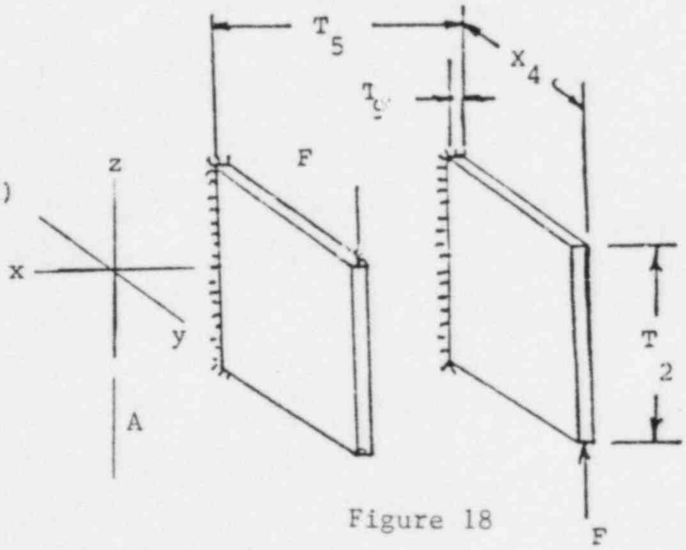


Figure 18

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$Fy = (W_1 + .5W_2)G_2 + OL_V$ $M_Z = FyX_1$ $M_X = FyX_2$ B

$S_{Ty} = \frac{Fy}{2T_9T_2} + \frac{M_Z T_5}{2J_3} + \frac{M_X T_2}{2J_2}$ TENSILE (PSI)

$J_2 = 2\left[\frac{T_9 T_2^3}{12}\right]$ $J_3 = 2\left[\frac{T_2 T_9^3}{12} + T_9 T_2 (T_{5/2} - T_{9/2})^2\right]$

B. TRANSVERSE DIRECTION (F_v)

$F_X = (W_1 + .5W_2)\ G_1 + OL_T$ $Ty = F_X X_2$ $M_Z = F_X (X_3 + X_4)$ B

$S_{SX} = S_{SSX} + \frac{F_X}{T_9 T_2}$ SHEAR (PSI) See Page 42A for derivation of S_{SSX}

$S_{TZ} = \frac{6\ X_4\ Ty}{T_5 T_9 T_2^2} + \frac{M_Z\ T_5}{2\ J_3} + S_{BX}$ TENSILE (PSI) See Page 42B for derivation of S_{BX} B

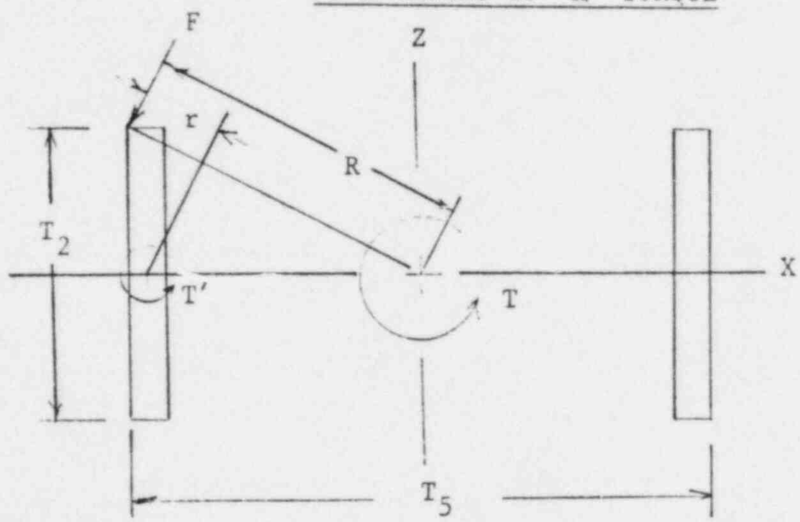
C. LONGITUDINAL DIRECTION (F_Z)

$F_Z = (W_1 + .5W_2)\ G_3$ $Ty = F_Z X_1$ $M_X = F_Z\ (X3 + X4)$

$S_{SZ} = \frac{Ty}{T_9 T_2 T_5} + \frac{F_Z}{T9\ T2}$ SHEAR (PSI)

$S_{TX} = \frac{6\ X_4\ Ty}{T_5\ T_9\ T_2^2} + \frac{M_X T_2}{2\ J_2}$

STRESSES ACTING ON THE BRACKET IN THE X DIRECTION AS A RESULT OF A TORQUE



$$F = \frac{T}{T_5} \qquad R = \sqrt{\left(\frac{T_2}{2}\right)^2 + \left(\frac{T_5}{2}\right)^2}$$

$$r = R - \frac{T_5}{2}\cos\theta \qquad \cos\theta = \frac{T_5}{\sqrt{T_2^{\,2}+T_5^{\,2}}}$$

$$r = \frac{\sqrt{T_2^{\,2} + T_5^{\,2}}}{2} - \frac{T_5^{\,2}}{2\sqrt{T_2^{\,2} + T_5^{\,2}}}$$

$$T' = r\,F$$

$$S_S = \frac{T(3a + 1.8b)}{8a^2\,b^2}$$ per Table IX, Case 4, Ref. (c)

$$a = \frac{T_2}{2} \qquad b = \frac{T_9}{2}$$

$$S_S = \frac{T}{T_5}\left(\frac{\sqrt{T_2^{\,2} + T_5^{\,2}}}{2} - \frac{T_5^{\,2}}{2\sqrt{T_2^{\,2} + T_5^{\,2}}}\right)\left(\frac{3\,\frac{T_2}{2} + 1.8\,\frac{T_9}{2}}{8\left(\frac{T_2}{2}\right)^2\left(\frac{T_9}{2}\right)^2}\right)$$

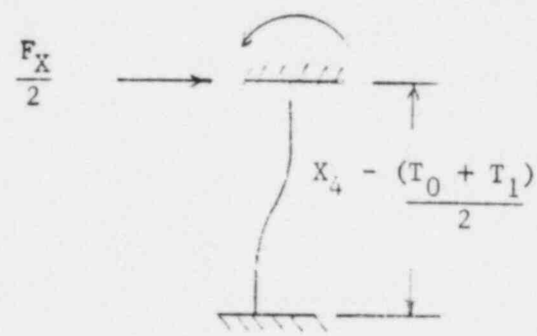
for S_{SSO} - T = Valve Operating Torque

for S_{SSX} - T = T_y

BRACKET STRESS DUE TO TRANSVERSE SHEAR

Maximum Bending Moment

$$M = \frac{\frac{F_X}{2}\left(X_4 - \left(\frac{T_0 + T_1}{2}\right)\right)}{2}$$



B

Section Modulus $= \frac{T_2 \; T_9^{\,2}}{6}$

Bending Stress $= S_{BX} = 1.5 \, \frac{F_X \; (X_4 - (T_0 + T_1)/2)}{T_2 \; T_9^{\,2}}$

ROOT SUM SQUARE STRESSES:

$S_{SS} = \sqrt{S_{SX}^2 + S_{SZ}^2 + S_S}$ SHEAR (PSI)

$S_{TS} = \sqrt{S_{Ty}^2 + S_{TZ}^2 + S_{TX}^2 + S_B}$ TENSILE (PSI)

MAXIMUM STRESS: MAX. STRESS THEORY

$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^2}$

BRACKET/VALVE BOLTING

LOCA STRESSES -

$S_{SOX} = \frac{2X_8 T}{N_2 A_2 X_9^2}$ $S_{SOZ} = \frac{2 X_7 T}{N_2 A_2 X_9^2}$

WHERE" T= LOCA TORQUE (IN-LBS)

N_2= NO. OF BRACKET BOLTS= 4

A_2= TENSILE STRESS AREA OF BOLTS (IN.)

$X_9 = \sqrt{X_7^2 + X_8^2}$

= EQUIVALENT BOLT DIA. (IN.)

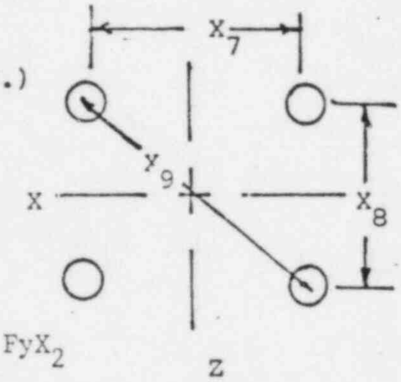


Figure 19

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$Fy = (W_1 + W_2) * G_2 + OL_V$ $M_Z = FyX_1$ $M_X = FyX_2$ E

$F_{RX} = \frac{M_X}{2X_8}$ $F_{RZ} = \frac{M_Z}{2X_7}$ $F_T = \frac{Fy}{N_2} + F_{RX} + F_{RZ}$ TOTAL TENSILE LOAD ON BOLT (LBS.)

$S_{Ty} = \frac{F_T}{A_2}$ TENSILE (PSI)

B. TRANSVERSE DIRECTION (F_X)

$F_X = (W_1 + W_2) * G_1 + OL_T$ $Ty = F_X X_2$ $M_Z = F_X (X_3 + X_4)$ E

$S_{SSX} = \frac{2X_8 Ty}{N_2 A_2 X_9^2} + \frac{F_X}{N_2 A_2}$ SHEAR (PSI)

$F_{RZ} = \frac{M_Z}{2X_7}$ $S_{TZ} = \frac{F_{RZ}}{A_2}$ TENSILE (PSI)

C. LONGITUDINAL DIRECTION (F_Z)

$F_Z = (W_1 + W_2) * G_3$ $Ty = F_Z X_1$ $M_X = F_Z (X_3 + X_4)$

$S_{SSZ} = \frac{2X_7 Ty}{N_2 A_2 X_9^2} + \frac{F_Z}{N_2 A_2}$

$F_{RX} = \frac{M_X}{2X_8}$ $S_{TX} = \frac{F_{RX}}{A_2}$ TENSILE (PSI)

ROOT SUM SQUARE STRESSES:

$$S_{SS} = \sqrt{(S_{SSX} + S_{SOX})^2 + (S_{SSZ} + S_{SOZ})^2}$$

$$S_{TS} = \sqrt{S_{Ty}^{\;2} + S_{TZ}^{\;2} + S_{TX}^{\;2}}$$

MAXIMUM STRESS: MAX. STRESS THEORY

$$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^{\;2}}$$

VALVE NECK -

OPERATING & LOCA STRESSES -

$$S_S = \frac{T_C}{J_1} \quad \text{SHEAR}$$

W_3 = Weight of Valve Neck (LBS)

$$J_1 = \frac{8(T3/2)^2(T4/2)^3}{3\,T3/2 + 1.8\,T4/2} - \frac{8(R5/2 + R6)^2(T4/2)^3}{3(R5/2 + R6) + 1.8\,T4/2}$$

$$+ \frac{8(R5/2)^2(T4/2)^3}{3(R5/2) + 1.8\,T4/2} - \frac{\pi}{32}\,Di^4$$

A Based on sheer stress equation given in Table IX, Case 4, of Ref. (c)

OR $J_1 = \frac{\pi}{32}(d_3^{\;4} - Di^4)$

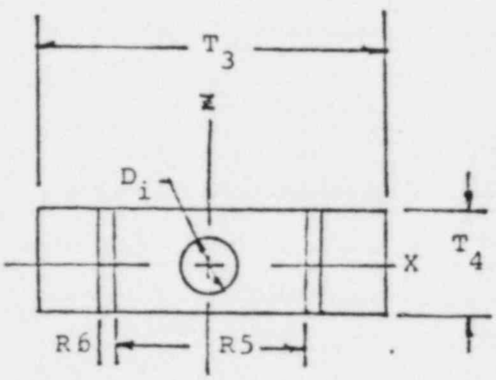


Figure 20

$C = \frac{T4}{2}$ DIST. TO MAX. FIBER STRESS

$$S_P = P\left[\frac{T_4^{\;2} + Di2}{T_4^{\;2} - Di2}\right] \text{ OR } P\left[\frac{d_3^{\;2} + Di2}{d_3^{\;2} - Di2}\right] \quad \text{HOOP (PSI)}$$

Based on hoop stress equation given in Table XIII, Case 33, of Ref. (c).

T_4 & d_3 = 26 Di = 2a

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$Fy = (W_1 + W_2 + W_3)*G_2 + OL_V \quad M_Z = FyX_1 \quad M_X = FyX_2$ B

$$S_{Ty} = \frac{Fy}{A} + \frac{M_Z T_3}{2J_3} + \frac{M_X T_4}{2J_2} \quad \text{TENSILE (PSI)}$$

$A = (T_3 - 2R_5)T_4 - \pi \frac{Di^2}{4}$

OR

$A = \frac{\pi}{4}(d_3 2 - {}_{Di}2)$ (in^2)

$$J_2 = \frac{(T3 - 2R_6)T_4 3}{12} - \frac{\pi}{64} Di^4 \text{ OR } \frac{\pi}{64}(d_3 4 - Di^4)$$

$$J_3 = \frac{T_4 T_3 3}{12} - \frac{2R_5^{\;3} T_4}{12} - 2R_5 T_4 (R_6/_2 + R_5/_2)2 - (\frac{\pi}{64} Di4) \text{ OR } \frac{\pi}{64}(d_3 4 - Di^4)$$

B. TRANSVERSE DIRECTION (F_X)

$F_X = (W_1 + W_2 + W_3)*G_1 + OL_T \quad Ty = F_X X_2 \quad M_Z = F_X(X_3 + X_4 + X_5)$ B

$$S_{SX} = \frac{TyT4}{2J_1} + \frac{F_X}{A} \quad \text{SHEAR (PSI)}$$

$$S_{TZ} = \frac{M_Z T_3}{2J_3} \quad \text{TENSILE (PSI)}$$

C. LONGITUDINAL DIRECTION (F_Z)

$F_Z = (W_1+W_2+W_3)*G_3 \quad Ty = F_Z X_1 \quad M_X = F_Z(X_3 + X_4 + X_5)$

$S_{SZ} = \frac{TyT4}{2J_1} + \frac{F_Z}{A}$ SHEAR (PSI)

$S_{TX} = \frac{MxT4}{2J_2}$ TENSILE (PSI)

ROOT SUM SQUARE STRESSES:

$S_{SS} = \sqrt{S_{SX}^2 + S_{SZ}^2} + S_S$ SHEAR (PSI)

$S_{TS} = \sqrt{S_{Ty}^2 + S_{TZ}^2 + S_{TX}^2} + S_P$ TENSILE (PSI)

MAXIMUM STRESS: MAX. STRESSTHEORY

$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^2}$

Valve with Gussets

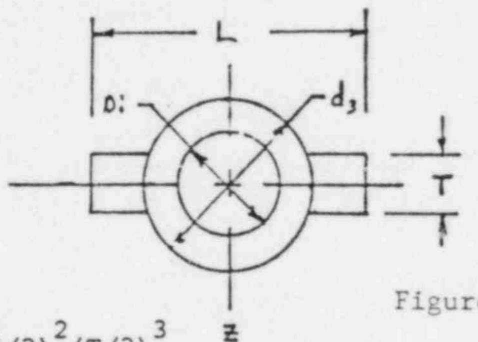


Figure 2

$J_1 = J_1 + \frac{8\ (L/2)^2 (T/2)^3}{3(L/2)+1.8(T/2)} - \frac{8(d3/2)^2 (T/2)^3}{3(d3/2) + 1.8(T/2)}$

$C = \frac{d_3}{2}$

$J_2 = J_2 + \frac{(L - d_3)\ T^3}{12}$

$J_3 = J_3 + \frac{T \left[\frac{L - d_3}{2}\right]^3}{6} + 2\ (L - d_3)\ T \left[\frac{L + d_3}{4}\right]^2$

$A = A + (L - d_3)T \qquad W_3 = A * X5 * .283$

$S_{Ty} = \frac{Fy}{A} + \frac{Mz\ L}{2J_3} + \frac{Mx\ d_3}{ZJ_2}$

$S_{SX} = \frac{Ty\ d_3}{2J_1} + \frac{Fx}{A} \quad ST_z = \frac{Mz\ L}{2J_3}$

$S_{SZ} = \frac{Tyd_3}{2J_1} + \frac{Fz}{A} \quad ST_X = \frac{Mxd_3}{2J_2}$

VALVE STEM:

OPERATING & LOCA STRESSES -

$$S_S = \frac{16T}{\pi D_1^3} \quad \text{SHEAR (PSI)}$$

$$F = \frac{1}{2}\frac{P}{A} = \frac{\pi P D^2}{8} \quad \tfrac{1}{2} \text{ APPLIED FORCE ON DISC (LBS.)}$$

THE EFFECTIVE BEARING LENGTH IS DERIVED AS FOLLOWS:

$S_y = \frac{F}{A}$ WHERE A = PROJECTED BEARING AREA
$= L_1 D_1$ = EFFECTIVE BEARING LENGTH TIMES THE STEM DIAMETER.

$$S_y = \frac{F}{L_1 D_1}$$

SINCE THE LOAD IS ASSUMED TO BE TRIANGULAR, HALF OF THE YIELD STRENGTH (OR 15000 psi) IS USED.

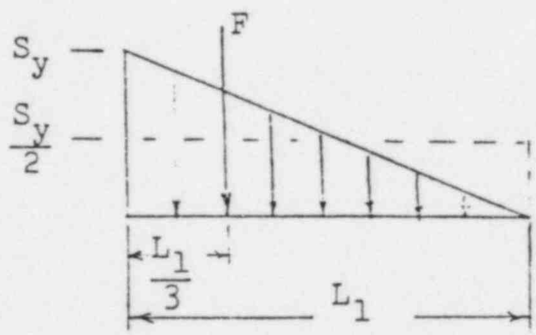


Figure 22

THEREFORE, $L_1 = \frac{F}{15000\ D_1}$

AS CAN BE SEEN IN THE FIGURE ABOVE, IT IS ASSUMED THE RESULTANT BEARING REACTION OCCURS AT $L_1/3$.

$$S_b = \frac{4PD^2}{D_1^3}\left[\frac{L1}{3} + L_2\right] \quad \text{BENDING DUE TO PRESSURE (PSI)}$$

WHERE $\left[\frac{L1}{3} + L_2\right]$ EQUALS LENGTH OF STEM FROM THE END OF DISC TO THE BEARING REACTION.

SEISMIC STRESSES -

$$M = \frac{W4g}{2}\left[\frac{L1}{3} + L_2\right] \qquad g = \sqrt{g_x^{\,2} + g_z^{\,2}}$$

$$S_b1 = \frac{32M}{\pi D_1 3} = \frac{16\ W4g}{\pi D_1 3}\left[\frac{L1}{3} + L_2\right] \qquad \text{BENDING (PSI)}$$

$$S_{bs} = S_b + S_b1$$

MAXIMUM STRESS: MAX. STRESS THEORY

$$S_t = \frac{Sbs}{2} + \sqrt{\left[\frac{Sbs}{2}\right]^2 + Ss^2}$$

VALVE DISC PIN:

$$S_S = \frac{2(\%/100)T}{D_1 As} \qquad \text{SHEAR STRESS (PSI)}$$

T = Torque due to LOCA

% = Percentage of torque taken up by the top pin. See the sketch below for the two different pinning configurations. A

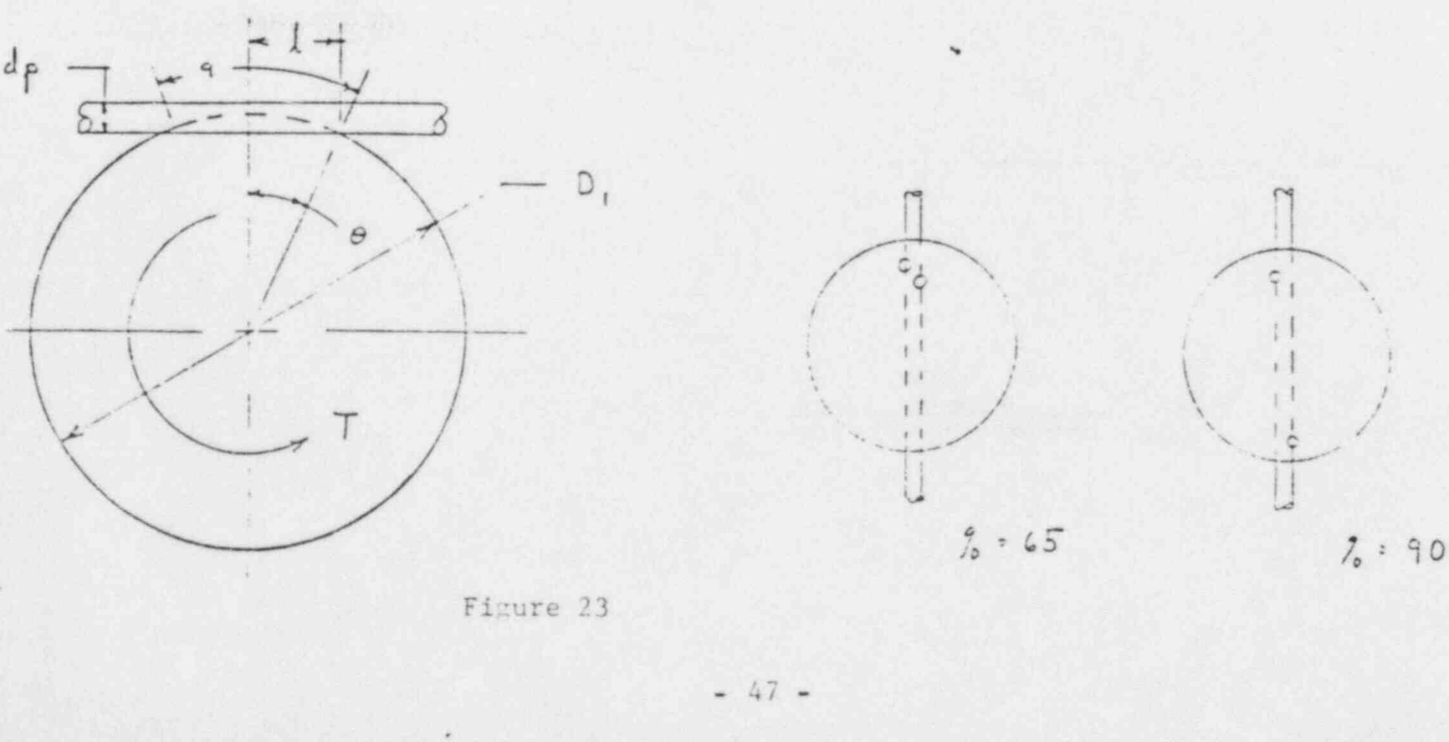


Figure 23

$As = .7854\ adp$ SHEAR AREA (IN^2) along chordal length a

$a = .01745\ D_1\theta$ ARC. LENGTH (IN.)

$\theta = SIN^{-1}(\frac{2l}{D_1})$

$l = \sqrt{dp(\frac{D1}{2}) - \frac{dp^2}{4}}$ CHORDAL LENGTH

VALVE AND PIPING SECTION MODULUS:

$Zv = \frac{\pi}{32d_1}(d_1{}^4 - R_7{}^4)$ SECTION MODULUS OF VALVE (IN^3)

$Zp = \frac{\pi}{32\ R8}(R_8{}^4 - R_9{}^4)$ SECTION MODULUS OF ADJACENT PIPING (IN^3)

$Zv > 1.1Zp$

WHERE: d_1= VALVE BODY O.D. (IN.)

R_7= VALVE BODY WATERWAY DIA. (IN.)

R_8= O.D. OF ADJACENT PIPING (IN.)

R_9= I.D. OF ADJACENT PIPING (IN.)

DEFLECTIONS:

$$\Delta X = \frac{(W_1 + .5\ W_2)\ g_{x,y}}{K_x} \qquad g_{x,y} = \sqrt{G_1{}^2 + G_2{}^2}$$

$$g_{z,y} = \sqrt{G_3{}^2 + G_2{}^2}$$

$$\Delta Z = \frac{(W_1 + .5\ W_2)\ g_{z,y}}{K_z} \qquad K_{x,z} = \text{Springrate (lbs/in)}$$

VALVE BODY BOLTING:

$F = \frac{4}{X_O N_3}\left[\ Cos\ \frac{\pi}{N_3}\ \right] M_4$ MAXIMUM BOLT LOAD (LBS)

$S_T = \frac{F}{A4}$ TENSILE STRESS (PSI)

WHERE: M_4= MAXIMUM PIPING MOMENT (IN-LBS)

N_3= NO. OF BODY BOLTS

X_O= D_{BC} OF BODY BOLTS (IN)

A_4= ROOT AREA OF BODY BOLTS (IN^2)

NOTE: NOT APPLICABLE IF BODY IS WAFER STYLE OR THE ALLOWABLE MATERIAL STRENGTH OF VALVE EXCEEDS THAT OF ADJACENT PIPING, OR IF THE VALVE SECTION MODULUS IS 1.1 TIMES GREATER THAN THAT OF THE ADJACENT PIPE AS DETERMINED ABOVE. PIPING MAT'L ASSUMED SA106 GR.B S ALLOW = 15,000

DISC STRESSES

Shown on Pages 48D and E are the equations Posi-Seal uses for analyzing the disc when subject to design pressure.

For the purpose of this report the disc will be analyzed for two cases. For the first case, stresses will be calculated due to the LOCA flow acting on the disc, the pressure drop due to the LOCA flow acting across the disc and due to seismic loads. The second case will analyze the disc stresses due to the full pressure drop acting across the disc in the shut position and due to seismic loads.

Case 1

Moments about the X - axis

A. LOCA

$M_{XL} = T_{LOCA}$ (LOCA Torque)

B. Pressure Drop

To determine M_{XP} for this case the flow pressure drop is substituted into the equation for M_X on Page 48D.

C. Seismic

$F_S = W_4 \sqrt{G_1^2 + G_3^2} / 2$ per side

$M_{XS} = \frac{4 D F_S}{3\pi}$

$$\sum M_X = M_X = M_{XL} + M_{XP} + M_{XS}$$

To determine the stress M_X is substituted into the equation for σ_X on Page 48D.

Moments about the Y - axis

A. LOCA

For this analysis it will be assumed that the bearing reaction is equal to half the LOCA torque divided by the distance from the disc centerline to the centroid. The resulting M_Y is as follows:

$$M_{YL} = \frac{1}{2} \frac{T_{LOCA}}{\frac{2D}{3\pi}} \left[\frac{D}{2} + L_2 + \frac{L_1}{3}\right]$$

B. Pressure Drop

M_{XP} is determined by substituting the flow pressure drop into the equation for M_Y on Page 48E.

C. Seismic

$$M_{YS} = F_S \left[\frac{D}{2} + L_2 + \frac{L_1}{3}\right]$$

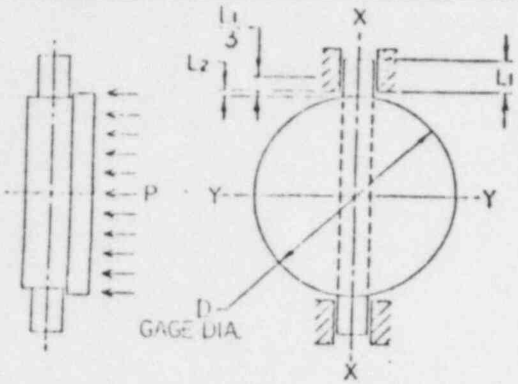
$$\sum M_Y = M_Y = M_{YL} + M_{YP} + M_{YS}$$

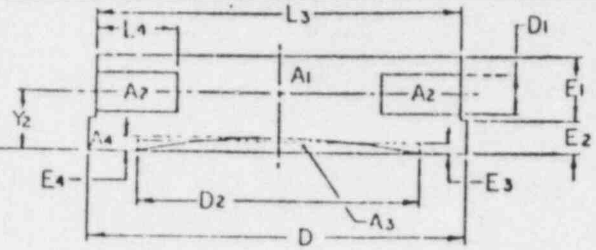
The stress due to M_Y is calculated using the equation for σ_Y on Page 48E.

The combined stress is then calculated using the equation for σ_C on Page 48E.

Case 2

This case is the same as Case 1 except the moments due to flow are not determined and the pressure used in the equations for M_X and M_Y is the pressure when the disc is closed.





NOTE 1: FOR EASE OF CALCULATING A_3 ASSUME AN EQUIVILANT RECTANGLE IN LIEU OF CIRCLE SEGMENT.
$E_3 = 0.667 E_4 = 0.667$ ( ) = ____ IN.
NOTE 2: FOR THRU SHAFT ONLY USE $\frac{1}{2} L_3$ FOR L_4.

D =	____ IN.
D_1 =	____ IN.
D_2 =	____ IN.
L_2 =	____ IN.
L_3 =	____ IN.
L_4 =	____ IN.
E_1 =	____ IN.
E_2 =	____ IN.
E_4 =	____ IN.
Y_2 =	____ IN.

CALCULATION OF $\bar{Y}_x$:

$A_1 = L_3 E_1 = (\quad)(\quad)$ A_1 = ____ IN^2
$A_2 = 2L_4 D_1 = 2(\quad)(\quad)$ A_2 ____ IN^2
$A_3 = D_2 E_3 = (\quad)(\quad)$ A_3 ____ IN^2
$A_4 = D\ E_2 = (\quad)(\quad)$ A_4 ____ IN^2

$Y_1 = E_2 + .5E_1 = (\quad) + .5(\quad)$ Y_1 = ____ IN.
$Y_3 = .5E_3 = .5(\quad)$ Y_3 = ____ IN.
$Y_4 = .5E_2 = .5(\quad)$ Y_4 = ____ IN.

$$\bar{Y}_x = \text{DISTANCE FROM DATUM TO NEUTRAL AXIS} = \frac{A_1Y_1 - A_2Y_2 - A_3Y_3 + A_4Y_4}{A_1 - A_2 - A_3 + A_4} = \frac{(\quad)(\quad) - (\quad)(\quad) - (\quad)(\quad) + (\quad)(\quad)}{(\quad) - (\quad) - (\quad) + (\quad)}$$ $\bar{Y}_x$ = ____ IN.

CALCULATION OF I_x:

$$I_x = \frac{L_3 E_1^3}{12} + A_1(|\bar{Y}_x - Y_1|)^2 - \frac{2L_4 D_1^3}{12} - A_2(|\bar{Y}_x - Y_2|)^2 - \frac{D_2 E_3^3}{12} - A_3(|\bar{Y}_x - Y_3|)^2 + \frac{D E_2^3}{12} + A_4(|\bar{Y}_x - Y_4|)^2$$

$$I_x = \frac{(\quad)(\quad)^3}{12} + (\quad)(\quad - \quad)^2 - \frac{2(\quad)(\quad)^3}{12} - (\quad)(\quad - \quad)^2 - \frac{(\quad)(\quad)^3}{12} - (\quad)(\quad - \quad)^2 + \frac{(\quad)(\quad)^3}{12} + (\quad)(\quad - \quad)^2$$

I_x = ____ IN^4

CALCULATION OF M_x:

$$M_x = \frac{0.2122\ \pi D^3 P}{8} = \frac{0.2122\ \pi (\quad)^3 (\quad)}{8}$$

M_x = ____ IN.-LBS.

CALCULATION OF σ_x:

$$\sigma_x = \frac{M_x(E_1 + E_2 - \bar{Y}_x)}{I_x} = \frac{(\quad)(\quad + \quad - \quad)}{(\quad)}$$

σ_x = ____ PSI

DISC MATERIAL ____
DESIGN PRESSURE (P) ____
DESIGN TEMPERATURE ____
MIN. YIELD ____
ALLOWABLE STRESS ____

SHEET NO. 1 OF 2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON
DECIMALS ±.005
FRACTIONS ±1/64
ANGLES ±1/2°
DO NOT SCALE DWG.
BREAK ALL SHARP EDGES .005 TO .015 RAD

DRAWN | DATE
CHECKED
APPROVED
APPROVED

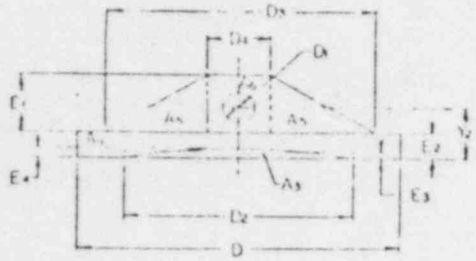
POSI SEAL INTERNATIONAL INC.
WESTERLY, R.I.

TITLE
STRESS REPORT
DISC - LB- WCG

SIZE C | SCALE | DRAWING NUMBER | REV

LTR | REVISION | APPVD | DATE

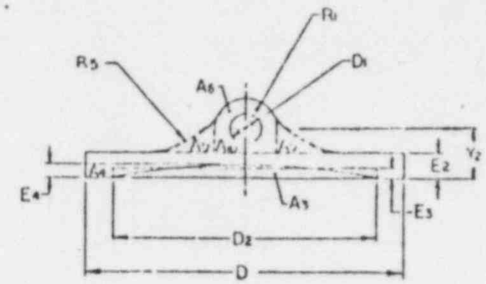
TYPE (1)



D3= ______ IN

D4= ______ IN

TYPE (2)



R_5 = ______ IN

L_6 = ______ IN

E_5 = ______ IN

R_1 = ______ IN

$R = R_1 + R_5 =$ ______

$Z = R_5 - Y_2 + E_2 =$ ______

$A_0 = \text{ARCCOS}\left(\frac{Z}{R}\right) =$ ______

$H = R_5\left(1 - \cos\left(\frac{A_0}{2}\right)\right) =$ ______

$E_5 = \frac{R_5 Z}{R} + Y_2 - E_2 - \frac{H}{2\cos A_0}$

$L_6 = 2\sqrt{R^2 - Z^2} - \frac{H}{\sin A_0}$

CALCULATION OF $\bar{Y}_T$ (TYPE 1)

$A_5 = .5(D_3 - D_4)E_1 = .5(\quad - \quad X \quad)$ $A_5 =$ ______ IN^2

$A_6 = D_4 E_1 = (\quad X \quad)$ $A_6 =$ ______ IN^2

$Y_5 = .33E_1 + E_2 = .33(\quad) + (\quad)$ $Y_5 =$ ______ IN

$Y_6 = .5E_1 + E_2 = .5(\quad) + (\quad)$ $Y_6 =$ ______ IN

$\bar{Y}_T = \frac{A_4 Y_4 - A_3 Y_3 + A_6 Y_6 + A_5 Y_5}{A_4 - A_3 + A_6 + A_5} = \frac{(\quad X \quad) - (\quad X \quad) + (\quad)(\quad) + (\quad)(\quad)}{(\quad) - (\quad) + (\quad) + (\quad)}$

$\bar{Y}_T =$ ______ IN

CALCULATION OF I_T (TYPE 1)

$I_T = \frac{D E_2^3}{12} + A_4(\bar{Y}_T - Y_4)^2 - \frac{D_2 E_3^3}{12} - A_3(\bar{Y}_T - Y_3)^2 + \frac{D_4 E_1^3}{12} + A_6(\bar{Y}_T - Y_6)^2 + \frac{(D_3 - D_4)E_1^3}{36} + A_5(\bar{Y}_T - Y_5)^2$

$I_T = \frac{(\quad X \quad)^3}{12} + (\quad X \quad - \quad)^2 - \frac{(\quad X \quad)^3}{12} - (\quad X \quad - \quad)^2 + \frac{(\quad X \quad)^3}{12} + (\quad X \quad - \quad)^2 + \frac{(\quad - \quad X \quad)^3}{36} + (\quad X \quad - \quad)^2$

$I_T =$ ______ IN^4

CALCULATION OF $\bar{Y}_T$ (TYPE 2)

$A_9 = .5(L_6 - 2R_1)E_5 = .5[\quad - 2(\quad)](\quad)$ $A_9 =$ ______ IN^2

$A_{10} = 2R_1(Y_2 - E_2) = 2(\quad)(\quad - \quad)$ $A_{10} =$ ______ IN^2

$A_8 = 1.57R_1^2 = 1.57(\quad)^2$ $A_8 =$ ______ IN^2

$Y_9 = .33E_5 + E_2 = .33(\quad) + (\quad)$ $Y_9 =$ ______ IN

$Y_{10} = .5(Y_2 + E_2) = .5(\quad + \quad)$ $Y_{10} =$ ______ IN

$Y_8 = .424R_1 + Y_2 = .424(\quad) + (\quad)$ $Y_8 =$ ______ IN

$\bar{Y}_T = \frac{A_4 Y_4 - A_3 Y_3 + A_{10} Y_{10} + A_9 Y_9 + A_8 Y_8}{A_4 - A_3 + A_{10} + A_9 + A_8} = \frac{(\quad X \quad) - (\quad X \quad) + (\quad X \quad) + (\quad X \quad) + (\quad X \quad)}{(\quad) - (\quad) + (\quad) + (\quad) + (\quad)}$

$\bar{Y}_T =$ ______ IN

CALCULATION OF I_T (TYPE 2)

$I_T = \frac{D E_2^3}{12} + A_4(\bar{Y}_T - Y_4)^2 - \frac{D_2 E_3^3}{12} - A_3(\bar{Y}_T - Y_3)^2 + \frac{2R_1(Y_2 - E_2)^3}{12} + A_{10}(\bar{Y}_T - Y_{10})^2 + \frac{(L_6 - 2R_1)E_5^3}{36} + A_9(\bar{Y}_T - Y_9)^2 + .1098R_1^4 + A_8(\bar{Y}_T - Y_8)^2$

$I_T = \frac{(\quad X \quad)^3}{12} + (\quad X \quad - \quad)^2 - \frac{(\quad X \quad)^3}{12} - (\quad X \quad - \quad)^2 + \frac{2(\quad X \quad - \quad)^3}{12} + (\quad X \quad - \quad)^2 + \frac{[\quad - 2(\quad)](\quad)^3}{36} + (\quad X \quad - \quad)^2 + .1098(\quad)^4 + (\quad X \quad - \quad)^2$

$I_T =$ ______ IN^4

CALCULATION OF M_T

$L_1 = \frac{PD^2}{.7419 \cdot D_1} = \frac{(\quad X \quad)^2}{.7419 \cdot (\quad)}$ $L_1 =$ ______ IN

$M_T = \frac{\pi L_1^2 P}{6}\left[\left(\frac{D}{2} + L_2 + \frac{L_1}{3}\right) - .2122D\right] = \frac{\pi(\quad)^2(\quad)}{8}\left[\left(\frac{(\quad)}{2} + (\quad) + \frac{(\quad)}{3}\right) - .2122(\quad)\right]$

$M_T =$ ______ IN-LBS

CALCULATION OF σ_T

$\sigma_T = \frac{M_T(E_1 + E_2 - \bar{Y}_T)}{I_T} = \frac{(\quad)(\quad + \quad - \quad)}{(\quad)}$

$\sigma_T =$ ______ PSI

CALCULATION OF σ_C (COMBINED STRESS)

$\sigma_C = \sqrt{\sigma_x^2 + \sigma_T^2 - \sigma_x \sigma_T} = \sqrt{(\quad)^2 + (\quad)^2 - (\quad X \quad)}$

$\sigma_C =$ ______ PSI

SHEET NO 2 OF 2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON		DRAWN	DATE	POSI SEAL INTERNATIONAL INC WESTERLY, R.I.
DECIMALS	± .025	CHECKED		STRESS REPORT
FRACTIONS	± 1/64	APPROVED		SEC - LB- WOG
ANGLES	± 1/2°	APPROVED		
DO NOT SCALE DWG				

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DETAILED ANALYSIS

Determination of LOCA Torques

Per Reference (g) when a LOCA occurs the pressure inside containment will increase to 50 psig and the temperature of 300 degrees F.

Since the make up of the media is not known, two conditions are analyzed for each of the three cases in order to insure that the largest aerodynamic torque is determined. The two conditions are air and steam.

The results of the LOCA analysis are given in Appendix B.

As can be seen in Appendix A, Cases 1 and 2, there is bend upstream of Valve VADPBC-09. Therefore, the effects of these bends on the aerodynamic torques during a LOCA have to be determined.

Posi-Seal has performed an investigation to determine what effect a pipe bend will have. To date this investigation has not revealed anything Posi-Seal can use with confidence. Consequently, Posi-Seal has taken the following approach:

1. Assume the flow results in a resultant load acting at the midpoint between the edge of the disc and the stem center line.

2. Determine the load based on the principles of impulse and momentum.

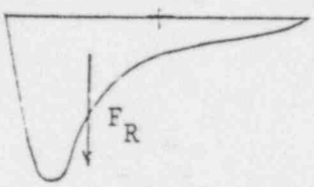
3. Calculate the resulting torque choosing the angle of attack which results in the worst case when added to the aerodynamic torque of the normal flow thru the valve.

The assumption that the flow resultant acts at the midpoint between the edge of the disc and the stem center line with a bend upstream is based on the following:

1. For flow through a straight pipe the largest aerodynamic torque will occur at 80 degrees open for flow in the preferred direction and 90 degrees for flow in the nonpreferred direction. This torque is predominately due to the lift and drag forces acting on the disc. Only a small amount of torque is due to the flow impacting on the disc since the moment arm is relatively small.

2. It is assumed that the resultant of the flow impacts the disc at the midpoint between the disc edge and the stem center line throughout the closure from 90 degrees open to fully closed. Although this may not be conservative at the smaller angles, it will result in very conservative results at 80 and 90 degrees where the maximum torques due to the lift and drag forces occur. See the diagram below.

Figure 24



Velocity profile with resultant acting at midpoint between disc edge and stem ℄

Valve at 80 degrees

Velocity profile acting on the disc at 80 degrees and the corresponding resultant.

Posi-Seal uses the full value of F_R throughout the valve closure.

The magnitude of the force impacting the disc is determined by using the principles of impulse and momentum as follows:

$$\Delta M\ V_1 + F\ \Delta t = \Delta M\ V_2$$

$$V_2 = 0$$

$$\Delta M V_1 = F\ \Delta t$$

where ΔM = Change in mass - lbm

V = Velocity - ft/sec

F = Force - lbs

Δt = Change in time

$$\Delta M = \frac{A\ \rho V\ \Delta t}{g}$$

where A = Area - ft^2

ρ = Density - lbm/ft^3

g = Gravitational Constant

$W = A\ \rho V$ = Flow - lbs/sec

$$\frac{W\ V_1}{g}\ \Delta t = F\ \Delta t$$

$$F = \frac{W\ V_1}{g}$$

$$W = \frac{.0764\ Q\ G}{3600}$$

where Q = Flow - SCFH

$$F = \frac{.0764\ Q\ V}{32.2\ (3600)} = \frac{Q\ V\ G}{1.517X10^6}$$

DETERMINATION OF AERODYNAMIC TORQUES RESULTING FROM A BEND

The orientation of Valve VADPBC-09 relative to the end is as shown below. Flow is in the nonpreferr-d direction.

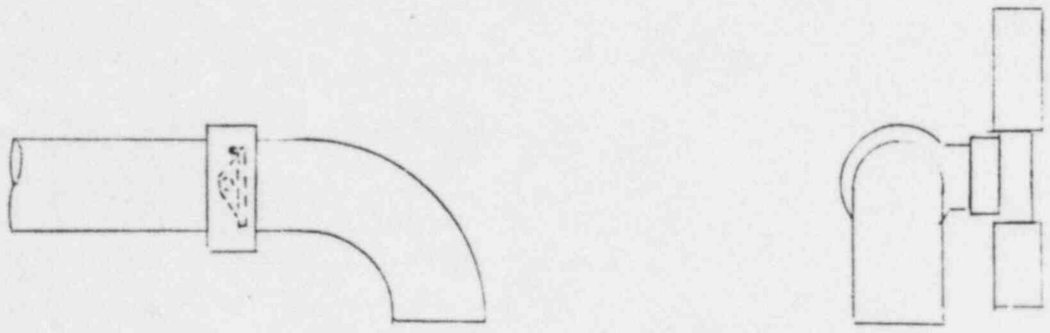


Figure 25

Since Case 2A resulted in much larger flows and aerodynamic torques than did Case 1A just Case 2A will be investigated.

The determination of the flow resultant force for both air and steam is as follows:

Air (G = 1.0)

Degree	Q	V	F
	(Per Appendix B, Case 2A)		
90	8,549,000	528	2976
80	8,549,000	558	3144
70	7,760,000	534	2732
60	6,131,000	548	2214
50	4,522,000	512	1526
40	3,042,000	401	804
30	1,860,000	266	495
20	942,000	139	86
10	476,000	71	22

Steam (G = .62)

Degree	Q	V	F
(Per Appendix B, Case 2A, Cond. 1)			
90	10,140,000	627	2598
80	10,140,000	658	2727
70	9,345,000	634	2421
60	7,548,000	666	2055
50	5,578,000	642	1464
40	3,762,000	516	793
30	2,303,000	346	327
20	1,166,000	182	87
10	590,000	93	22

Since the air resulted in higher forces just the resulting torques from the air are calculated.

R = Radius corrected for the component acting normal to the disc at the worst angle of attack. A

$$R = \frac{D}{4} \cos(45-\theta) = \frac{16.659}{4} \cos(45-\theta) = 4.16 \cos(45-\theta)$$

See Figure 26 on Page 57 for the determination that the angle of 45 degrees represents the worst case.

Degree	R	T_{Bend} +	T_{LOCA} (Per Appendix B) =	T_T
90	2.94	- 8761	15640	6879
80	3.41	-10720	1620	- 9100
70	3.77	-10310	- 3035	-13350
60	4.02	- 8903	- 549	- 9452
50	4.15	- 6329	1566	- 4763
40	4.15	- 3335	2190	- 1145
30	4.02	- 1991	2390	399
20	3.77	- 324	2470	2146
10	3.41	- 75	2485	2410

DETERMINATION OF CLOSING TIMES

Based on the aerodynamic torques determined in Appendix B and the preceding pages, the closing times are calculated using the computer programs "FLOW-CL" and "FLOW-CL1". The results of these calculations are shown in Appendix C.

As can be seen on Pages C-2 Valve VADPBC-09 will not close when subject to a LOCA in the full open position. When all the valves are restricted to 65 degrees open, the closing times are less than the closing times for no flow and less than the required time of 5.0 seconds.

Shown in Appendix D is a comparison of the calculated closing time to that actually measured.

The measured times which were recorded prior to shipment of the valves were as follows:

PSI Item No.	Tag No.	Closing Time (Sec)
14758-2A	CP1-VADPBC-09	1.5
2B	10	1.0
14759-2A	CP2-VADPBC-09	2.5
2B	10	2.5

Posi-Seal believes the difference in closing times between those for Unit 1 and those for Unit 2 to be attributed to the difference in quick exhaust valves. This belief is based on Matryx Certified Actuator Drawings not calling out the specific make or model of the quick exhausts.

Posi-Seal, in performing the closing time analysis, assumed the quick exhausts to be Parker-Hannifin OR-37s. As can be seen in Appendix D the calculated time was approximately the same as for Valve CP1-VADPBC-09. Posi-Seal felt justified in using the C_v for two OR-37s, since, for the case where flow is resisting closure if the valve could not meet the required closing time with this C_v, it could not meet it with a smaller C_v.

As it turns out, with restricting the valve opening to 65 degrees, the LOCA flow will assist closure, thus the closing times will be less than for the no flow condition.

SEISMIC ANALYSIS

Since the fundamental natural frequency of the subject valves is less than 33 Hz, the input accelerations are taken from Reference (h). Because the valves are located at an elevation of 879'6" and the response accelerations at 905.75' are greater than those at 860', the maximum response accelerations at 905.75' are used for the seismic analysis. These accelerations are 3.2 Gs in the vertical direction and 2.6 in the horizontal direction.

For Valve VADPBC-10 which has its actuator mounted on the bottom, one G is added to the vertical acceleration input to account for the actuator dead weight.

Since the seismic analysis is based on the vertical axis (y) being the axis in which the weight of the actuator acts and the transverse axis (x) being perpendicular to the pipeline, the relative orientation for Valve VADPBC-09 has to be changed for the analysis. The reason being, the actuator for this valve is mounted on the side. See Figure 25 and Page 52.

With the actuator on the side, for the purpose of the analysis the vertical direction becomes the transverse direction and vice versa. As a consequence, one G is added to the transverse acceleration for the actuator dead weight.

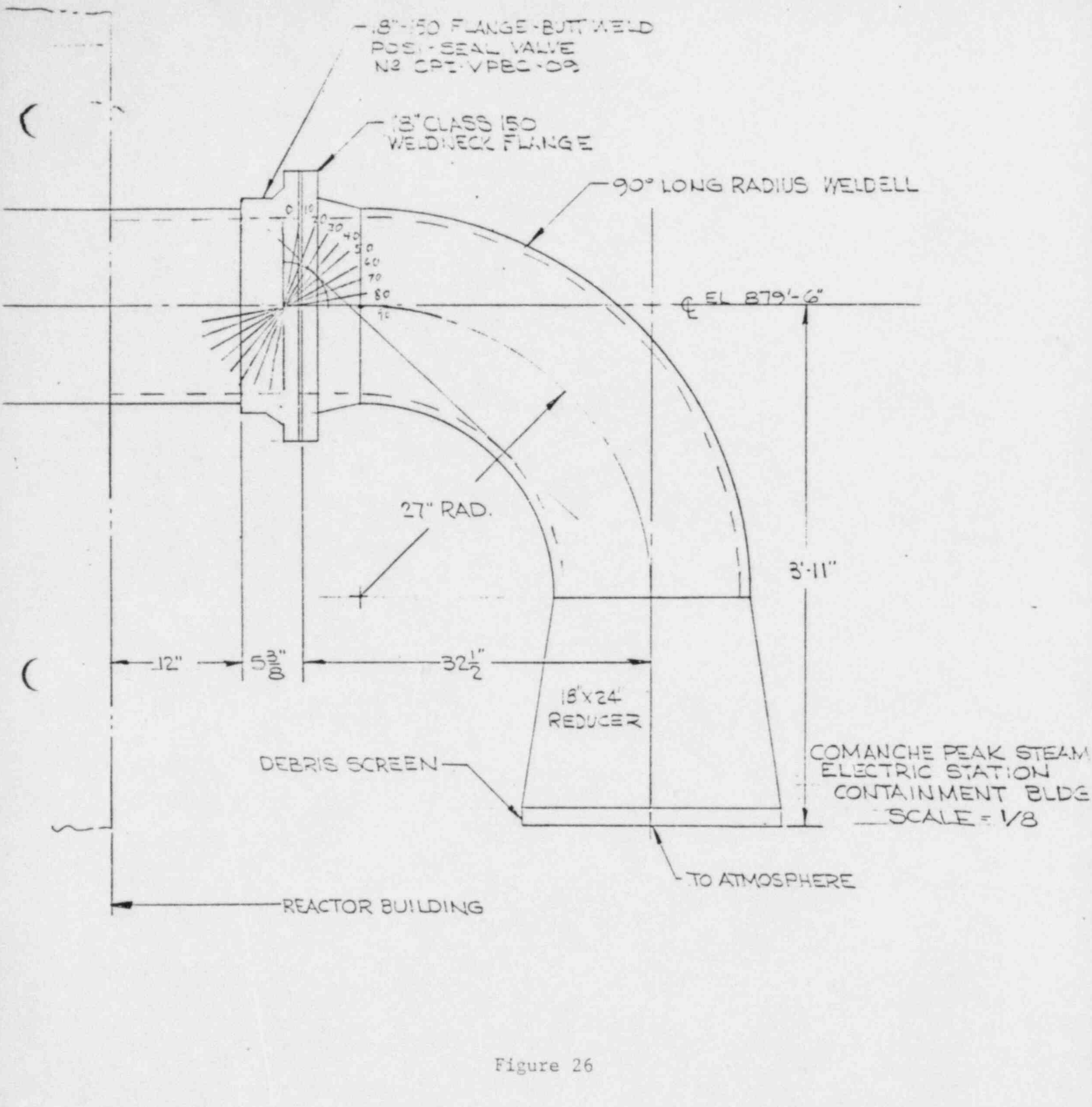
It should be noted that 10 lbs. has been added to the actuator weight to take into consideration the weight of the internal stop used to restrict the valve opening to 65 degrees.

Shown on Page E-3 of Appendix E is the seismic analysis for VADPBC-10 fully open with the largest aerodynamic torque calculated applied. As can be seen, the disc pin stress exceeds the allowable.

On Pages E-9 and E-15 are the seismic analyses for Valve VADPBC-10 and 09, respectively, with the amount of valve opening restricted to 65 degrees.

It should be noted that the occasional load is a 500 lb. load which acts in the vertical direction. Consequently, for valve VADPBC-10 which is installed upside down the vertical load acts in the vertical direction for the purpose of the analysis. However, for valve VADPBC-09 which is mounted such that the actuator is on the side, the vertical load acts in the transverse direction.

B



18"-150 FLANGE-BUTTWELD
POSI-SEAL VALVE
Nº CPI-VPBC-09
18" CLASS 150
WELDNECK FLANGE
90° LONG RADIUS WELDELL
℄ EL 879'-6"
27" RAD.
3'-11"
12"
5 3/8"
32 1/2"
18"x24"
REDUCER
DEBRIS SCREEN
COMANCHE PEAK STEAM
ELECTRIC STATION
CONTAINMENT BLDG
SCALE = 1/8
TO ATMOSPHERE
REACTOR BUILDING

Figure 26

APPENDIX A

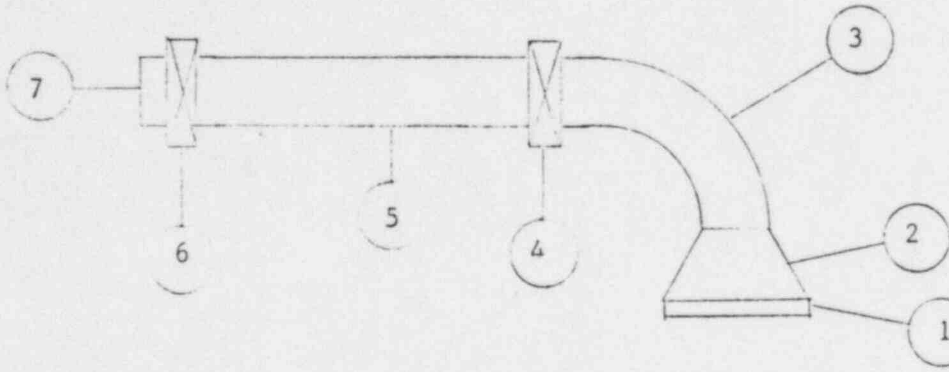
Schematics of the Piping Systems

CASE 1

18" - 150 Class Valves CP1-VADPBC-09 & 10

Piping outboard of Valve CP1-VADPBC-10 breaks off.

The resulting system is as shown below.



Station No.	Type of Resistance (No)	
1	Entrance (1)	K = .5 D_{in} = 24"
2	Reducer (2)	D_{in} = 24" D_{out} = 18"
3	90° Bend (5)	K = 12 f_t = .14
4	Valve (7) Flow in the Nonpreferred Direction	C_v = 11053
5	Straight Pipe (4)	L = 9.5'
6	Valve (7) Flow in the Preferred Direction	C_v = 11053
7	Exit (8)	K = 1.0 D_{out} = 18"

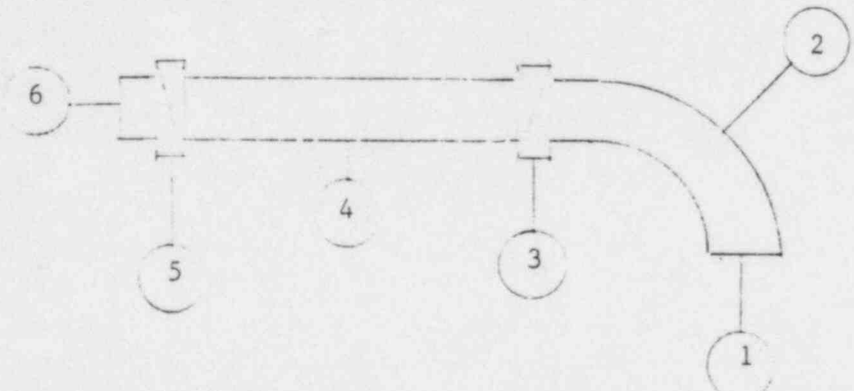
Case 1 A Valve 9 cycles closed
B Valve 10 cycles closed

CASE 2

18" - 150 Class Valves CP1-VADPBC-09 & 10

Reducer in front of valve CP1-VADPBC-09 breaks off and piping outboard of Valve CP1-VADPBC-10 breaks off.

The resulting system is as shown below.



Station No.	Type of Resistance (No)	
1	Entrance (1)	K = .5 D_{in} = 18"
2	90° Bend (5)	K = 12 f_t = .14
3	Valve (7) Flow in the Nonpreferred Direction	C_v = 11053
4	Straight Pipe (4)	L = 9.5'
5	Valve (7) Flow in the Preferred Direction	C_v = 11053
6	Exit (8)	K = 1.0 D_{out} = 18"

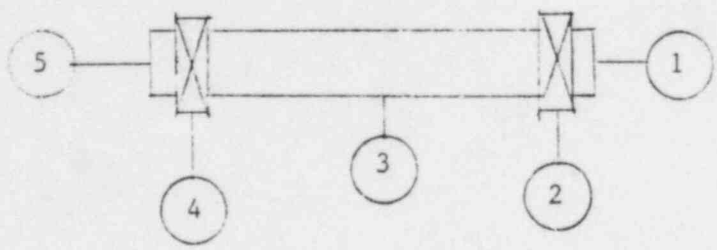
Case 1 A Valve 9 cycles closed
B Valve 10 cycles closed

CASE 3

18" - 150 Class Valves CP1-VADPBC-09 & 10

Piping inboard of Valve CP1-VADPBC-09 and outboard of Valve CP1-VADPBC-10 breaks off.

The resulting system is as shown below.



Station No.	Type of Resistance (No)		
1	Entrance (1)	K = .5	D_{in} = 18"
2	Valve (7) Flow in the Nonpreferred Direction	C_v = 11053	
3	Straight Pipe (4)	L = 9.5'	
4	Valve (7) Flow in the Preferred Direction	C_v = 11053	
5	Exit (8)	K = 1.0	D_{out} = 18"

Case 1 A Valve 9 cycles closed
B Valve 10 cycles closed

APPENDIX B

Determination of Flow Conditions

CASE 1A

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .230 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1 -

HYDRODYNAMIC FACTOR
@ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Non preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2398 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY=X10**2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	3245

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.75	16.554	1058	2396

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.50000
2	REDUCER	24.0	0.0	0.499	0.49985
3	PIPE BEND	18.0	0.0	0.140	0.44246
4	VALVE	18.0	0.0	0.768	2.4272[illegible]
5	STRAIGHT PIPE	18.0	9.5	0.095	0.30024
6	VALVE	18.0	0.0	0.768	2.42787
7	EXIT	18.0	0.0	1.000	3.16049

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 6,922,252 SCFM

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	203.3
2	[illegible]	0.2276	298.7	[illegible]
3	57.0	0.2191	289.3	394.0
4	53.3	0.2002	283.8	412.7
5	49.9	0.1911	279.6	432.3
6	47.2	0.1837	274.2	448.7
7	43.3	0.1720	267.6	477.1
8	14.7	0.0753	193.8	10[illegible].2

CONDITIONS WITH VALVE SHUT
VALVE TORQUE- 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	6,922,253	3.35	10,709

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	203.3
2	63.7	0.2275	298.7	205.1
3	57.0	0.2101	289.3	394.0
4	53.3	0.2000	283.8	412.[illegible]
5	49.9	0.1911	278.5	432.3
6	47.2	0.1837	274.2	448.7
7	43.3	0.1729	267.6	477.1
8	14.7	0.0765	173.5	1066.2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	6,706,411	5.15	1,372

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	199.3
2	63.7	0.2276	298.7	201.0
3	57.3	0.2111	289.9	384.5
4	53.8	0.2017	284.6	401.6
5	48.7	0.1877	276.6	431.5
6	45.0	0.1804	272.0	448.0
7	42.2	0.1696	265.5	476.8
8	[illegible]	[illegible]	[illegible]	[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	6,493,[illegible]	8.30	1,715

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	190.7
2	63.7	0.2280	298.9	191.9
3	58.1	0.2131	290.9	364.1
4	54.7	0.2047	286.3	379.7
5	46.1	0.1805	272.3	429.5
6	43.6	0.1736	268.1	445.[illegible]
7	39.9	0.1630	261.4	474.5
8	14.7	0.0826	199.2	931.1

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	5,707,216	18.70	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	157.6
2	64.1	0.2285	299.[illegible]	169.3
3	59.8	0.2176	293.4	313.7
4	57.5	0.21[illegible]	290.[illegible]	321.8
5	38.7	0.1593	259.0	427.6
6	36.7	0.1535	255.2	442.9
7	33.3	0.1433	248.3	474.4
8	14.7	0.0799	196.6	846.4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	4,382,288	32.09	1,460

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	128.7

3	62.0	0.2232	296.4	234.9
4	60.9	0.2203	294.8	237.8
5	28.8	0.1291	238.1	407.6
6	27.5	0.1252	235.2	420.1
7	25.7	0.1189	232.4	442.4
8	14.7	0.0798	196.4	559.5

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	2,9[illegible],838	41.9[illegible]	2,093

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	89.0
2	64.[illegible]	[illegible]	299.[illegible]	89.[illegible]
3	64.6	0.2273	298.6	157.9
4	[illegible]	0.2263	298.0	158.2
5	21.3	0.1039	218.3	364.3
6	22.7	0.1020	216.7	350.7
7	19.9	0.0991	214.2	363.2
8	14.7	0.0798	196.4	451.1

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,853,368	46.75	2,342

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	54.0
2	64.6	[illegible]	299.7	54.0
3	64.3	0.2291	299.6	97.7
4	64.2	0.2280	297.4	97.7
5	17.2	0.0894	205.7	250.3
6	[illegible]	0.0880	[illegible]	[illegible]
7	16.7	0.0877	204.9	255.8
8	14.7	0.0798	196.4	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	747,577	47.15	2,457

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	27.8
2	64.6	0.2299	299.9	27.8
3	64.6	0.2298	299.9	49.4
4	64.5	0.2297	299.8	49.6
5	15.[illegible]	0.0827	199.2	137.1
6	15.[illegible]	0.0820	199.0	137.9
7	15.2	0.0819	198.5	138.9
8	14.[illegible]	0.0798	196.4	142.6

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	485,769	49.77	2,482

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	14.2
2	64.6	0.2299	299.9	14.2
3	64.6	0.2299	299.9	25.3

5	14.9	0.0805	19[illegible].2	72.3
6	14.8	0.0805	197.1	72.4
7	[illegible]4.8	0.0803	196.9	72.[illegible]
8	[illegible].7	0.0798	196.4	73.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 1A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.1 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .159 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Nonpreferred

GAGE DIA. 12.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 1A
Cond 2

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10**2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	15.9	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
STEAM	1.329	.62	1	3245

STEM DIA.	CASE DIA.	PACKING TORQUE	SEAL TORQUE
1.75	16.654	1059	2396

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.50000
2	REDUCER	24.0	0.0	0.499	0.49935
3	PIPE BEND	18.0	0.0	0.140	0.44246
4	VALVE	18.0	0.0	0.768	2.42787
5	STRAIGHT PIPE	18.0	9.5	0.095	0.30024
6	VALVE	18.0	0.0	0.768	2.42787
7	EXIT	18.0	0.0	1.000	3.16049

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 8,157,471 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	[illegible]	[illegible]	[illegible]	[illegible]
3	56.8	0.1442	290.5	467.2
4	53.0	0.1369	285.6	491.1
5	50.1	0.1313	281.7	512.1
6	47.4	0.1259	277.8	532.4
7	44.7	0.1203	272.9	562.[illegible]
8	14.7	0.0521	207.8	1299.4

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	8,159,671	2.87	10,251

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	63.7	0.1571	299.8	241.9
3	56.8	0.1442	290.5	467.2
4	53.[illegible]	0.1369	285.5	491.1
5	50.1	0.1313	281.7	512.1
6	47.4	0.1259	277.8	532.4
7	44.7	0.1203	272.9	562.7
8	14.7	0.0521	207.8	1299.4

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	8,159,671	4.66	1,380

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	63.7	0.1571	298.8	241.9
3	56.8	0.1442	290.5	467.2
4	53.0	0.1369	285.5	491.1
5	48.3	0.1277	279.1	526.3
6	[illegible]	[illegible]	[illegible]	[illegible]
7	44.7	0.1203	269.9	562.7
8	14.7	0.0521	207.8	1299.4

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	8,159,671	9.50	2,153

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	63.7	0.1571	298.8	241.9
3	56.8	0.1442	290.5	467.2
4	53.0	0.1369	285.5	491.1
5	43.5	0.1180	271.9	569.8
6	40.4	0.1117	267.1	600.5
7	44.7	0.1203	260.2	562.7
8	14.7	0.0521	207.8	1299.4

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	[illegible]	17.09	273

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	204.3
2	64.1	0.1580	299.4	204.9
3	59.4	0.1492	293.8	385.0
4	57.1	0.1447	290.8	395.5
5	40.0	0.1107	266.3	517.0
6	37.9	0.1064	262.8	536.4
7	34.9	0.1000	257.6	570.5
8	14.7	0.0517	207.3	1096.5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	5,39[illegible],653	30.94	1,399

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	158.0
2	64.4	0.1583	299.7	158.0
3	61.9	0.1537	296.7	289.2
4	60.6	0.1514	295.2	293.0
5	29.7	0.0887	247.5	503.6
6	28.5	0.0858	244.9	520.6
7	26.8	0.0819	241.2	544.9
8	14.[illegible]	0.0521	207.8	357.0

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	[illegible]	41.25	2,0[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	109.2
2	64.5	0.1588	299.8	109.2
3	63.5	0.1569	298.7	196.0
4	63.1	0.1560	298.1	196.6
5	21.9	0.0703	229.3	439.1
6	21.2	0.0689	227.8	448.2
7	20.5	0.0670	225.7	460.7
8	14.7	0.0521	207.8	592.2

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	2,3[illegible]	46.81	2,333

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	67.5
2	64.6	0.1589	299.9	67.5
3	64.4	0.1585	299.7	120.1
4	64.3	0.1583	299.5	120.1
5	17.5	0.0595	217.1	320.9
6	17.2	0.0589	218.4	324.1
7	16.9	0.0581	218.4	328.5
8	14.7	0.0521	207.8	356.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	1,179,275	49.07	2,654

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	34.6
2	64.6	0.1589	299.9	34.6
3	64.6	0.1588	299.9	61.5
4	64.5	0.1588	299.8	61.5
5	15.5	0.0543	210.7	180.2
6	15.4	0.0541	210.5	180.7
7	15.3	0.0537	210.0	182.0
8	14.7	0.0521	207.8	187.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	17.7
2	64.6	0.1589	299.9	17.7
3	64.6	0.1589	299.9	31.5
4	64.6	0.1589	299.9	31.5
5	14.9	0.0527	208.6	95.2
6	14.9	0.0526	208.5	95.2
7	14.8	0.0525	208.4	95.5
8	14.7	0.0521	207.8	96.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 1B

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .230 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=12 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10#2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	3245

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.75	1[illegible].[illegible]54	1058	2378

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.50000
2	REDUCER	24.0	0.0	0.499	0.49985
3	PIPE BEND	18.0	0.0	0.140	0.44246
4	VALVE	18.0	0.0	[illegible]	[illegible]
5	STRAIGHT PIPE	18.0	9.5	0.095	0.30024
6	VALVE	18.0	0.0	0.768	2.42[illegible]87
7	EXIT	18.0	0.0	1.000	3.16049

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 6,[illegible]22.253 [illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	203.3
2	[illegible]	[illegible]	[illegible]	[illegible]
3	57.[illegible]	0.21[illegible]	289.3	39[illegible]
4	[illegible]	0.2002	[illegible]	[illegible]
5	49.[illegible]	0.1911	27[illegible].6	4[illegible]2.2
6	47.[illegible]	0.1837	274.2	448.7
7	43.3	0.1728	267.6	477.1
8	14.7	0.0780	193.[illegible]	10[illegible].2

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	6,9[illegible]	3.28	= 9,351

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	203.3
2	63.7	0.2275	298.7	205.1
3	57.0	0.2101	289.3	394.0
4	53.3	0.2002	[illegible]	412.[illegible]
5	49.9	0.1911	278.[illegible]	432.3
6	47.2	0.1837	274.2	448.7
7	[illegible]	0.1720	[illegible]	477.1
8	14.7	0.0768	197.5	1045.2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	6,7[illegible],511	6.04	= 11,762

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	199.3
2	[illegible]	0.2276	298.[illegible]	201.0
3	57.3	0.2111	289.9	384.5
4	53.9	0.2017	284.6	401.6
5	50.6	0.1932	279.7	419.4
6	48.1	0.1862	275.7	434.0
7	42.1	0.1692	265.3	477.5
8	[illegible]	[illegible]	[illegible]	[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	6,497,833	10.81	= 7,692

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	190.7
2	63.7	0.2280	298.9	191.9
3	58.1	0.2131	290.9	364.4
4	54.9	0.2047	286.3	378.7
5	52.1	0.1972	282.1	393.1
6	47.9	0.1912	[illegible]	406.4
7	39.1	0.1607	259.9	401.3
8	14.7	0.0788	194.4	1001.6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	5,522,780	22.26	= 2,417

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	162.5
2	64.1	0.2286	297.2	163.2
3	60.1	0.2182	293.7	303.4
4	[illegible]	0.2120	[illegible]	310.5
5	56.2	0.2079	288.1	317.8
6	54.7	0.2041	286.0	323.2
7	32.4	0.1406	246.4	472.4
8	14.7	0.0798	196.4	832.6

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	4,277,297	34.21	592

1	64.7	0.2300	300.0	125.6
2	64.5	0.2295	299.7	125.5
3	62.2	0.2237	296.6	228.9
4	61.1	0.2209	295.1	231.4
5	60.0	0.2181	293.7	234.2
6	59.3	0.2163	292.7	235.3
7	25.1	0.1171	229.0	438.4
8	14.7	0.0799	196.4	643.7

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	2,970,116	42.82	1,767

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	87.2
2	[illegible]	[illegible]	299.8	87.2
3	63.5	0.2277	298.6	156.4
4	63.0	0.2264	298.1	156.8
5	62.8	0.2261	297.4	157.6
6	62.6	0.2247	297.2	157.6
7	19.8	0.0987	213.9	361.2
8	14.7	0.0798	196.4	447.0

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,[illegible]	47.[illegible]	2,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	54.3
2	64.6	0.2299	299.9	54.3
3	64.4	0.2294	299.6	96.7
4	[illegible]	[illegible]	[illegible]	96.7
5	64.1	0.2287	299.3	96.9
6	64.1	0.2286	299.2	96.9
7	16.7	0.0875	203.8	253.9
8	14.7	0.0798	196.4	270.7

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	937,542	49.31	2,449

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	27.5
2	64.6	0.2299	299.9	27.5
3	64.6	0.2298	299.9	49.0
4	64.6	0.2297	299.9	49.0
5	64.6	0.2296	299.8	49.0
6	64.5	0.2296	299.8	49.0
7	15.2	0.0813	198.4	137.8
8	14.7	0.0798	196.4	141.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	481,745	49.81	2,482

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	14.1

3	64.5	0.2299	299.9	25.1
4	64.5	0.2299	299.9	25.1
5	64.5	0.2299	299.9	25.1
6	64.5	0.2299	299.9	25.1
7	14.8	0.0803	196.9	72.0
8	14.7	0.0798	175.4	72.5

NOTE: THERE IS CHOKED FLOW AT STATION 6

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE Case 1B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .159 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 1B
Cond 2

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18   VALVE CLASS=150   FLOW-[illegible]

UPSTREAM PRESSURE	INITIAL DENSITY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	15.[illegible]	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR PRO DEG
STEAM	[illegible]	.[illegible]	1	[illegible]

[illegible]	[illegible]	VALVE TORQUE	SEAL TORQUE
[illegible]	[illegible]	[illegible]	[illegible]

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.[illegible]	0.10000
2	REDUCER	24.0	0.0	0.4[illegible]	0.40[illegible]
3	PIPE BEND	18.0	0.0	0.140	0.44[illegible]
[illegible]	VALVE	18.[illegible]	[illegible]	[illegible]	[illegible]
5	STRAIGHT PIPE	18.0	[illegible]	0.0[illegible]	0.30[illegible]
6	VALVE	18.0	0.0	0.7[illegible]	[illegible]
7	EXIT	18.[illegible]	[illegible]	1.[illegible]	[illegible]

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= [illegible] CCFM

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	229.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.1442	[illegible]	[illegible]47.[illegible]
4	53.[illegible]	0.1[illegible]	[illegible]	471.1
5	[illegible]	0.1[illegible]	[illegible]	[illegible]
6	47.[illegible]	0.1[illegible]	[illegible]	[illegible]
7	44.7	0.1203	[illegible]	562.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	[illegible]	[illegible]	[illegible]
2	63.7	0.1571	[illegible]	[illegible]
3	56.3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	50.1	[illegible]	[illegible]	512.1
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,157,671	2.77	11,197

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	63.7	[illegible]	298.8	[illegible]
3	56.3	0.1442	290.5	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	50.1	[illegible]	281.7	512.1
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]
8	14.7	0.0521	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	2.77	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	239.6
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	467.2
4	[illegible]	[illegible]	[illegible]	491.1
5	50.1	[illegible]	281.7	[illegible]
6	[illegible]	[illegible]	277.8	[illegible]
7	44.7	0.1203	254.5	562.7
8	[illegible]	0.0521	207.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	199.4
2	64.1	0.1580	299.4	203.1
3	59.7	0.1497	294.1	374.7
4	57.4	0.1453	291.2	388.0
5	55.6	0.1420	289.0	394.1
6	54.1	0.1391	287.0	401.2
7	31.4	0.1011	257.0	557.2
8	14.7	0.0521	207.8	1081.8

ANGLE	FLOW	DP ACROSS VALVE	Tsloshing
60	5,[illegible]7,35[illegible]	32.90	474

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	155.0
2	64.4	0.1586	299.7	155.0
3	62.1	0.1541	296.9	202.7
4	60.8	0.1518	295.5	226.4
5	59.8	0.1500	294.3	229.9
6	59.1	[illegible]	[illegible]	[illegible]
7	24.[illegible]	0.0807	240.0	541.[illegible]
8	14.7	0.0521	207.8	840.4

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tsloshing
40	3,[illegible],421	[illegible].16	1,757

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	107.6
2	[illegible]	0.1583	[illegible]	[illegible]
3	63.6	0.1569	299.7	193.2
4	63.1	0.1561	298.2	193.9
5	62.7	0.1552	297.[illegible]	194.9
6	62.5	0.1549	297.[illegible]	191.7
7	[illegible]	0.0665	225.3	457.0
8	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tsloshing
[illegible]	[illegible]	47.[illegible]	2,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1590	300.0	67.[illegible]
2	[illegible]	0.1587	299.7	67.6
3	[illegible]	0.1585	299.7	120.2
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	0.1580	299.3	120.[illegible]
6	[illegible]	0.1579	299.3	120.4
7	[illegible]	0.0581	211.[illegible]	309.[illegible]
8	14.7	0.0521	207.8	366.7

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tsloshing
20	[illegible]	47.22	2,143

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	34.5
2	64.[illegible]	[illegible]	[illegible]	34.5
3	64.6	0.1589	299.9	61.4
4	64.6	0.1588	299.9	61.4
5	64.5	0.1587	299.8	61.4
6	[illegible]	0.1587	299.8	61.4
7	15.3	0.0537	209.9	181.6
8	14.7	0.0521	207.8	127.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	TWISTING
10	503.191	49.79	2,131

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1590	300.3	17.7
2	[illegible]	[illegible]	[illegible]	[illegible]
3	84.6	0.1590	299.9	31.4
4	87.6	0.1587	299.9	31.1
5	84.2	0.1589	299.9	31.5
6	84.7	0.1579	299.9	31.5
7	14.[illegible]	0.1525	300.4	95.2
8	[illegible]	[illegible]	[illegible]	75.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

[illegible]

CASE 2A

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA	INITIAL DENSITY .230 LBS/FT^3
INITIAL TEMPERATURE 300 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 64.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.	GAGE DIA. 16.654 IN
PACKING TORQUE 1058 IN.LBS.	SEAL TORQUE 2396 IN.LBS
DIRECTION Non preferred	

INPUT STATION NO., H FACTORS, ETC.

(See Appendix A)

Case 4

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-FAC

UPSTREAM PRESSURE	INITIAL DENSITY-X10*2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR
AIR	1.[illegible]	1	1	[illegible]

[illegible]	[illegible]	[illegible] TORQUE	[illegible] TORQUE
[illegible]	[illegible]	1058	[illegible]

STATION NO.	TYPE OF RESISTANCE	DIAMETER (D)	LENGTH-(L)	RESISTANCE (K)	MODIFIED RESISTANCE (K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	PIPE BEND	18.0	0.0	0.140	0.14000
3	VALVE	18.0	0.0	0.7[illegible]	0.76819
4	STRAIGHT PIPE	18.0	7.0	[illegible]	[illegible]
5	VALVE	18.0	0.0	0.768	0.76819
6	EXIT	18.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= [illegible] SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.22[illegible]	[illegible]	[illegible]
2	57.9	0.21[illegible]	298.7	482.9
3	[illegible]	[illegible]	[illegible]	[illegible]
4	50.8	0.1937	290.1	502.9
5	[illegible]	0.1899	[illegible]	537.6
6	43.1	0.1724	287.3	594.6
7	11.7	0.0798	196.4	1284.8

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= [illegible] IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	T-closing
[illegible]	2,2[illegible]	[illegible]	15,5[illegible]4

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.2300	300.0	445.4
2	57.9	0.2126	295.7	482.3
3	[illegible]	0.2076	287.9	492.5
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	0.1890	[illegible]	537.6
6	[illegible]	0.1776	247.3	594.[illegible]
7	[illegible]	0.0798	196.[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	T-closing
80	2,549,[illegible]	9.00	1,62[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	300.0	445.[illegible]
2	57.9	0.2126	295.7	452.0
3	56.3	0.2076	287.[illegible]	452.5
4	47.[illegible]	0.1832	273.9	509.0
5	45.[illegible]	0.1792	271.[illegible]	540.9
6	38.4	0.1587	259.[illegible]	646.8
7	14.7	[illegible]	196.[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	T-closing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	405.2
2	59.4	0.2185	292.0	429.4
3	59.1	0.2131	290.9	435.5
4	[illegible]	[illegible]	[illegible]	[illegible]
5	40.[illegible]	0.1703	266.3	543.5
6	36.[illegible]	0.1606	254.7	610.[illegible]
7	14.7	0.0798	196.[illegible]	11[illegible]7.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	T-closing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	300.0	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	61.0	0.2207	295.0	332.4
4	[illegible]	[illegible]	241.0	548.8
5	29.5	0.1314	239.8	560.2
6	[illegible]	[illegible]	[illegible]	[illegible]
7	14.7	0.0798	196.4	922.7

NOTE: THERE IS CHOKED FLOW AT STATION 3

50	4,522,445	41.10	1,555

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	[illegible]
2	63.3	0.2266	299.1	238.2
3	[illegible]	[illegible]	[illegible]	[illegible]
4	21.9	0.1041	220.1	511.3
5	21.4	0.1036	218.9	510.8
6	19.5	0.0979	213.2	514.4
7	14.7	0.0798	196.4	580.5

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	TEISSING
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	64.1	0.2286	299.2	157.5
3	64.0	0.2284	299.1	159.5
4	17.7	0.0911	207.1	400.7
5	17.5	0.0904	206.5	403.9
6	[illegible]	[illegible]	203.5	418.5
7	14.7	0.0798	196.4	457.8

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	TEISSING
10	[illegible]	[illegible]	2,399

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	[illegible]	300.0	97.1
2	64.5	[illegible]	299.8	97.1
3	[illegible]	[illegible]	[illegible]	97.1
4	15.7	[illegible]	200.4	266.0
5	15.7	[illegible]	200.2	266.0
6	15.2	0.0894	199.0	270.9
7	14.7	0.0798	196.4	280.0

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	TEISSING
20	943,[illegible]18	49.10	2,47[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	49.1
2	64.6	0.2299	299.9	49.1
3	[illegible]	[illegible]	299.9	49.1
4	[illegible]	[illegible]	[illegible]	139.3
5	[illegible]	0.0811	197.7	139.4
6	[illegible]	[illegible]	[illegible]	[illegible]
7	14.7	0.0798	196.4	141.7

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	TEISSING
10	476,281	49.89	2,485

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	24.8
2	64.6	0.2299	299.9	24.8

4	14.7	0.2801	198.7	71.3
5	14.7	0.2801	198.7	71.3
6	14.7	0.0799	195.5	71.5
6	14.7	0.0799	196.4	71.6

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 2A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .159 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Non preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 2A
cond 2

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 [illegible] FLOW=[illegible]

UPSTREAM PRESSURE	INITIAL DENSITY-MICRO	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.[illegible]	15.[illegible]	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	[illegible] FACTOR CYD DEG
STEAM	1.[illegible]	.62	1	[illegible]

STEM DIA.	SEAT DIA.	PACKING [illegible]	SEAL TORQUE
[illegible]	[illegible]	[illegible]	[illegible]

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	18.0	0.0	0.500	0.50020
2	PIPE BEND	18.0	0.0	0.140	0.140[illegible]
3	[illegible]	18.[illegible]	[illegible]	0.[illegible]	[illegible]
4	STRAIGHT PIPE	18.0	9.5	0.095	0.095[illegible]
5	VALVE	18.0	0.0	0.749	0.74919
[illegible]	EXIT	18.0	0.0	1.000	1.000[illegible]

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=10,[illegible],048 [illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.[illegible]	0.1590	300.[illegible]	529.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	5[illegible]	0.1521	299.[illegible]	590.9
4	51.0	0.127[illegible]	291.0	627.7
5	50.0	0.131[illegible]	291.[illegible]	638.[illegible]
6	44.2	0.1226	278.0	677.0
7	14.7	0.0521	291.9	1615.2

NOTE: THERE IS CHOKED FLOW AT STATION 6

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,736 IN. LBS
DELTA P=50.00 PSI

B-27

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	15,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1570	300.0	5[illegible]
2	57.[illegible]	0.1458	291.[illegible]	[illegible]
3	[illegible]	0.1421	[illegible]	58[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	0.1310	[illegible]	[illegible]
6	[illegible]	0.1206	[illegible]	[illegible]
7	[illegible]	0.0521	[illegible]	1,1[illegible]

NOTE: THERE [illegible] FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	10,1[illegible]	7.5[illegible]	1,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	57.5	0.1458	291.[illegible]	576.8
3	[illegible]	0.1421	289.1	588.9
4	[illegible]	0.1272	[illegible]	658.1
5	[illegible]	0.1243	274.[illegible]	[illegible]
6	[illegible]	0.1126	267.6	747.8
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.159[illegible]	[illegible]	487.9
2	59.1	0.1408	[illegible]	[illegible]
3	57.7	0.1460	291.7	507.3
4	[illegible]	[illegible]	[illegible]	[illegible]
5	44.0	0.1191	[illegible]	[illegible]
6	39.0	0.1080	264.[illegible]	7[illegible]
7	14.7	[illegible]	[illegible]	1[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	7,3[illegible],[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	61.4	0.15[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	32.2	0.0940	[illegible]	666.0
5	[illegible]	[illegible]	[illegible]	[illegible]
6	27.7	0.0840	2[illegible]	745.6
7	14.7	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1290	[illegible]	291.2
2	63.1	0.1561	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	0.0709	[illegible]	652.1
6	20.3	[illegible]	[illegible]	676.?
7	14.7	0.0321	297.8	989.3

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	34.1	[illegible]	[illegible]	[illegible]
4	17.9	[illegible]	219.2	516.5
5	17.7	0.0600	217.7	520.1
6	16.9	0.0579	215.2	538.7
7	[illegible]	[illegible]	[illegible]	597.2

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	120.3
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	347.5
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	0.0321	[illegible]	366.0

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	64.6	0.1587	299.9	60.7
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 3

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	[illegible]	300.0	30.7
2	[illegible]	[illegible]	[illegible]	30.7
3	[illegible]	[illegible]	[illegible]	30.7

[illegible]	14.[illegible]	0.[illegible]52[illegible]	2[illegible]3.1	93.[illegible]
5	1[illegible]	[illegible].[illegible]522	2[illegible]9.[illegible]	93.[illegible]
[illegible]	14.[illegible]	0.[illegible]521	2[illegible].[illegible]	93.[illegible]

NOTE: THERE IS [illegible] FLOW AT STATION 3

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 2B

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Rotork 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 700 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .230 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW=GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X1042	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR EXP FCT
AIR	1.4	1	1	32.5

STEM DIA.	VANE DIA.	PACKING TORQUE	SEAL TORQUE
1.75	[illegible]	1050	2350

STATION NO.	TYPE OF RESISTANCE	DIAMETER (D)	LENGTH (L)	RESIST(NULL+(K)	CORRECTED RESIST(NULL+(K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	PIPE BEND	18.0	0.0	0.140	0.14000
3	VALVE	18.0	0.0	0.762	0.76319
4	STRAIGHT PIPE	[illegible]	[illegible]	[illegible]	[illegible]
5	VALVE	18.0	0.0	0.762	0.76319
6	EXIT	18.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 8,547,698 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	446.4
2	57.9	0.2126	290.7	482.7
3	[illegible]	[illegible]	[illegible]	[illegible]
4	50.9	0.1927	290.1	532.9
5	48.1	0.1893	277.8	542.4
6	43.3	0.1726	267.3	594.6
7	14.7	0.0738	191.4	1000.6

NOTE: THERE IS CHOKED FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 6,396 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	8,5[illegible]	5.1[illegible]	- 15,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2302	300.0	[illegible]
2	57.[illegible]	[illegible]	[illegible]	[illegible]
3	56.0	0.2076	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	8,549,692	12.04	- 20,571

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	57.9	0.2126	[illegible]	[illegible]
3	56.0	0.2076	[illegible]	492.5
4	[illegible]	0.1937	280.1	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	37.4	0.1555	256.3	660.0
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	[illegible]	300.0	397.5
2	57.6	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	53.7	[illegible]	[illegible]	451.4
6	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]
4	59.3	[illegible]	292.7	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]
6	24.6	0.1154	227.7	610.5
7	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.22[illegible]	300.0	231.9
2	63.7	0.22[illegible]	298.2	[illegible]
3	63.1	0.22[illegible]	29[illegible].9	235.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	61.[illegible]	0.22[illegible]	296.7	23[illegible].9
5	17.3	0.0871	212.5	549.0
7	14.7	0.07[illegible]	19[illegible].4	662.4

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	2,[illegible]	[illegible]	1.[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	0.22[illegible]	[illegible]	[illegible]
3	[illegible]	0.22[illegible]	298.1	158.0
4	63.[illegible]	0.2272	298.8	158.0
5	63.5	0.2270	298.1	158.8
6	16.6	0.0871	203.4	415.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,[illegible]	[illegible].75	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	97.1
2	64.5	[illegible]	299.9	97.[illegible]
3	64.5	0.229[illegible]	[illegible].9	97.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	64.[illegible]	0.2291	299.5	97.3
6	15.7	0.09[illegible]	199.[illegible]	[illegible]
7	14.7	0.0799	196.4	200.1

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	937,094	49.73	2.961

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
[illegible]	64.[illegible]	[illegible]	[illegible]	[illegible]
2	64.6	0.2299	299.9	48.9
3	64.5	0.2299	299.9	48.9
4	64.6	0.2297	299.8	48.9
5	64.[illegible]	[illegible]	[illegible]	48.9
6	16.9	0.0904	197.9	127.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	473,7[illegible]	47.73	2.[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	24.7
2	64.6	0.2299	299.9	24.7
3	64.6	0.2299	299.9	24.7

5	[illegible]	0.2249	230.0	2?.7
6	14.7	0.2788	178.3	71.1
7	14.7	0.2788	198.?	71.2

NOTE: THERE IS CHOKED FLOW AT STATION 5

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 2B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .155 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2296 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 2B
Cond 2

CONTROL SYSTEM ANALYSIS

VALVE SIZE=[illegible]   VALVE CLASS=150   FLOW=GAS

UPSTREAM PRESSURE	INITIAL DENSITY-[illegible]	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.[illegible]	[illegible]	300	14.7	64.[illegible]

MEDIA	RATIO OF SP. HEATS	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR [illegible]
STEAM	1.3[illegible]	.62	1	324[illegible]

STEM DIA.	DISC DIA.	PACKING TORQUE	REQ. TORQUE
[illegible]	16.[illegible]	1000	[illegible]

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE	CORRECTED RESISTANCE-(U)
1	ENTRANCE	18.0	0.0	0.[illegible]	0.5[illegible]000
2	PIPE BEND	18.0	0.0	0.140	0.14000
3	VALVE	18.0	0.0	0.768	0.78819
4	STRAIGHT PIPE	18.0	[illegible]	0.0[illegible]	0.0[illegible]
5	VALVE	18.0	0.0	0.768	0.78819
6	EXIT	18.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=10,113,045 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1590	300.0	529.[illegible]
2	57.5	0.1456	291.4	574.8
3	55.[illegible]	0.1[illegible]	29[illegible]	[illegible]
4	51.2	0.1334	288.0	627.3
5	50.[illegible]	0.131[illegible]	2[illegible]	[illegible]
6	44.8	0.1206	277.0	697.0
7	14.7	0.0521	207.8	1615.2

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 6,[illegible] IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	10,1[illegible]	8.1[illegible]	= 16,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	529.6
2	57.5	0.1456	291.4	576.0
3	55.7	0.1421	289.1	589.9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	50.0	0.1310	281.4	635.9
6	[illegible]	[illegible]	277.8	697.0
[illegible]	[illegible]	[illegible]	207.9	1215.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	10,143,[illegible]	9.19	= 19,154

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1570	300.0	527.[illegible]
2	57.5	0.1456	291.4	576.0
3	55.7	0.1421	289.1	589.9
[illegible]	51.0	0.1334	283.2	627.3
5	50.5	0.1310	281.1	636.7
6	40.6	0.1120	267.1	751.7
[illegible]	14.7	0.0521	207.9	1615.0

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	9,[illegible]	15.[illegible]	= 11,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1570	300.0	483.2
2	59.1	0.1478	293.4	514.5
3	57.2	0.1441	291.8	521.6
[illegible]	[illegible]	[illegible]	287.4	[illegible]
5	53.6	0.1381	285.4	550.1
6	38.2	0.1071	263.0	715.5
7	14.7	0.0521	207.8	1470.6

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	7,3[illegible]	32.3[illegible]	= 3,970

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	61.7	0.1521	296.5	371.6
3	[illegible]	[illegible]	[illegible]	374.9
4	59.2	0.1488	293.5	406.7
5	57.[illegible]	0.1483	[illegible]	405.7
6	26.6	0.0915	240.8	746.9
7	14.7	0.0521	207.8	1169.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.159[illegible]	[illegible]	[illegible]
2	[illegible]	0.15[illegible]	[illegible]	291.[illegible]
3	[illegible]	0.15[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]
5	61.0	0.153[illegible]	[illegible]	[illegible]
6	[illegible]	0.0[illegible]59	[illegible]	890.3
7	14.[illegible]	0.0521	[illegible]	873.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]0	3,[illegible]	[illegible]	1,[illegible]31

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	0.15[illegible]1	[illegible]	195.[illegible]
3	[illegible]4.1	0.157[illegible]	[illegible]	195.[illegible]
4	[illegible]	0.1570	[illegible]	196.3
5	63.[illegible]	0.156[illegible]	[illegible]	196.3
6	16.[illegible]	0.0578	[illegible].1	[illegible]
7	14.[illegible]	0.0521	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.159[illegible]	[illegible]	120.[illegible]
2	[illegible]	0.159[illegible]	[illegible]	120.3
3	[illegible]	0.15[illegible]	[illegible]	120.3
4	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	0.1583	[illegible]	120.[illegible]
6	15.[illegible]	0.05[illegible]	210.[illegible]	353.0
7	14.[illegible]	0.0521	207.8	3[illegible]7.1

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	1,1[illegible],[illegible]13	49.[illegible]	2,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	[illegible]	[illegible]	[illegible]
2	64.6	0.159[illegible]	[illegible]	60.6
3	64.[illegible]	0.15[illegible]	[illegible]	[illegible]
4	[illegible]	0.15[illegible]	[illegible]	[illegible]
5	[illegible]	0.15[illegible]	[illegible]	[illegible]
6	1[illegible]	0.[illegible]	[illegible]	183.[illegible]
7	14.[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	[illegible]	1[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.15[illegible]	300.0	30.6
2	64.[illegible]	0.15[illegible]	[illegible]	30.6
3	64.6	0.159[illegible]	[illegible]	30.6

5	[illegible]	0.1589	[illegible]	30.5
6	[illegible]	0.0502	208.0	93.2
7	[illegible]	0.0521	[illegible]	93.4

NOTE: THERE IS CHOKED FLOW AT STATION 5

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 3A

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA	INITIAL DENSITY .230 LBS/FT^3
INITIAL TEMPERATURE 300 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 64.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.15 IN.	GAGE DIA. 16.654 IN
PACKING TORQUE 1058 IN.LBS.	SEAL TORQUE 2396 IN.LBS
DIRECTION Nonpreferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 3A

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-C[illegible]

UPSTREAM PRESSURE	INITIAL DENSITY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 090 DEG
AIR	1.4	1	1	32.5

STEM DIA.	VANE DIA.	BEARING TORQUE	SEAL TORQUE
1.75	17.[illegible]64	1058	2398

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE (K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	VALVE	18.0	0.0	0.768	0.76819
3	STRAIGHT PIPE	18.0	9.5	0.095	0.09500
4	VALVE	18.0	0.0	0.768	0.76819
5	EXIT	18.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 2,595,183 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	464.0
2	57.5	0.2115	290.1	492.5
3	52.3	0.1977	282.4	527.2
4	50.9	0.1938	280.1	536.7
5	44.7	0.1767	269.9	590.7
6	14.7	0.0798	196.4	1308.5

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 5,306 IN. LBS

DELTA P=50.00 PSI

B-42

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	[illegible]	[illegible]	15,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	454.0
2	57.5	0.2116	290.1	492.5
3	52.3	0.19[illegible]	282.4	527.2
4	[illegible]	[illegible]	[illegible]	[illegible]
5	44.7	0.1747	269.9	590.7
6	14.7	[illegible]	196.1	1300.5

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	8,6[illegible]5.183	9.01	1,626

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	454.0
2	57.5	0.2116	290.1	492.5
3	48.5	0.1874	276.4	556.2
4	47.0	0.18[illegible]	273.[illegible]	568.4
5	37.8	0.1627	261.2	641.6
6	14.7	0.0798	196.4	1300.5

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	7,371,[illegible]	14.4[illegible]	- 3,1[illegible]3

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.2300	[illegible]	411.0
2	59.2	0.2140	292.[illegible]	436.6
3	44.7	0.1763	270.0	533.4
4	43.5	0.1734	267.9	542.6
5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0799	196.4	1184.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	6,181,051	31.12	- 574

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	323.0
2	61.5	0.22[illegible]	295.8	333.9
3	[illegible]	[illegible]	[illegible]	[illegible]
4	29.6	0.1317	240.0	564.0
5	25.0	[illegible]	[illegible]	622.0
6	14.7	0.0798	196.4	930.9

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	4,531,403	41.41	1,572

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
2	[illegible]	0.2266	[illegible]	239.[illegible]
3	21.9	0.1061	220.1	512.0
4	21.[illegible]	0.1[illegible]46	218.9	529.0
5	19.6	0.1020	217.2	555.[illegible]
6	14.7	0.0799	196.[illegible]	591.[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	3,048,430	45.42	2,191

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	159.1
2	[illegible]	[illegible]	299.[illegible]	159.[illegible]
3	17.7	0.0915	207.2	401.3
4	17.6	0.0905	20[illegible].6	404.3
5	[illegible]	0.0873	203.5	419.1
6	14.7	0.0798	196.4	458.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,963,534	48.78	2,391

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	97.3
2	64.5	0.2297	299.8	97.[illegible]
3	15.8	0.0840	200.5	258.3
4	15.7	0.0837	200.3	267.1
5	15.3	0.0824	199.0	271.3
6	14.7	0.0798	196.4	280.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	943,483	49.61	2,470

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	49.[illegible]
2	64.6	0.2299	299.9	49.2
3	15.0	0.0811	197.8	139.5
4	15.0	0.0811	197.7	139.6
5	14.8	0.0804	197.1	140.7
6	14.7	0.0798	196.4	141.9

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	477,014	49.99	2,485

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	24.9
2	64.6	0.2299	299.9	24.9
3	14.7	0.0801	196.7	71.4
4	14.7	0.0801	196.7	71.4
5	14.7	0.0799	196.6	71.6
6	14.7	0.0798	196.4	71.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

[illegible] INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 3A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA	INITIAL DENSITY .159 LBS/FT^3
INITIAL TEMPERATURE 300 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 64.7 PSIA	MEDIA Steam
RATIO OF SP. HEAT 1.329	SPECIFIC GRAVITY .62
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.	GAGE DIA. 16.657 IN
PACKING TORQUE 1058 IN.LBS.	SEAL TORQUE 2396 IN.LBS
DIRECTION Non preferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

Case 3A
Cond 2

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-FAC

UPSTREAM PRESSURE	INITIAL DENSITY-X10**2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	15.9	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 290 DEG
STEAM	1.329	.62	1	3245

STEM DIA.	DISC DIA.	PACKING TORQUE	SEAL TORQUE
1.75	16.654	1058	2396

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT (L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	VALVE	18.0	0.0	0.788	0.78817
3	STRAIGHT PIPE	18.0	9.5	0.095	0.09500
4	VALVE	18.0	0.0	0.788	0.78817
5	EXIT	18.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=10,272,979 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	57.3	0.1451	291.1	586.5
3	52.8	0.1365	285.3	623.5
4	51.[illegible]	0.1340	28[illegible].5	632.8
5	46.5	0.1240	276.2	687.9
6	14.7	0.0521	207.8	1636.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	10,278,[illegible]	4.[illegible]	16,331

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	57.3	0.1451	291.1	588.5
3	52.9	0.1348	285.3	623.5
4	51.5	[illegible]	283.5	632.2
5	44.6	0.1240	274.2	687.9
6	14.7	0.0521	207.8	1635.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	10,270,779	7.58	1,572

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	57.3	0.1451	291.1	588.5
3	49.7	0.1304	281.0	652.6
4	48.2	0.1275	279.0	665.4
5	42.6	0.1161	270.4	734.2
6	14.7	0.0521	207.8	1636.7

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	9,469,031	12.56	- 3,102

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	494.4
2	58.8	0.1480	293.0	527.4
3	46.7	0.1236	276.1	634.2
4	45.1	0.1212	274.3	644.3
5	40.1	0.1109	266.3	708.5
6	14.7	0.0521	207.8	1507.9

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	7,617,292	28.31	- 708

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	392.7
2	61.2	0.1526	296.0	413.3
3	30.6	0.0951	253.3	664.9
4	31.3	0.0932	251.[illegible]	670.[illegible]
5	28.1	0.0849	244.1	744.4
6	14.7	0.0521	207.8	1213.0

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	5,506,400	40.44	1,494

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	292.7

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
3	[illegible]	0.0727	231.[illegible]	[illegible]43.[illegible]
4	22.1	0.0710	230.1	554.8
5	20.4	0.0[illegible]	22[illegible].6	[illegible]
6	14.7	0.0521	207.[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	3,7[illegible]3,[illegible]1	[illegible]6.[illegible]2	2,167

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	19[illegible].[illegible]
2	64.[illegible]	0.1580	299.4	19[illegible]
3	17.[illegible]	0.0604	21[illegible]	517.3
4	17.[illegible]	0.0599	217.7	521.5
5	16.[illegible]	0.0580	215.[illegible]	539.4
6	[illegible]	0.0521	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	[illegible]	4[illegible]	2,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.1590	3[illegible].0	120.[illegible]
2	64.5	0.1587	29[illegible].8	120.[illegible]
3	15.8	0.0553	211.9	346.6
4	15.[illegible]	0.0550	211.5	347.[illegible]
5	15.4	0.0542	210.6	352.9
6	14.7	0.0521	207.8	367.1

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	1,167,146	49.59	2,4[illegible]8

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	60.9
2	[illegible].8	0.1589	[illegible]	[illegible]
3	15.0	0.0531	209.1	182.3
4	15.0	0.0530	209.1	182.6
5	14.8	0.0526	208.5	184.0
6	14.7	0.0521	20[illegible].8	185.8

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	5[illegible]0,594	49.[illegible]9	2,485

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	30.8
2	64.6	0.1589	299.7	30.8
3	14.7	0.0523	208.2	93.5
4	14.7	0.0523	208.1	93.6
5	14.7	0.0522	208.0	93.7
6	14.7	0.0521	207.8	93.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 3B

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx 26072 SR-80

UPSTREAM PRESSURE 64.7 PSIA	INITIAL DENSITY .270 LBS/FT^3
INITIAL TEMPERATURE 300 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 64.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.	GAGE DIA. 16.654 IN
PACKING TORQUE 1058 IN.LBS.	SEAL TORQUE 2396 IN.LBS
DIRECTION Preferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 VALVE CLASS=150 FLOW-[illegible]

UPSTREAM PRESSURE	INITIAL DENSITY-X10**2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	23	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	3245

STEM DIA.	BALL DIA.	PACKING TORQUE	SEAL TORQUE
1.75	16.654	1058	2396

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	VALVE	18.0	0.0	0.788	0.78819
3	STRAIGHT PIPE	18.0	9.5	0.095	0.09500
4	VALVE	18.0	0.0	0.788	0.78819
5	EXIT	18.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,875,133 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	454.0
2	57.5	0.2116	290.1	492.5
3	52.3	0.1977	282.4	527.2
4	50.[illegible]	0.1738	280.1	536.[illegible]
5	44.7	0.1767	269.9	590.7
6	14.7	0.0793	176.4	1300.5

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	3,2[illegible]	2.[illegible]	- 18,2[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	454.0
2	57.8	0.2116	290.1	492.5
3	52.3	0.1977	282.4	527.2
4	[illegible]	0.1730	[illegible]	536.[illegible]
5	44.7	0.1747	269.[illegible]	550.[illegible]
6	14.7	0.0778	196.4	1300.5

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	8,395,133	11.59	- 20,609

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	454.0
2	57.8	0.2116	290.1	492.5
3	52.3	0.1977	282.4	527.2
4	50.9	0.1930	280.1	536.7
5	39.0	0.1603	259.6	651.3
6	14.7	0.0778	196.4	1300.5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	7,727,204	18.54	- 12,171

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	403.4
2	59.4	0.2165	292.5	427.6
3	55.7	0.2066	287.4	448.2
4	54.7	0.2042	285.0	452.6
5	36.2	0.1520	254.1	610.2
6	14.7	0.0790	195.4	1150.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	5,992,555	34.70	- 3,791

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	312.9
2	61.9	0.2230	296.3	322.0
3	59.9	0.2177	293.4	329.8
4	57.8	0.2187	292.9	339.6
5	24.3	0.1161	228.2	619.7
6	14.7	0.0790	196.6	901.9

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	4,450,040	42.74	395

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	232.4

3	[illegible]	0.2237	[illegible]	[illegible]
4	60.1	0.2231	295.5	278.4
5	[illegible]	0.0972	[illegible]	549.[illegible]
6	14.7	0.0798	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	3,[illegible]	46.[illegible]	1,7[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	157.7
2	64.1	0.2286	299.2	158.4
3	63.6	0.2274	298.5	159.2
4	63.5	0.2272	298.5	159.2
5	16.6	0.0871	203.5	416.2
6	14.7	[illegible]	176.4	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,3[illegible],740	48.97	2,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	97.4
2	64.5	0.2297	299.8	97.4
3	64.4	0.2292	299.6	97.6
4	64.3	0.2291	299.6	97.6
5	15.3	0.0824	199.0	271.6
6	14.7	0.0798	176.4	280.7

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	937,3[illegible]3	49.[illegible]4	2,441

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	49.0
2	64.6	0.2299	299.9	49.0
3	64.6	0.2298	299.8	49.0
4	64.6	0.2297	299.8	49.0
5	14.8	0.0804	197.1	140.1
6	14.7	0.0798	176.4	141.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	474,865	49.93	2,435

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.2300	300.0	24.7
2	64.6	0.2299	299.9	24.7
3	64.6	0.2299	299.9	24.7
4	64.6	0.2299	299.9	24.7
5	14.7	0.0799	176.6	71.3
6	14.7	0.0798	176.4	71.4

NOTE: THERE IS CHOKED FLOW AT STATION 4

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 3B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 18"

VALVE CLASS: 150

ACTUATOR: Matryx LC072 SR-80

UPSTREAM PRESSURE 64.7 PSIA

INITIAL TEMPERATURE 300 °F

SHUT OFF PRESSURE 64.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .159 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 3245 IN.LBS/PSI

STEM DIA. 1.75 IN.

PACKING TORQUE 1058 IN.LBS.

DIRECTION Preferred

GAGE DIA. 16.654 IN

SEAL TORQUE 2396 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=18 [illegible] FLUID=GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10E2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
64.7	15.9	300	14.7	64.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 90 DEG
STEAM	1.329	.62	1	3245

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.75	18.654	1058	2396

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	18.0	0.0	0.500	0.50000
2	VALVE	18.0	0.0	0.768	0.76819
3	STRAIGHT PIPE	18.0	9.5	0.095	0.09500
4	VALVE	18.0	0.0	0.768	0.76819
5	EXIT	18.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=10,279,979 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	57.3	0.1451	291.1	586.5
3	52.8	0.1365	285.3	623.5
4	51.5	0.1340	283.8	[illegible]
5	46.5	0.1240	276.2	687.9
6	14.7	0.0521	207.8	1636.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 5,306 IN. LBS
DELTA P=50.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	[illegible]	[illegible]	- 14,395

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	[illegible]	0.1451	291.1	586.5
3	52.8	0.1365	285.3	623.5
4	51.5	0.1347	[illegible]	533.5
5	44.5	0.1240	278.2	687.9
6	14.7	0.0521	207.8	1636.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	10,273,979	9.24	- 17,270

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	536.7
2	57.3	0.1451	291.1	586.5
3	52.8	0.1365	285.3	623.5
4	51.5	0.1340	283.6	632.8
5	42.3	0.1165	270.0	738.5
6	14.7	0.0521	207.8	1636.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	9,340,300	15.25	- 11,727

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	488.3
2	59.1	0.1485	293.3	521.0
3	55.6	0.1419	288.9	545.9
4	54.5	0.1400	287.7	551.7
5	39.4	0.1095	265.2	709.7
6	14.7	0.0521	207.8	1490.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	7,380,487	32.48	- 4,007

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	305.3
2	61.0	0.1531	296.3	399.2
3	59.5	0.1494	293.9	409.0
4	59.3	0.1489	293.6	409.0
5	26.8	0.0820	241.3	746.7
6	14.7	0.0521	207.8	1175.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	5,508,557	41.35	225

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	287.6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
3	63.1	0.1542	[illegible]	298.2
4	61.9	0.1579	296.8	295.8
5	20.1	0.0660	224.7	692.0
6	14.7	0.0521	207.3	877.2

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	3,722,302	46.[illegible]	1,732

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	194.9
2	64.2	0.1581	299.4	195.5
3	63.7	0.1572	299.9	196.5
4	63.3	0.1571	299.8	196.5
5	16.8	0.0570	215.1	535.2
6	[illegible]	[illegible]	[illegible]	594.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	2,306,225	48.39	2,313

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	120.4
2	64.5	0.1587	299.8	120.4
3	64.4	0.1584	299.6	120.6
4	64.3	0.1584	299.6	120.5
5	15.4	0.0542	210.5	353.1
6	14.7	0.0521	207.3	367.2

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	[illegible]	49.72	2,453

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	60.6
2	64.6	0.1589	299.9	60.6
3	64.6	0.1588	299.9	60.6
4	64.6	0.1588	299.9	60.6
5	14.8	0.0526	208.5	183.0
6	14.7	0.0521	207.3	184.9

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	581,978	49.93	2,485

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	64.7	0.1590	300.0	30.6
2	64.6	0.1589	299.9	30.6
3	64.6	0.1589	299.9	30.6
4	64.6	0.1589	299.9	30.6
5	14.7	0.0522	208.0	93.2
6	[illegible]	[illegible]	[illegible]	93.4

NOTE: THERE IS CHOKED FLOW AT STATION 4

NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

APPENDIX C

Determination of Closing Times

NOTE: Positive torques are tending to open the valve, negative torques are tending to close the valve.

CASE 3A

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 3245

PACKING TORQUE 1058 IN.LBS.

STEM DIA. 1.75 IN.

BUILDING PRESSURE 50 PSIG

ACTUATOR YOKE RADIUS 2.63 IN.

SOLENOID VALVE C_v 8.48

VALVE C_v 11053

SHUT OFF PRESSURE DROP 50 PSI

SEAL TORQUE 2396 IN.LBS.

GAGE DIA. 16.654 IN.

dt 0.5 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0801	71.4	49.9
20	.0811	139	49.6
30	.0840	266	48.8
40	.0912	401	46.4
50	.106	513	41.4
60	.134	552	31.1
70	.177	533	14.5
80	.187	556	9.01
90	.195	527	5.22

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 10400	Tspring ending= 6420	TEMPERATURE= 300	
ACT. VOL.= 2.84	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8.48
MEDIA=AIR	VALVE Cv= 11053	HYDRO. TORQUE @ 90= 3245	SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058	SEAL TORQUE= 2396	Dstem= 1.75	Dgage= 16.654
BUILDING PRESSURE= 50			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0801	.0811	.0840	.0912	.1060	.1340	.1770	.1870	.1980
VELOCITY	71.4	139.0	266.0	401.0	513.0	552.0	533.0	556.0	527.0
PRES DROP	49.90	49.60	48.80	46.40	41.40	31.10	14.50	9.01	5.22

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	11861	6301	-10390	14743 *	1058 *	149 *	90.00	5.22
0.50	9660	4100	-10390	14743	1058	149	90.00	5.22
1.00	8728	3168	-10390	14743	1058	149	90.00	5.22
1.50	8172	2612	-10390	14743	1058	149	90.00	5.22
2.00	7794	2234	-10390	14743	1058	149	90.00	5.22
2.50	7517	[illegible]	-10390	14743	1058	149	90.00	5.22
3.00	[illegible]	1745	-10390	14743	1058	149	90.00	5.22
3.50	7136	1576	-10390	14743	1058	149	90.00	5.22
4.00	6998	[illegible]	-10390	14743	1058	149	90.00	5.22
4.50	6883	1323	-10390	14743	1058	149	90.00	5.22
5.00	6786	1226	-10390	14743	1058	149	90.00	5.22
5.50	6703	1143	-10390	14743	1058	149	90.00	5.22
6.00	6630	1070	-10390	14743	1058	149	90.00	5.22
6.50	6567	1007	-10390	14743	1058	149	90.00	5.22
7.00	6511	951	-10390	14743	1058	149	90.00	5.22
7.50	6460	901	-10390	14743	1058	149	90.00	5.22
8.00	6415	856	-10390	14743	1058	149	90.00	5.22
8.50	6375	815	-10390	14743	1058	149	90.00	5.22
9.00	6338	778	-10390	14743	1058	149	90.00	5.22
9.50	6304	744	-10390	14743	1058	149	90.00	5.22
10.00	6274	714	-10390	14743	1058	149	90.00	5.22

B

* 14743 + 1058 + 149 agree with Page B-43

CASE 3A

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_v 8.48

MEDIA Air

VALVE C_v 11053

HYDRODYNAMIC TORQUE @ 90 3245

SHUT OFF PRESSURE DROP 50 PSI

PACKING TORQUE 1058 IN.LBS.

SEAL TORQUE 2396 IN.LBS.

STEM DIA. 1.75 IN.

GAGE DIA. 16.654 IN.

BUILDING PRESSURE 50 PSIG

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0801	71.4	49.9
20	.0811	139	49.6
30	.0840	266	48.8
40	.0912	401	46.4
50	.106	513	41.4
60	.134	552	31.1
70	.177	533	14.5
80	.187	556	9.01
90	.198	527	5.22

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 10400 Tspring ending= 6420 TEMPERATURE= 300
ACT. VOL.= 2.84 ACT. YOKE RADIUS= 2.63 ACT. PRESS= 80 SOL. VALVE Cv= 8.48
MEDIA=AIR VALVE Cv= 11053 HYDRO. TORQUE @ 90= 3245 SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058 SEAL TORQUE= 2396 Dstem= 1.75 Dgage= 16.654
BUILDING PRESSURE= 50

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0801	.0811	.0840	.0912	.1060	.1340	.1770	.1870	.1980
VELOCITY	71.4	139.0	266.0	401.0	513.0	552.0	533.0	556.0	527.0
PRES DROP	49.90	49.60	48.80	46.40	41.40	31.10	14.50	9.01	5.22

LOCA CLOSES THE VALVE TO 54 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -3111* IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	0	4032	-4993	-1281	1058	1067	54.00	37.28
0.05	0	3067	-4830	-516	1058	1221	47.49	42.65
0.10	0	2659	-4731	-279	1058	1293	42.46	45.16
0.15	0	2417	-4652	-163	1058	1341	38.13	46.84
0.20	0	2308	-4626	-108	1058	1368	34.26	47.77
0.25	0	2255	-4636	-70	1058	1392	30.70	48.63
0.30	0	2257	-4676	-42	1058	1403	27.38	49.00
0.35	0	2296	-4741	-23	1058	14.0	24.26	47.75
0.40	0	2365	-4829	-11	1058	1417	21.30	49.49
0.45	0	2464	-4937	-6	1058	1421	18.47	49.64
0.50	0	2587	-5065	-4	1058	1424	15.77	49.72
0.55	0	2729	-5210	-2	1058	1426	13.19	49.80
0.60	0	2888	-5374	-1	1058	1428	10.73	49.87
0.65	0	3066	-5552	-0	1058	1429	8.38	49.91
0.70	0	3258	-5746	-0	1058	1430	6.15	49.93
0.75	0	3464	-5952	-0	1058	1430	4.03	49.95
0.80	0	2317	-6170	-0	2421	1431	2.02	49.97
0.85	0	1781	-6312	-0	3099	1431	0.82	49.99

B

* Agrees with Page B-43

CASE 3A

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 65°

DIRECTION OF FLOW Nonpreferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 3245

PACKING TORQUE 1058 IN.LBS.

STEM DIA. 1.75 IN.

BUILDING PRESSURE 50 PSIG

ACTUATOR YOKE RADIUS 2.63 IN.

SOLENOID VALVE C_v 8.48

VALVE C_v 11053

SHUT OFF PRESSURE DROP 50 PSI

SEAL TORQUE 2396 IN.LBS.

GAGE DIA. 16.654 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0801	71.4	49.9
20	.0811	139	49.6
30	.0840	266	48.8
40	.0912	401	46.4
50	.106	513	41.4
60	.134	552	31.1
70	.177	533	14.5
80	.187	556	9.01
90	.198	527	5.22

B

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 65 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 10400
ACT. VOL.= 2.84
MEDIA=AIR
PACKING TORQUE= 1058
BUILDING PRESSURE= 50

Tspring ending= 6420
ACT. YOKE RADIUS= 2.63
VALVE Cv= 11053
SEAL TORQUE= 2396

TEMPERATURE= 300
ACT. PRESS= 80
HYDRO. TORQUE @ 90= 3245
Dstem= 1.75

SOL. VALVE Cv= 8.48
SHUT-OFF PRES. DROP= 50
Dgage= 16.654

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0801	.0811	.0840	.0912	.1060	.1340	.1770	.1870	.1980
VELOCITY	71.4	139.0	266.0	401.0	513.0	552.0	533.0	556.0	527.0
PRES DROP	49.90	49.60	48.80	46.40	41.40	31.10	14.50	9.01	5.22

LOCA CLOSES THE VALVE TO 53 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -1786 IN.LBS. @ 65 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	0	3896	-4960	-1114	1058	1097	53.00	38.31
0.05	0	2999	-4819	-470	1058	1233	46.68	43.05
0.10	0	2607	-4714	-254	1058	1303	41.76	45.51
0.15	0	2396	-4645	-153	1058	1345	37.52	46.99
0.20	0	2297	-4625	-101	1058	1371	33.70	47.90
0.25	0	2252	-4640	-65	1058	1396	30.18	48.75
0.30	0	2261	-4684	-38	1058	1404	26.90	49.04
0.35	0	2305	-4753	-21	1058	1411	23.80	49.29
0.40	0	2378	-4844	-10	1058	1418	20.86	49.53
0.45	0	2481	-4955	-6	1058	1422	18.06	49.65
0.50	0	2607	-5085	-3	1058	1424	15.38	49.73
0.55	0	2752	-5234	-2	1058	1426	12.81	49.81
0.60	0	2914	-5400	-1	1058	1428	10.37	49.88
0.65	0	3094	-5581	-0	1058	1429	8.04	49.91
0.70	0	3288	-5776	-0	1058	1430	5.82	49.94
0.75	0	3496	-5985	-0	1058	1430	3.72	49.96
0.80	0	2159	-6204	-0	2613	1431	1.73	49.98
0.85	0	1716	-6335	-0	3187	1431	0.63	49.99

CASE 3B

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 3245

PACKING TORQUE 1058 IN.LBS.

STEM DIA. 1.75 IN.

BUILDING PRESSURE 0 PSIG

ACTUATOR YOKE RADIUS 2.63 IN.

SOLENOID VALVE C_v 8.48

VALVE C_v 11053

SHUT OFF PRESSURE DROP 50 PSI

SEAL TORQUE 2396 IN.LBS.

GAGE DIA. 16.654 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0799	71.3	49.9
20	.0804	140	49.7
30	.0824	272	49.0
40	.0871	416	47.0
50	.0972	550	42.7
60	.116	619	34.7
70	.152	610	18.5
80	.160	651	11.9
90	.177	591	6.17

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 10400	Tspring ending= 6470	TEMPERATURE= 70	
ACT. VOL.= 2.84	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8.48
MEDIA=AIR	VALVE Cv= 11053	HYDRO. TORQUE @ 90= 3245	SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058	SEAL TORQUE= 2396	Dstem= 1.75	Dgage= 16.654
BUILDING PRESSURE= 0			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0799	.0804	.0824	.0871	.0972	.1160	.1520	.1600	.1770
VELOCITY	71.3	140.0	272.0	416.0	550.0	619.0	610.0	651.0	591.0
PRES DROP	49.90	49.70	49.00	47.00	42.70	34.70	18.50	11.90	6.17

LOCA CLOSES THE VALVE TO 65 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -20599* IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	0	13190	-5614	-9496	1058	761	65.00	26.60
0.05	0	3111	-4717	-774	1058	1322	41.87	46.19
0.10	0	2553	-4632	-349	1058	1369	35.83	47.83
0.15	0	2339	-4634	-160	1058	1397	31.05	48.78
0.20	0	2300	-4684	-83	1058	1409	26.93	49.21
0.25	0	2338	-4771	-42	1058	1416	23.17	49.47
0.30	0	2427	-4888	-20	1058	1423	19.66	49.70
0.35	0	2562	-5034	-11	1058	1425	16.38	49.77
0.40	0	2727	-5206	-5	1058	1427	13.26	49.83
0.45	0	2918	-5403	-2	1058	1428	10.32	49.87
0.50	0	3135	-5622	-0	1058	1429	7.55	49.92
0.55	0	3372	-5861	-0	1058	1430	4.94	49.95
0.60	0	2651	-6117	-0	2034	1431	2.50	49.97
0.65	0	1778	-6313	-0	3102	1431	0.81	49.99

B

* Agrees with Pages B-51 & E-1

CASE 2B

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 3645

PACKING TORQUE 1058 IN.LBS.

STEM DIA. 1.75 IN.

BUILDING PRESSURE 0 PSIG

ACTUATOR YOKE RADIUS 2.63 IN.

SOLENOID VALVE C_v 8.48

VALVE C_v 11053

SHUT OFF PRESSURE DROP 50 PSI

SEAL TORQUE 2396 IN.LBS.

GAGE DIA. 16.654 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0799	7.3	49.9
20	.0804	140	49.7
30	.0824	272	49.0
40	.0871	416	47.0
50	.0972	550	42.7
60	.116	619	34.7
70	.152	610	18.5
80	.160	651	11.9
90	.177	591	6.17

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 10400 Tspring ending= 6420 TEMPERATURE= 70
ACT. VOL.= 2.84 ACT. YOKE RADIUS= 2.63 ACT. PRESS= 80 SOL. VALVE Cv= 8.48
MEDIA=AIR VALVE Cv= 11053 HYDRO. TORQUE @ 90= 3245 SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058 SEAL TORQUE= 2396 Dstem= 1.75 Dgage= 16.654
BUILDING PRESSURE= 0

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0799	.0804	.0824	.0871	.0972	.1160	.1520	.1600	.1770
VELOCITY	71.3	140.0	272.0	416.0	550.0	619.0	610.0	651.0	591.0
PRES DROP	49.90	49.70	49.00	47.00	42.70	34.70	18.50	11.90	6.17

LOCA CLOSES THE VALVE TO 62 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -12212* IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	0	10643	-5394	-7222	1058	900	62.00	31.46
0.05	0	3215	-4735	-851	1058	1313	42.63	45.86
0.10	0	2589	-4635	-378	1058	1366	36.38	47.72
0.15	0	2352	-4631	-174	1058	1394	31.51	48.69
0.20	0	2299	-4677	-88	1058	1408	27.33	49.18
0.25	0	2332	-4760	-46	1058	1416	23.54	49.45
0.30	0	2415	-4875	-21	1058	1423	20.01	49.69
0.35	0	2546	-5018	-11	1058	1425	16.71	49.76
0.40	0	2708	-5187	-6	1058	1426	13.58	49.82
0.45	0	2897	-5381	-2	1058	1428	10.62	49.88
0.50	0	3112	-5598	-1	1058	1429	7.83	49.92
0.55	0	3347	-5835	-0	1058	1430	5.20	49.94
0.60	0	2903	-6089	-0	1755	1431	2.74	49.97
0.65	0	1800	-6305	-0	3073	1431	0.87	49.99

* Agrees with Pages B-33 & E-4

CASE 2B

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 65°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_v 8.48

MEDIA Air VALVE C_v 11053

HYDRODYNAMIC TORQUE @ 90 3645 SHUT OFF PRESSURE DROP 50 PSI

PACKING TORQUE 1058 IN.LBS. SEAL TORQUE 2396 IN.LBS.

STEM DIA. 1.75 IN. GAGE DIA. 16.654 IN.

BUILDING PRESSURE 0 PSIG dt .05 SEC.

B

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0799	71.3	49.9
20	.0804	140	49.7
30	.0824	272	49.0
40	.0871	416	47.0
50	.0972	556	42.7
60	.116	619	34.7
70	.152	610	18.5
80	.160	651	11.9
90	.177	591	6.17

DETERMINATION OF CLOSING TIME
18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 65 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 10400 Tspring ending= 6420 TEMPERATURE= 70
ACT. VOL.= 2.84 ACT. YOKE RADIUS= 2.63 ACT. PRESS= 80 SOL. VALVE Cv= 8.48
MEDIA=AIR VALVE Cv= 11053 HYDRO. TORQUE @ 90= 3245 SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058 SEAL TORQUE= 2396 Dstem= 1.75 Dgage= 16.654
BUILDING PRESSURE= 0

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0799	.0804	.0824	.0871	.0972	.1160	.1520	.1600	.1770
VELOCITY	71.3	140.0	272.0	416.0	550.0	619.0	610.0	651.0	591.0
PRES DROP	49.90	49.70	49.00	47.00	42.70	34.70	18.50	11.90	6.17

LOCA CLOSES THE VALVE TO 62 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -7677 IN.LBS. @ 65 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	0	10265	-5394	-7222	1058	900	62.00	31.46
0.05	0	3318	-4753	-927	1059	1304	43.34	45.56
0.10	0	2623	-4639	-405	1058	1363	36.88	47.62
0.15	0	2366	-4629	-187	1058	1392	31.92	48.61
0.20	0	2299	-4671	-93	1058	1407	27.69	49.16
0.25	0	2327	-4751	-49	1058	1415	23.83	49.42
0.30	0	2405	-4863	-22	1058	1422	20.33	49.67
0.35	0	2533	-5003	-12	1058	1424	17.00	49.75
0.40	0	2692	-5171	-6	1058	1426	13.86	49.82
0.45	0	2879	-5363	-2	1058	1428	10.38	49.88
0.50	0	3091	-5577	-1	1058	1429	8.03	49.91
0.55	0	3325	-5813	-0	1058	1430	5.44	49.94
0.60	0	3317	-6066	-0	1317	1430	2.96	49.97
0.65	0	1777	-6313	-0	3104	1431	0.81	49.99

D

CASE 2A

DETERMINATION OF CLOSING TIME

VALVE SIZE 18" VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400 SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 3245

PACKING TORQUE 1058 IN.LBS.

STEM DIA. 1.75 IN.

BUILDING PRESSURE 50 PSIG

ACTUATOR YOKE RADIUS 2.63 IN.

SOLENOID VALVE C_v 9.48

VALVE C_v 11053

SHUT OFF PRESSURE DROP 50 PSI

SEAL TORQUE 2396 IN.LBS.

GAGE DIA. 16.654 IN.

dt .05 SEC.

DEG.	AERO TORQUE (IN.LBS.)	PRESSURE DROP (PSI)
10	2410	49.9
20	2146	49.6
30	399	48.8
40	- 1145	46.4
50	- 4763	41.1
60	- 9453	30.6
70	- 13350	14.5
80	- 9100	9.00
90	6879	5.19

B

NOTE: The AERO TORQUE is the calculated LOCA torque minus the packing and bearing torques.

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 10400	Tspring ending= 6420	TEMPERATURE= 300	
ACT. VOL.= 2.84	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8.48
MEDIA=AIR	VALVE Cv= 11053	HYDRO. TORQUE @ 90= 3245	SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058	SEAL TORQUE= 2396	Dstem= 1.75	Dgage= 16.654
BUILDING PRESSURE= 50			

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	2410	2146	399	-1145	-4763	-9452	-13350	-9100	6879
PRES DROP	49.90	49.60	48.80	46.40	41.10	30.60	14.50	9.00	5.19

LOCA CLOSES THE VALVE TO 33 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -13350* IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	0	4749	-4626	-2499	1058	1376	33.00	48.080
0.02	0	4143	-4648	-1951	1058	1393	29.39	48.848
0.05	0	3668	-4694	-1437	1058	1405	26.41	49.087
0.07	0	3298	-4750	-1007	1058	1411	23.91	49.286
0.10	0	2980	-4812	-642	1058	1416	21.79	49.456
0.12	0	2730	-4876	-331	1053	1420	19.77	49.600
0.15	0	2752	-4941	-291	1058	1421	18.39	49.648
0.17	0	2781	-5010	-252	1058	1423	16.[illegible]7	49.693
0.20	0	2817	-5084	-215	1058	1424	15.[illegible]1	49.737
0.22	0	2858	-5162	-179	1058	1425	14.[illegible]1	49.779
0.25	0	2904	-5244	-144	1058	1426	12.65	49.820
0.27	0	2956	-5330	-111	1058	1427	11.35	49.859
0.30	0	3012	-5419	-79	1058	1428	10.10	49.896
0.32	0	3092	-5511	-68	1058	1429	8.90	49.910
0.35	0	3179	-5607	-59	1058	1429	7.73	49.922
0.37	0	3269	-5706	-50	1058	1429	6.59	49.934
0.40	0	3362	-5808	-42	1058	1430	5.48	49.945
0.42	0	3459	-5913	-34	1058	1430	4.41	49.955
0.45	0	3558	-6021	-26	1058	1430	3.37	49.966
0.47	0	2564	-6131	-18	2154	1431	2.37	49.976
0.50	0	2147	-6210	-12	2644	1431	1.68	49.983
0.52	0	1903	-6275	-8	2948	1431	1.13	49.988
0.55	0	1730	-6332	-5	3175	1431	0.65	49.993
0.57	0	1597	-6384	-1	3356	1431	0.23	49.997

B

* Agrees with Pages 53 and E-10

CASE 2A

DETERMINATION OF CLOSING TIME

VALVE SIZE 18"   VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 65°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400   SPRING ENDING 6420

ACTUATOR VOLUME 2.87 SCF   ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG   SOLENOID VALVE C_v 9.48

MEDIA Air   VALVE C_v 11053

HYDRODYNAMIC TORQUE @ 90 3245   SHUT OFF PRESSURE DROP 50 PSI

PACKING TORQUE 1058 IN.LBS.   SEAL TORQUE 2396 IN.LBS.

STEM DIA. 1.75 IN.   GAGE DIA. 16.654 IN.

BUILDING PRESSURE 50 PSIG   dt .05 SEC.

DEG.	AERO TORQUE (IN.LBS.)	PRESSURE DROP (PSI)
10	2410	49.9
20	2146	49.6
30	399	48.8
40	- 1145	46.4
50	- 4763	41.1
60	- 9453	30.6
70	- 13350	14.5
80	- 9100	9.00
90	6879	5.19

NOTE: The AERO TORQUE is the calculated LOCA torque minus the packing and bearing torques.

DETERMINATION OF CLOSING TIME
18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THE VALVE OPENING IS RESTRICTED TO 65 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 10400 Tspring ending= 6420 TEMPERATURE= 300
ACT. VOL.= 2.84 ACT. YOKE RADIUS= 2.63 ACT. PRESS= 80 SOL. VALVE Cv= 8.48
MEDIA=AIR VALVE Cv= 11053 HYDRO. TORQUE @ 90= 3245 SHUT-OFF PRES. DROP= 50
PACKING TORQUE= 1058 SEAL TORQUE= 2396 Dstem= 1.75 Dgage= 16.654
BUILDING PRESSURE= 50

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	2410	2146	339	-1145	-4763	-9452	-13350	-9100	6879
PRES DROP	49.90	49.60	48.80	46.40	41.10	30.60	14.50	9.00	5.19

LOCA CLOSES THE VALVE TO 32 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -1.401 IN.LBS. @ 65 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	0	4603	-4628	-2399	1058	1383	32.00	48.320
0.02	0	4058	-4659	-1857	1058	1400	28.55	48.915
0.05	0	3588	-4709	-1344	1058	1407	25.67	49.146
0.07	0	3213	-4768	-915	1058	1412	23.26	49.338
0.10	0	2908	-4831	-552	1058	1417	21.23	49.501
0.12	0	2736	-489[illegible]	-319	1058	1420	19.48	49.615
0.15	0	2760	-4961	-279	1058	1422	17.92	49.662
0.17	0	2791	-5032	-240	1058	1423	16.42	49.707
0.20	0	2829	-5107	-204	1058	1424	14.97	49.750
0.22	0	2871	-5187	-168	1058	1425	13.59	49.792
0.25	0	2919	-5270	-134	1058	1427	12.25	49.832
0.27	0	2972	-5357	-101	1056	1428	10.97	49.870
0.30	0	3035	-5447	-74	1058	1429	9.73	49.902
0.32	0	3118	-5540	-65	1058	1429	8.53	49.914
0.35	0	3206	-5637	-56	1058	1429	7.37	49.926
0.37	0	3297	-5737	-48	1058	1430	6.25	49.937
0.40	0	3391	-5840	-39	1058	1430	5.15	49.948
0.42	0	3489	-5946	-31	1058	1430	4.09	49.959
0.45	0	3589	-6054	-23	1058	1430	3.06	49.969
0.47	0	2357	-6165	-15	2392	1431	2.06	49.979
0.50	0	2036	-6237	-11	2781	1431	1.44	49.985
0.52	0	1827	-6299	-7	3047	1431	0.93	49.990
0.55	0	1672	-6354	-3	3253	1431	0.48	49.995
0.57	0	1551	-6404	-0	3421	1431	0.08	49.999

β

APPENDIX D

Comparison of Actual to Calculated Closing Times

NOTE: Calculated positive torques are tending to open the valve, negative torques are tending to close the valve.

CASE ________

DETERMINATION OF CLOSING TIME

VALVE SIZE 18"   VALVE CLASS 150

ACTUATOR Matryx 26072-SR80

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW No Flow

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 10400   SPRING ENDING 6420

ACTUATOR VOLUME 2.84 SCF   ACTUATOR YOKE RADIUS 2.03 IN.

ACTUATOR PRESSURE 80 PSIG   SOLENOID VALVE C_v 8.48

MEDIA ________   VALVE C_v ________

HYDRODYNAMIC TORQUE @ 90 ________   SHUT OFF PRESSURE DROP ____ PSI

PACKING TORQUE 1058 IN.LBS.   SEAL TORQUE 2396 IN.LBS.

STEM DIA. 1.75 IN.   GAGE DIA. 16.654 IN.

BUILDING PRESSURE 0 PSIG   dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10			
20			
30			
40			
50			
60			
70			
80			
90			

DETERMINATION OF CLOSING TIME

18 - 150 CLASS VALVE WITH A 26072-SR80 ACTUATOR

THERE IS NO FLOW

Tspring begin= 10400   Tspring ending= 6420   TEMPERATURE= 70
ACT. VOL.= 2.84   ACT. YOKE RADIUS= 2.63   ACT. PRESS= 80   SOL. VALVE Cv= 8.48
PACKING TORQUE= 1058   SEAL TORQUE= 2396   Dstem= 1.75   Dgage= 16.654
BUILDING PRESSURE= 0

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	6903	16805	-10390	-0	1058	1431	90.00	49.99
0.05	7029	14931	-10390	-0	1058	1431	90.00	49.99
0.10	5550	13451	-10390	-0	1058	1431	90.00	49.99
0.15	4349	12250	-10390	-0	1058	1431	90.00	49.99
0.20	3353	11254	-10390	-0	1058	1431	90.00	49.99
0.25	2512	10414	-10390	-0	1058	1431	90.00	49.99
0.30	1793	9694	-10390	-0	1058	1431	90.00	49.99
0.35	1169	9070	-10390	-0	1058	1431	90.00	49.99
0.40	623	8524	-10390	-0	1058	1431	90.00	49.99
0.45	141	8042	-10390	-0	1058	1431	90.00	49.99
0.50	0	7613	-10390	-0	1058	1431	90.00	49.99
0.55	0	6382	-8871	-0	1058	1431	85.41	49.99
0.60	0	5166	-7655	-0	1058	1431	80.36	49.99
0.65	0	4252	-6741	-0	1058	1431	75.13	49.99
0.70	0	3577	-6067	-0	1058	1431	69.83	49.99
0.75	0	3090	-5580	-0	1058	1431	64.56	49.99
0.80	0	2748	-5237	-0	1058	1431	59.41	49.99
0.85	0	2519	-5008	-0	1058	1431	54.40	49.99
0.90	0	2378	-4868	-0	1058	1431	49.57	49.99
0.95	0	2309	-4799	-0	1058	1431	44.90	49.99
1.00	0	2197	-4687	-0	1058	1431	40.39	49.99
1.05	0	2144	-4634	-0	1058	1431	36.13	49.99
1.10	0	2138	-4628	-0	1058	1431	32.09	49.99
1.15	0	2173	-4663	-0	1058	1431	28.25	49.99
1.20	0	2243	-4733	-0	1058	1431	24.60	49.99
1.25	0	2345	-4835	-0	1058	1431	21.11	49.99
1.30	0	2477	-4967	-0	1058	1431	17.79	49.99
1.35	0	2636	-5126	-0	1058	1431	14.63	49.99
1.40	0	2821	-5311	-0	1058	1431	11.63	49.99
1.45	0	3030	-5520	-0	1058	1431	8.79	49.99
1.50	0	3260	-5749	-0	1058	1431	6.11	49.99
1.55	0	3508	-5998	-0	1058	1431	3.59	49.99
1.60	0	1937	-6262	-0	2893	1431	1.23	49.99
1.65	0	1553	-6403	-0	3418	1431	0.08	49.99

NUCLEAR

VALVE ASSEMBLY CYCLE TEST REPORT

NUCLEAR

PSI VALVE SERIAL NO. 14758-2-A		TRAVELER NO. 78-14758-02-0800	
CUSTOMER Texas Utilities	PURCHASE ORDER NO. CP-0086	ITEM	TAG NO. CPI-VADPBC-09 (1-HV-5549)
OPERATOR TYPE # 26072 SR-80	MANUFACTURER Matryx	SERIAL NO. 21927-1-2	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 14758 TP-4, Rev. —

TEST CONDITIONS

1. Each valve shall be cycled four (4) times with its operator to insure that no binding or unusual operating characteristics exist. During this test, the closing time shall be five (5) seconds or less. No pressure on the valve is required during this test.
2. Each valve shall be cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure shall be dumped to atmosphere. The valves shall be cycled using the specified actuators.
3. For all cycle testing, the air pressure to pneumatic actuators shall be 80 PSIG and electric actuators shall use available standard electrical service.

TEST RESULTS

1. First Closing: 1.5 Seconds
   Second Closing: 1.5 Seconds
   Third Closing: 1.5 Seconds
   Fourth Closing: 1.5 Seconds
2. Each valve and its actuator were cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure was dumped to atmosphere.
3. The cycle test was performed and completed satisfactorily to the requirements per PSI Specification No. 14758 TP-4, —.

TESTED BY	DATE	INSPECTED BY	DATE
R. Giles	7-31-78	F. Rose	7-31-78
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

...CLEAR VALVE ASSEMBLY CYCLE TEST REPORT NUCLEAR

PSI VALVE SERIAL NO.		TRAVELER NO.	
14758-2-B		78-14758-02-0800	
CUSTOMER	PURCHASE ORDER NO.	ITEM	TAG NO.
Texas Utilities	CP-0086		CP1-VADPBC-10 (1-HV-5548)
OPERATOR TYPE	MANUFACTURER	SERIAL NO.	
# 26072 SR-80	Matryx	21927-1-1	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 14758 TP-4, Rev. -

TEST CONDITIONS

1. Each valve shall be cycled four (4) times with its operator to insure that no binding or unusual operating characteristics exist. During this test, the closing time shall be five (5) seconds or less. No pressure on the valve is required during this test.
2. Each valve shall be cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure shall be dumped to atmosphere. The valves shall be cycled using the specified actuators.
3. For all cycle testing, the air pressure to pneumatic actuators shall be 80 PSIG and electric actuators shall use available standard electrical service.

TEST RESULTS

1. First Closing: 1 Seconds
   Second Closing: 1 Seconds
   Third Closing: 1 Seconds
   Fourth Closing: 1 Seconds
2. Each valve and its actuator were cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure was dumped to atmosphere.
3. The cycle test was performed and completed satisfactorily to the requirements per PSI Specification No. 14758 TP-4, -.

TESTED BY	DATE	INSPECTED BY	DATE
E. GEARS	7/31/78	D. C. [signature]	7/31/78
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

NUCLEAR VALVE ASSEMBLY CYCLE TEST REPORT NUCLEAR

PSI VALVE SERIAL NO.		TRAVELER NO.	
14759-2-A		79-1459-02-0800	
CUSTOMER	PURCHASE ORDER NO.	ITEM	TAG NO.
Texas Utilities	CP-0086		CP2-VADPGC-09 (2-HV-5549)
OPERATOR TYPE	MANUFACTURER	SERIAL NO.	
#26072 SR-80	MATRYX	25377-2	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 14758 TP-4, -

TEST CONDITIONS

1. Each valve shall be cycled four (4) times with its operator to insure that no binding or unusual operating characteristics exist. During this test, the closing time shall be five (5) seconds or less. No pressure on the valve is required during this test.

2. Each valve shall be cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure shall be dumped to atmosphere. The valves shall be cycled using the specified actuators.

3. For all cycle testing, the air pressure to pneumatic actuators shall be 80 PSIG and electric actuators shall use available standard electrical service.

TEST RESULTS

1. Failure Mode: Close

2. First Closing: 2.5 Seconds
   Second Closing: 2.5 Seconds
   Third Closing: 2.5 Seconds
   Fourth Closing: 2.5 Seconds

3. Each valve and its actuator were cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure was dumped to atmosphere.

4. The cycle test was performed and completed satisfactorily to the requirements per PSI Specification No. 14758 TP-4, -.

TESTED BY	DATE	INSPECTED BY	DATE
W. Debigare	1-11-80	F. Rowe	1-11-80
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

NUCLEAR VALVE ASSEMBLY CYCLE TEST REPORT NUCLEAR

PSI VALVE SERIAL NO.		TRAVELER NO.	
14759-2-B		79-1459-02-0800	
CUSTOMER	PURCHASE ORDER NO.	ITEM	TAG NO.
Texas Utilities	CP-0086		CP2-VADPBC-10 (2-HV-5548)
OPERATOR TYPE	MANUFACTURER	SERIAL NO.	
#26072 SR-80	MATRYX	253771	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 14758 TP-4, -

TEST CONDITIONS

1. Each valve shall be cycled four (4) times with its operator to insure that no binding or unusual operating characteristics exist. During this test, the closing time shall be five (5) seconds or less. No pressure on the valve is required during this test.

2. Each valve shall be cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure shall be dumped to atmosphere. The valves shall be cycled using the specified actuators.

3. For all cycle testing, the air pressure to pneumatic actuators shall be 80 PSIG and electric actuators shall use available standard electrical service.

TEST RESULTS

1. Failure Mode: Close
2. First Closing: 2.5 Seconds
   Second Closing: 2.5 Seconds
   Third Closing: 2.5 Seconds
   Fourth Closing: 2.5 Seconds
3. Each valve and its actuator were cycled once with a 50 PSIG pressure applied to one (1) side of the disc. Upon opening, the pressure was dumped to atmosphere.
4. The cycle test was performed and completed satisfactorily to the requirements per PSI Specification No. 14758 TP-4, -.

TESTED BY	DATE	INSPECTED BY	DATE
N. DeBigare	1/25/80	D. H. Kline	1/25/80
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

APPENDIX E

Seismic and LOCA Stress Analyses

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 18" — Valve V-10
VALVE CLASS: 150
ACTUATOR: Matryx 26072-SR80
CUSTOMER: Texas Utilities
P.O. NO.: CPF-12296-S
SPEC. NO.: 2323-SS-20
REFERENCE NO.: 34977 (14758 & 9)
ITEM NO.: 1 (2)

REFERENCE DWGS.

A. ASS'Y DWG. NO.	14758-1	REV.	D
B. BODY DWG. NO.	9144-180-3	REV.	-
C. DISC DWG. NO.	1144-180-9	REV.	B
D. STEM DWG. NO.	1304-362	REV.	-
E. PIN DWG. NO.	1306-14	REV.	A
F. BRACKET DWG. NO.	12300	REV.	-

ALLOWABLE STRESSES

A. BODY	SA515 GR 70	26250	PSI
B. STEM	SA564 GR 630 Cond H1100	52500	PSI
C. PIN	SA564 GR 630 Cond H1100	35000	PSI
D. BRACKET	A500	41400	PSI
E. BOLTING	A193 GR B7	94500	PSI
F. DISC	SA351 GR CF8M	24750	PSI

B

B

DESIGN CONDITIONS

PRESSURE:	50	PSI
TEMPERATURE:	300	DEG. F.
FLOW PRESS. DROP:	0.17	PSI

B

VALVE TORQUES

LOCA TORQUE: 20609 IN-LBS — Case 3B 90° Page B-51
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3% Damping 2.6 x 1.5 = 3.9
VERTICAL: ( ) (3.2+1) x 1.5 = 6.3
LONGITUDINAL: SSE 2.6 x 1.5 = 3.9

OCCASIONAL LOAD

TRANSVERSE: 0 LBS
VERTICAL: 500 LBS

DIMENSIONAL DATA

SIZE 18" CLASS 150

ACTUATOR Matryx 26072-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.32	X1	X1
LONGITUDINAL DIST.ACTUATOR C.G.TO ℄ VALVE	0.63	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	6.48	X3	X3
HEIGHT BRACKET	4	X4	X4
HEIGHT VALVE NECK	3	X5	X5
ACTUATOR WEIGHT	491	W1	W4
BRACKET WEIGHT	11	W2	W5
DISC WEIGHT	133	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.5	T1	T1
WIDTH OF BRACKET	4.5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3.688	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.5	T9	T9
THICKNESS OF BRACKET TOP PLATE	.5	T0	T0
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.5	Di	E5
STEM DIA.	1.75	D1	D1
GAGE DIA. OF DISC	16.654	D	D
WIDTH SMALL DIA. BACK OF DISC	2.438	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
DISC SPHERICAL INDENTATION DIA.	12.25	D2	D2
DIST. BETWEEN T-WASHER FLATS ON DISC	16.34	L3	L3
STEM ENGAGEMENT IN DISC	2.625	L4	L4
DEPTH OF SPHERICAL INDENTATION IN DISC	.813	E4	E4
LARGE DIA. OF CONICAL SECTION OF DISC	15.75	D3	D3
SMALL DIA. OF CONICAL SECTION OF DISC	3.375	D4	D4
THRUST WASHER THICKNESS	.348	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.812	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
DBC OF ACTUATOR BOLTS	4.5	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	8	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	0	R5	R5
DIA. OF VALVE BODY BOLT HOLES	0	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.496	dp	D5
VALVE BODY O.D.	25	d1	D8
VALVE BODY WATERWAY DIA.	17	R7	R7
ADJACENT PIPING O.D.	18	R8	R8
ADJACENT PIPING I.D.	16.876	R9	R9
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF NECK FLANGE	0	D6	D6
THICKNESS OF NECK FLANGE	0	T6	T6
MODULUS OF ELASTICITY	30,000,000	E	E
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS		N3	N3
DBC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		E0	E0

POSI-SEAL INTERNATIONAL, INC.

NUCLEAR SEISMIC ANALYSIS

18 CLASS 150 VALVE ASSEMBLY
WITH 26072-SR80 ACTUATOR

CUSTOMER: TEXAS UTILITIES
P.O.NO.CPF-12296-S
SPEC.NO.: 2323-SS-20
REF.NO.: 34977
ITEM NO.: 1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)	DESIGN & FLOW CONDITIONS
A.ASS'Y DWG.NO.: 14758-1 REV.D	A.BODY: 26250	
B.BODY DWG.NO.: 9144-180-3 REV.-	B.STEM: 52500	SHUT-OFF PRESS.(PSI)= 50
C.DISC DWG.NO.: 1144-180-9 REV.B	C.PIN: 35000	TEMPERATURE(°F)= 300
D.STEM DWG.NO.: 1304-362 REV.-	D.BRACKET: 41400	FLOW PRESS. DROP(PSI)= 6.17
E.PIN DWG.NO. : 1306-14 REV.A	E.BOLTING: 94500	
F.BRACKET DWG.NO.12300 REV.-	F.DISC: 24750	

	G LOADINGS	OCCASSIONAL LOADS
LOCA TORQUE= 20309	TRANSVERSE= 3.7	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 6.3	VERTICAL= 500
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3.7	

DIMENSIONAL DATA

X1= 3.32	X2= .63	X3= 6.48	X4= 4	X5= 3	W1= 481	W2= 11
W4= 133	T1= .5	T2= 4.5	T3= 7	T4= 3.788	T9= .5	T0= .5
d3= 0	Di= 2.5	D1= 1.75	D= 16.654	E1= 2.438	E2= .313	
D2= 12.25	L3= 16.34	L4= 2.625	E4= .813	D3= 15.75	D4= 3.375	
L2= .348	Y2= 1.812	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .334	X7= 5	X8= 2	T5= 8	R5= 0	R6= 0	
Z= 65	dp= .496	d1= 25	R7= 17	R8= 18	R9= 16.376	
L= 0	T= 0	D6= 0	T6= 0	E= 30000000		

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 17 VS. 33HZ.
TRANSVERSE(Y) ACT./VALVE= 40 VS. 33HZ.
LATERAL DISC/STEM= 411 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 23841 PSI
TENSILE= 28898 PSI
COMBINED= 42328 PSI VS.ALLOW.= 94500

BRACKET BOLT STRESSES
SHEAR= 8629 PSI
TENSILE= 18064 PSI
COMBINED= 21523 PSI VS.ALLOW= 94500

BRACKET STRESSES
SHEAR= 9856 PSI
TENSILE= 19317 PSI
COMBINED= 23458 PSI VS.ALLOW= 41400

VALVE NECK STRESSES
SHEAR= 1358 PSI
TENSILE= 2292 PSI
COMBINED= 2923 PSI VS.ALLOW= 26250

STEM STRESSES
SHEAR= 19584 PSI
TENSILE= 4608 PSI
COMBINED= 22023 PSI VS.ALLOW= 52500

DISC PIN STRESS
SHEAR= 35790 PSI VS.ALLOW= 21000

SECTION MODULUS
VALVE= 1205.99 IN↑3
PIPING= 130.16 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= .242729 INCHES
TRANSVERSE= 4.37000000E-02 INCHES

BODY BOLTING
NOT APPLICABLE

DISC STRESSES

WITH FLOW
BENDING STRESS,Sx= 1988
BENDING STRESS,Sy= 1910
COMBINE STRESS= 3376 PSI VS.ALLOW= 24750

DISC SHUT
BENDING STRESS,Sx= 2032
BENDING STRESS,Sy= 3509
COMBINE STRESS= 4856 PSI VS.ALLOW= 24750

SIGNED....[signature]......DATED...0/15/85....

B

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 18 — Valve - V10
VALVE CLASS: 150
ACTUATOR: Matryx 26072-SR80
CUSTOMER: Texas Utilities
P.O. NO.: CPF-12296-S
SPEC. NO.: 2323-SS-20
REFERENCE NO.: 34977 (14758 d 9)
ITEM NO.: 1 (2)

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	14758-1	REV.	D
B.	BODY DWG. NO.	9144-180-3	REV.	-
C.	DISC DWG. NO.	1144-180-9	REV.	B
D.	STEM DWG. NO.	1304-362	REV.	-
E.	PIN DWG. NO.	1306-14	REV.	A
F.	BRACKET DWG. NO.	12300	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA515 GR 70	26250	PSI	
B.	STEM	SA564 GR 630 Cond H1100	52500	PSI	
C.	PIN	SA564 GR 630 Cond H1100	35000	PSI	B
D.	BRACKET	A500	41400	PSI	
E.	BOLTING	A193 GR B7	94500	PSI	
F.	DISC	SA 351 GR CF8M	24750	PSI	B

DESIGN CONDITIONS

PRESSURE:	50	PSI	
TEMPERATURE:	300	DEG. F.	
FLOW PRESS. DROP:	19.03	PSI	B

VALVE TORQUES

LOCA TORQUE: 1219 8 IN-LBS Case 2B
MEDIA: Air 70°
FLOW DIRECTION: Preferred B-33

G-LOADINGS

TRANSVERSE: 3% Damping 2.6 x 1.5 = 3.9
VERTICAL: (2.2+1) x 1.5 = 6.3
LONGITUDINAL: SSE 2.6 x 1.5 = 3.9

OCCASIONAL LOAD

TRANSVERSE: 0 LBS
VERTICAL: 500 LBS — B

SIZE 18" CLASS 150

DIMENSIONAL DATA

ACTUATOR Matryx 26072-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.32	X1	X1
LONGITUDINAL DIST.ACTUATOR C.G.TO ℄ VALVE	0.63	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	6.48	X3	X3
HEIGHT BRACKET	4	X4	X4
HEIGHT VALVE NECK	3	X5	X5
ACTUATOR WEIGHT	481	W1	W4
BRACKET WEIGHT	11	W2	W5
DISC WEIGHT	133	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.5	T1	T1
WIDTH OF BRACKET	4.5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3.688	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.5	T9	T9
THICKNESS OF BRACKET TOP PLATE	.5	T0	T0
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.5	D1	B5
STEM DIA.	1.75	D1	D1
GAGE DIA. OF DISC	16.654	D	D
WIDTH SMALL DIA. BACK OF DISC	2.438	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
DISC SPHERICAL INDENTATION DIA.	12.25	D2	D2
DIST. BETWEEN T-WASHER FLATS ON DISC	16.34	L3	L3
STEM ENGAGEMENT IN DISC	2.625	L4	L4
DEPTH OF SPHERICAL INDENTATION IN DISC	.813	E4	E4
LARGE DIA. OF CONICAL SECTION OF DISC	15.75	D3	D3
SMALL DIA. OF CONICAL SECTION OF DISC	3.375	D4	D4
THRUST WASHER THICKNESS	.348	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.812	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
DBC OF ACTUATOR BOLTS	4.5	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	8	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	0	R5	R5
DIA. OF VALVE BODY BOLT HOLES	0	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.496	dp	D5
VALVE BODY O.D.	25	d1	D8
VALVE BODY WATERWAY DIA.	17	R7	R7
ADJACENT PIPING O.D.	18	R8	R8
ADJACENT PIPING I.D.	11.876	R9	R9
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF NECK FLANGE	0	D6	D6
THICKNESS OF NECK FLANGE	0	T6	T6
MODULUS OF ELASTICITY	30,000,000	E	E
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS		N3	N3
DBC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		E0	E0

B

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

18 CLASS 150 VALVE ASSEMBLY
WITH 26072-SR80 ACTUATOR

CUSTOMER: TEXAS UTILITIES
P.O.NO.CPF-12296-S
SPEC.NO.: 2323-SS-20
REF,NO,: 34977
ITEM NO.: 1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)	DESIGN & FLOW CONDITIONS
A.ASS'Y DWG.NO.: 14758-1 REV.D	A.BODY: 26250	
B.BODY DWG.NO.: 9144-180-3 REV.-	B.STEM: 52500	SHUT-OFF PRESS.(PSI)= 50
C.DISC DWG.NO.: 1144-180-9 REV.B	C.PIN: 35000	TEMPERATURE('F)= 300
D.STEM DWG.NO.: 1304-362 REV.-	D.BRACKET: 41400	FLOW PRESS. DROP(PSI)= 19.03
E.PIN DWG.NO. : 1306-14 REV.A	E.BOLTING: 94500	
F.BRACKET DWG.NO.12300 REV.-	F.DISC: 24750	

	G LOADINGS	OCCASSIONAL LOADS
LOCA TORQUE= 12198	TRANSVERSE= 3.7	TRANSVERSE= 0
MEDIA=AIR	VERTICAL= 5.3	VERTICAL= 500
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3.7	

DIMENSIONAL DATA

X1= 3.32	X2= .63	X3= 6.48	X4= 4	X5= 3	W1= 481	W2= 11
W4= 133	T1= .5	T2= 4.5	T3= 7	T4= 3.688	T9= .5	T0= .5
d3= 0	Di= 2.5	D1= 1.75	D= 16.654	E1= 2.438	E2= .813	
D2= 12.25	L3= 16.34	L4= 2.625	E4= .813	D3= 15.75	D4= 3.375	
L2= .348	Y2= 1.812	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .334	X7= 5	X8= 2	T5= 8	R5= 0	R6= 0	
%= 65	dp= .496	dI= 25	R7= 17	R8= 18	R9= 15.876	
L= 0	T= 0	D6= 0	T6= 0	E= 30000000		

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 17 VS. 33HZ.	SHEAR= 17274 PSI
TRANSVERSE(Y) ACT./VALVE= 40 VS. 33HZ.	TENSILE= 28898 PSI
LATERAL DISC/STEM= 411 VS.33HZ.	COMBINED= 36970 PSI VS.ALLOW.= 94500

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 6404 PSI	SHEAR= 6557 PSI
TENSILE= 18064 PSI	TENSILE= 16825 PSI
COMBINED= 20104 PSI VS.ALLOW= 94500	COMBINED= 19079 PSI VS.ALLOW= 41400

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 976 PSI	SHEAR= 11591 PSI
TENSILE= 2292 PSI	TENSILE= 4608 PSI
COMBINED= 2651 PSI VS.ALLOW= 26250	COMBINED= 14122 PSI VS.ALLOW= 52500

DISC PIN STRESS	SECTION MODULUS
SHEAR= 21183 PSI VS.ALLOW= 21000	VALVE= 1205.99 IN↑3
	PIPING= 130.16 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= .242729 INCHES	NOT APPLICABLE
TRANSVERSE= 4.37000000E-02 INCHES	

DISC STRESSES

WITH FLOW	DISC SHUT
BENDING STRESS,Sx= 2978	BENDING STRESS,Sx= 2032
BENDING STRESS,Sy= 2903	BENDING STRESS,Sy= 3509
COMBINE STRESS= 5094 PSI VS.ALLOW= 24750	COMBINE STRESS= 4856 PSI VS.ALLOW= 24750

SIGNED....[signature]......DATED....10/15/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 18 — Valve - V10
VALVE CLASS: 150
ACTUATOR: Matryx 26072 - SR80
CUSTOMER: Texas Utilities
P.O. NO.: CPF - 12296 - S
SPEC. NO.: 2323 - SS - 20
REFERENCE NO.: 34977 (14758 & 9)
ITEM NO.: 1 (2)

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	14758-1	REV.	D
B.	BODY DWG. NO.	9144-180-3	REV.	-
C.	DISC DWG. NO.	1144-180-9	REV.	B
D.	STEM DWG. NO.	1304-362	REV.	-
E.	PIN DWG. NO.	1306-14	REV.	A
F.	BRACKET DWG. NO.	12300	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA515 GR 70	26250	PSI	
B.	STEM	SA564 GR 630 Cond H1100	52500	PSI	
C.	PIN	SA564 GR 630 Cond H1100	35000	PSI	B
D.	BRACKET	A500	41400	PSI	
E.	BOLTING	A193 GR B7	94500	PSI	
F.	DISC	SA 351 GR CF8M	24250	PSI	B

DESIGN CONDITIONS

PRESSURE: 50 PSI
TEMPERATURE: 300 DEG. F.
FLOW PRESS. DROP: 26.6 PSI — B

VALVE TORQUES

LOCA TORQUE: 7677 IN-LBS — Case 2B
MEDIA: Air — 650
FLOW DIRECTION: Preferred — C-12

G-LOADINGS

TRANSVERSE: 3% Damping — 2.6 x 1.5 = 3.9
VERTICAL: ( ) — (3.2+1) x 1.5 = 6.3
LONGITUDINAL: SSE — 2.6 x 1.5 = 3.9

OCCASIONAL LOAD

TRANSVERSE: 0 LBS
VERTICAL: 500 LBS — B

DIMENSIONAL DATA

SIZE 18" CLASS 150

ACTUATOR Matryx 26072-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.32	X1	X1
LONGITUDINAL DIST.ACTUATOR C.G.TO ℄ VALVE	0.63	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	6.48	X3	X3
HEIGHT BRACKET	4	X4	X4
HEIGHT VALVE NECK	3	X5	X5
ACTUATOR WEIGHT	491	W1	W4
BRACKET WEIGHT	11	W2	W5
DISC WEIGHT	133	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.5	T1	T1
WIDTH OF BRACKET	4.5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3.688	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.5	T9	T9
THICKNESS OF BRACKET TOP PLATE	.5	T0	T0
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.5	Di	B5
STEM DIA.	1.75	D1	D1
GAGE DIA. OF DISC	16.654	D	D
WIDTH SMALL DIA. BACK OF DISC	2.438	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
DISC SPHERICAL INDENTATION DIA.	12.25	D2	D2
DIST. BETWEEN T-WASHER FLATS ON DISC	16.34	L3	L3
STEM ENGAGEMENT IN DISC	2.625	L4	L4
DEPTH OF SPHERICAL INDENTATION IN DISC	.813	E4	E4
LARGE DIA. OF CONICAL SECTION OF DISC	15.75	D3	D3
SMALL DIA. OF CONICAL SECTION OF DISC	3.375	D4	D4
THRUST WASHER THICKNESS	.348	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.812	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
DBC OF ACTUATOR BOLTS	4.5	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	8	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	0	R5	R5
DIA. OF VALVE BODY BOLT HOLES	0	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.496	dp	D5
VALVE BODY O.D.	25	d1	D8
VALVE BODY WATERWAY DIA.	17	R7	R7
ADJACENT PIPING O.D.	18	R8	R8
ADJACENT PIPING I.D.	11.876	R9	R9
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF NECK FLANGE	0	D6	D6
THICKNESS OF NECK FLANGE	0	T6	T6
MODULUS OF ELASTICITY	30,000,000	E	E
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS	↓	N3	N3
DBC OF BODY BOLTS	↓	X0	X0
ROOT AREA OF BODY BOLTS	↓	E0	E0

B

POSI-SEAL INTERNATIONAL, INC.

NUCLEAR SEISMIC ANALYSIS

18 CLASS 150 VALVE ASSEMBLY
WITH 26072-SR80 ACTUATOR

CUSTOMER:T XAS UTILITIES
P.O.NO.CPF-12296-S
SPEC.NO.:2323-SS-20
REF,NO.:34977
ITEM NO.:1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)	DESIGN & FLOW CONDITIONS
A.ASS'Y DWG.NO.:14758-1 REV.D	A.BODY: 26250	
B.BODY DWG.NO.:9144-180-3 REV.-	B.STEM: 52500	SHUT-OFF PRESS.(PSI)= 50
C.DISC DWG.NO.:1144-180-9 REV.G	C.PIN: 35000	TEMPERATURE('F)= 300
D.STEM DWG.NO.:1304-362 REV.-	D.BRACKET: 41400	FLOW PRESS. DROP(PSI)= 26.6
E.PIN DWG.NO. :1306-14 REV.A	E.BOLTING: 94500	
F.BRACKET DWG.NO.12300 REV.-	F.DISC: 24750	

	G LOADINGS	OCCASSIONAL LOADS
LOCA TORQUE= 7677	TRANSVERSE= 3.7	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 6.3	VERTICAL= 500
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3.7	

DIMENSIONAL DATA

X1= 3.32	X2= .63	X3= 6.48	X4= 4	X5= 3	W1= 481	W2= 11
W4= 133	T1= .5	T2= 4.5	T3= 7	T4= 3.688	T9= .5	TO= .5
d3= 0	Di= 2.5	D1= 1.75	D= 16.654	E1= 2.438	E2= .813	
D2= 12.25	L3= 16.34	L4= 2.625	E4= .813	D3= 15.75	D4= 3.375	
L2= .348	Y2= 1.812	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .334	X7= 5	X8= 2	T5= 8	R5= 0	R6= 0	
%= 65	dp= .496	d1= 25	R7= 17	R8= 18	R9= 16.876	
L= 0	T= 0	D6= 0	T6= 0	E= 30000000		

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 17 VS. 33HZ.
TRANSVERSE(Y) ACT./VALVE= 40 VS. 33HZ.
LATERAL DISC/STEM= 411 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 13756 PSI
TENSILE= 28898 PSI
COMBINED= 34400 PSI VS.ALLOW.= 94500

B

BRACKET BOLT STRESSES
SHEAR= 5248 PSI
TENSILE= 18064 PSI
COMBINED= 19478 PSI VS.ALLOW= 94500

BRACKET STRESSES
SHEAR= 4784 PSI
TENSILE= 15485 PSI
COMBINED= 16844 PSI VS.ALLOW= 41400

VALVE NECK STRESSES
SHEAR= 771 PSI
TENSILE= 2292 PSI
COMBINED= 2527 PSI VS.ALLOW= 26250

STEM STRESSES
SHEAR= 7295 PSI
TENSILE= 4608 PSI
COMBINED= 9954 PSI VS.ALLOW= 52500

DISC PIN STRESS
SHEAR= 13332 PSI VS.ALLOW= 21000

SECTION MODULUS
VALVE= 1205.99 IN^3
PIPING= 130.16 IN^3

ACTUATOR DEFLECTIONS
LONGITUDINAL= .242727 INCHES
TRANSVERSE= 4.37000000E-02 INCHES

BODY BOLTING
NOT APPLICABLE

DISC STRESSES

WITH FLOW
BENDING STRESS,Sx= 3584
BENDING STRESS,Sy= 3507
COMBINE STRESS= 6141 PSI VS.ALLOW= 24750

DISC SHUT
BENDING STRESS,Sx= 2032
BENDING STRESS,Sy= 3509
COMBINE STRESS= 4856 PSI VS.ALLOW= 24750

SIGNED...*[signature]*.......DATED...10/15/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 18" Valve - V9
VALVE CLASS: 150
ACTUATOR: Matryx 26072-SR80
CUSTOMER: Texas Utilities
P.O. NO.: CPF-12296-S
SPEC. NO.: 2323-SS-20
REFERENCE NO.: 34977 (14758 & 9)
ITEM NO.: 1 (2)

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	14758-1	REV.	D
B.	BODY DWG. NO.	9144-180-3	REV.	-
C.	DISC DWG. NO.	1144-180-9	REV.	B
D.	STEM DWG. NO.	1304-362	REV.	-
E.	PIN DWG. NO.	1306-14	REV.	A
F.	BRACKET DWG. NO.	12300	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA515 GR 70	26250	PSI	
B.	STEM	SA564 GR 630 Cond H1100	52500	PSI	
C.	PIN	SA564 GR 630 Cond H1100	35000	PSI	B
D.	BRACKET	A500	41400	PSI	
E.	BOLTING	A193 GR B7	94500	PSI	
F.	DISC	SA351 GR CF8M	24750	PSI	B

DESIGN CONDITIONS

PRESSURE: 50 PSI
TEMPERATURE: 300 DEG. F.
FLOW PRESS. DROP: 14.46 PSI | B

VALVE TORQUES

LOCA TORQUE: 13350 IN-LBS Case 2A
MEDIA: Air 70°
FLOW DIRECTION: Non preferred Page 53

G-LOADINGS

TRANSVERSE: 3% Damping (2.6+1) x 1.5 = 5.4
VERTICAL: 3.2 x 1.5 = 4.8
LONGITUDINAL: SSE 2.6 x 1.5 = 3.9

OCCASIONAL LOAD

TRANSVERSE: 500 LBS
VERTICAL: 0 LBS | B

DIMENSIONAL DATA

SIZE 18" CLASS 150

ACTUATOR Matryx 26072-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.32	X1	X1
LONGITUDINAL DIST.ACTUATOR C.G.TO ℄ VALVE	0.63	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	6.48	X3	X3
HEIGHT BRACKET	4	X4	X4
HEIGHT VALVE NECK	3	X5	X5
ACTUATOR WEIGHT	491	W1	W4
BRACKET WEIGHT	11	W2	W5
DISC WEIGHT	133	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.5	T1	T1
WIDTH OF BRACKET	4.5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3.688	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.5	T9	T9
THICKNESS OF BRACKET TOP PLATE	.5	T0	T0
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.5	Di	B5
STEM DIA.	1.75	D1	D1
GAGE DIA. OF DISC	16.654	D	D
WIDTH SMALL DIA. BACK OF DISC	2.438	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
DISC SPHERICAL INDENTATION DIA.	12.25	D2	D2
DIST. BETWEEN T-WASHER FLATS ON DISC	16.34	L3	L3
STEM ENGAGEMENT IN DISC	2.625	L4	L4
DEPTH OF SPHERICAL INDENTATION IN DISC	.813	E4	E4
LARGE DIA. OF CONICAL SECTION OF DISC	15.75	D3	D3
SMALL DIA. OF CONICAL SECTION OF DISC	3.375	D4	D4
THRUST WASHER THICKNESS	.348	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.812	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
DBC OF ACTUATOR BOLTS	4.5	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	8	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	0	R5	R5
DIA. OF VALVE BODY BOLT HOLES	0	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.496	dp	D5
VALVE BODY O.D.	25	d1	D8
VALVE BODY WATERWAY DIA.	17	R7	R7
ADJACENT PIPING O.D.	18	R8	R8
ADJACENT PIPING I.D.	11.876	R9	R9
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF NECK FLANGE	0	D6	D6
THICKNESS OF NECK FLANGE	0	T6	T6
MODULUS OF ELASTICITY	30,000,000	E	E
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS	↓	N3	N3
DBC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		E0	E0

B

NUCLEAR SEISMIC ANALYSIS

18 CLASS 150 VALVE ASSEMBLY
WITH 26072-SR80 ACTUATOR

CUSTOMER: TEXAS UTILITIES
P.O.NO.CPF-12296-S
SPEC.NO.: 2323-SS-20
REF,NO.: 34977
ITEM NO.: 1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)	DESIGN & FLOW CONDITIONS
A.ASS'Y DWG.NO.: 14758-1 REV.D	A.BODY: 26250	
B.BODY DWG.NO.: 9144-180-3 REV.-	B.STEM: 52500	SHUT-OFF PRESS.(PSI)= 50
C.DISC DWG.NO.: 1144-180-9 REV.D	C.PIN: 35000	TEMPERATURE(°F)= 300
D.STEM DWG.NO.: 1304-362 REV.-	D.BRACKET: 41400	FLOW PRESS. DROP(PSI)= 14.46
E.PIN DWG.NO. : 1306-14 REV.A	E.BOLTING: 94500	
F.BRACKET DWG.NO.12300 REV.-	F.DISC: 24750	

	G LOADINGS	OCCASSIONAL LOADS
LOCA TORQUE= 13350	TRANSVERSE= 5.4	TRANSVERSE= 500
MEDIA=AIR	VERTICAL= 4.8	VERTICAL= 0
FLOW DIRECTION=NONPREFERRED	LONGITUDINAL= 3.9	

DIMENSIONAL DATA

X1= 3.32	X2= .63	X3= 6.48	X4= 4	X5= 3	W1= 481	W2= 11
W4= 133	T1= .5	T2= 4.5	T3= 7	T4= 3.599	T9= .5	T0= .5
d3= 0	Di= 2.5	D1= 1.75	D= 16.654	E1= 2.438	E2= .813	
D2= 12.25	L3= 16.34	L4= 2.625	E4= .813	D3= 15.75	D4= 3.375	
L2= .348	Y2= 1.812	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .334	X7= 5	X8= 2	T5= 8	R5= 0	R6= 0	
X= 65	dp= .496	d1= 25	R7= 17	R8= 18	R9= 16.876	
L= 0	T= 0	D6= 0	T6= 0	E= 30000000		

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 17 VS. 33HZ.
TRANSVERSE(Y) ACT./VALVE= 40 VS. 33HZ.
LATERAL DISC/STEM= 411 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 19891 PSI
TENSILE= 29658 PSI
COMBINED= 39640 PSI VS.ALLOW.= 94500

BRACKET BOLT STRESSES
SHEAR= 7486 PSI
TENSILE= 18761 PSI
COMBINED= 21382 PSI VS.ALLOW= 94500

BRACKET STRESSES
SHEAR= 7705 PSI
TENSILE= 22920 PSI
COMBINED= 25270 PSI VS.ALLOW= 41400

VALVE NECK STRESSES
SHEAR= 1072 PSI
TENSILE= 2524 PSI
COMBINED= 2918 PSI VS.ALLOW= 26250

STEM STRESSES
SHEAR= 12686 PSI
TENSILE= 4668 PSI
COMBINED= 15233 PSI VS.ALLOW= 52500

DISC PIN STRESS
SHEAR= 23184 PSI VS.ALLOW= 21000

SECTION MODULUS
VALVE= 1205.99 IN↑3
PIPING= 130.16 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= .202605 INCHES
TRANSVERSE= 4.26000000E-02 INCHES

BODY BOLTING
NOT APPLICABLE

DISC STRESSES

WITH FLOW
BENDING STRESS,Sx= 2554
BENDING STRESS,Sy= 2544
COMBINE STRESS= 4415 PSI VS.ALLOW= 24750

DISC SHUT
BENDING STRESS,Sx= 2062
BENDING STRESS,Sy= 3583
COMBINE STRESS= 4948 PSI VS.ALLOW= 24750

SIGNED....John A. Rodgers.....DATED....10/25/85...

B

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 18" Valve - V9
VALVE CLASS: 150
ACTUATOR: Matryx 26072-SR80
CUSTOMER: Texas Utilities
P.O. NO.: CPF-12296-S
SPEC. NO.: 2323-SS-20
REFERENCE NO.: 34977 (14758-9)
ITEM NO.: 1 (2)

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	14758-1	REV.	D
B.	BODY DWG. NO.	9144-180-3	REV.	-
C.	DISC DWG. NO.	1144-180-9	REV.	B
D.	STEM DWG. NO.	1304-362	REV.	-
E.	PIN DWG. NO.	1306-14	REV.	A
F.	BRACKET DWG. NO.	12300	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA515 GR 70	26250	PSI	
B.	STEM	SA564 GR 630 Cond H1100	52500	PSI	
C.	PIN	SA564 GR 630 Cond H1100	35000	PSI	B
D.	BRACKET	A500	41400	PSI	
E.	BOLTING	A193 GR B7	94500	PSI	B
F.	DISC	SA351 GR CF8M	24750	PSI	

DESIGN CONDITIONS

PRESSURE: 50 PSI
TEMPERATURE: 300 DEG. F.
FLOW PRESS. DROP: 22.6 PSI | B

VALVE TORQUES

LOCA TORQUE: 11401 IN-LBS Case 2A
MEDIA: Air 65°
FLOW DIRECTION: Nonpreferred Page C-12

G-LOADINGS

TRANSVERSE: 3% Damping (3.61)x1.5 = 5.4
VERTICAL: 3.2 x 1.5 = 4.8
LONGITUDINAL: SSE 2.6 x 1.5 = 3.9

OCCASIONAL LOAD

TRANSVERSE: 500 LBS
VERTICAL: 0 LBS

DIMENSIONAL DATA

SIZE 18" CLASS 150

ACTUATOR Matryx 26072-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	7.32	X1	X1
LONGITUDINAL DIST.ACTUATOR C.G.TO ℄ VALVE	0.63	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	6.48	X3	X3
HEIGHT BRACKET	4	X4	X4
HEIGHT VALVE NECK	3	X5	X5
ACTUATOR WEIGHT	491	W1	W4
BRACKET WEIGHT	11	W2	W5
DISC WEIGHT	133	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.5	T1	T1
WIDTH OF BRACKET	4.5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	7.698	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.5	T9	T9
THICKNESS OF BRACKET TOP PLATE	.5	T0	T0
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.5	Di	B5
STEM DIA.	1.75	D1	D1
GAGE DIA. OF DISC	16.654	D	D
WIDTH SMALL DIA. BACK OF DISC	2.435	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
DISC SPHERICAL INDENTATION DIA.	12.25	D2	D2
DIST. BETWEEN T-WASHER FLATS ON DISC	16.34	L3	L3
STEM ENGAGEMENT IN DISC	2.625	L4	L4
DEPTH OF SPHERICAL INDENTATION IN DISC	.813	E4	E4
LARGE DIA. OF CONICAL SECTION OF DISC	15.75	D3	D3
SMALL DIA. OF CONICAL SECTION OF DISC	3.375	D4	D4
THRUST WASHER THICKNESS	.348	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.812	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
DBC OF ACTUATOR BOLTS	4.5	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	8	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	0	R5	R5
DIA. OF VALVE BODY BOLT HOLES	0	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.496	dp	D5
VALVE BODY O.D.	25	d1	D8
VALVE BODY WATERWAY DIA.	17	R7	R7
ADJACENT PIPING O.D.	18	R8	R8
ADJACENT PIPING I.D.	16.876	R9	R9
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF NECK FLANGE	0	D6	D6
THICKNESS OF NECK FLANGE	0	T6	T6
MODULUS OF ELASTICITY	30,000,000	E	E
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS	↓	N3	N3
DBC OF BODY BOLTS	↓	X0	X0
ROOT AREA OF BODY BOLTS	↓	E0	E0

B

POSI-SEAL INTERNATIONAL, INC.

NUCLEAR SEISMIC ANALYSIS

18 CLASS 150 VALVE ASSEMBLY
WITH 26072-SR80 ACTUATOR

CUSTOMER: TEXAS UTILITIES
P.O.NO.CPF-12296-S
SPEC.NO.: 2323-SS-20
REF,NO,: 34977
ITEM NO.: 1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)	DESIGN & FLOW CONDITIONS
A.ASS'Y DWG.NO.: 14758-1 REV.D	A.BODY: 26250	
B.BODY DWG.NO.: 9144-180-3 REV.-	B.STEM: 52500	SHUT-OFF PRESS.(PSI)= 50
C.DISC DWG.NO.: 1144-180-9 REV.B	C.PIN: 35000	TEMPERATURE(°F)= 300
D.STEM DWG.NO.: 1304-362 REV.-	D.BRACKET: 41400	FLOW PRESS. DROP(PSI)= 22.6
E.PIN DWG.NO. : 1306-14 REV.A	E.BOLTING: 94500	
F.BRACKET DWG.NO.12300 REV.-	F.DISC: 24750	

	G LOADINGS	OCCASSIONAL LOADS
LOCA TORQUE= 11401	TRANSVERSE= 5.4	TRANSVERSE= 500
MEDIA=AIR	VERTICAL= 4.8	VERTICAL= 0
FLOW DIRECTION=NONPREFERRED	LONGITUDINAL= 3.9	

DIMENSIONAL DATA

X1= 3.32	X2= .63	X3= 6.48	X4= 4	X5= 3	W1= 481	W2= 11
W4= 133	T1= .5	T2= 4.5	T3= 7	T4= 3.688	T9= .5	T0= .5
d3= 0	D1= 2.5	D1= 1.75	D= 16.654	E1= 2.438	E2= .813	
D2= 12.25	L3= 16.34	L4= 2.625	E4= .813	D3= 15.75	D4= 3.375	
L2= .348	Y2= 1.812	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .334	X7= 5	X8= 2	T5= 8	R5= 0	R6= 0	
Z= 65	dp= .496	d1= 25	R7= 17	R8= 18	R9= 16.876	
L= 0	T= 0	D6= 0	T6= 0	E= 30000000		

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 17 VS. 33HZ.
TRANSVERSE(Y) ACT./VALVE= 40 VS. 33HZ.
LATERAL DISC/STEM= 411 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 18362 PSI
TENSILE= 29658 PSI
COMBINED= 38431 PSI VS.ALLOW.= 94500

BRACKET BOLT STRESSES
SHEAR= 4947 PSI
TENSILE= 1761 PSI
COMBINED= 5064 PSI VS.ALLOW= 94500

BRACKET STRESSES
SHEAR= 6941 PSI
TENSILE= 22343 PSI
COMBINED= 24324 PSI VS.ALLOW= 41400

VALVE NECK STRESSES
SHEAR= 983 PSI
TENSILE= 2574 PSI
COMBINED= 2863 PSI VS.ALLOW= 26250

STEM STRESSES
SHEAR= 10834 PSI
TENSILE= 4668 PSI
COMBINED= 13417 PSI VS.ALLOW= 52500

DISC PIN STRESS
SHEAR= 19799 PSI VS.ALLOW= 21000

SECTION MODULUS
VALVE= 1205.79 IN*3
PIPING= 130.16 IN*3

ACTUATOR DEFLECTIONS
LONGITUDINAL= .202605 INCHES
TRANSVERSE= 4.26000000E-02 INCHES

BODY BOLTING
NOT APPLICABLE

DISC STRESSES

WITH FLOW
BENDING STRESS,Sx= 3368
BENDING STRESS,Sy= 3320
COMBINE STRESS= 5792 PSI VS.ALLOW= 24750

DISC SHUT
BENDING STRESS,Sx= 2062
BENDING STRESS,Sy= 3583
COMBINE STRESS= 4948 PSI VS.ALLOW= 24750

SIGNED....[signature]....DATED...10/15/85...

6

APPENDIX F

Determination of Pressure Drops
for Normal Flow Conditions

VALVE SIZE= 18 IN. CLASS=150

Valve Angle 90°

Q= 120000 CV= 11053 P1= 164.7 Fp= 1

Fk= 1 Xt= .33 G= 1 °F= 300 Z= 1

DELTA P= 0.[illegible] PSI = 0.[illegible] IN OF WATER

VALVE SIZE= 18 IN. CLASS=150

Valve Angle 70°

Q= 120000 Cv= 6753 P1= 164.7 Fp= 1

Fk= 1 Xt= .42 G= 1 °F= 300 Z= 1

DELTA P= 0.00074208 PSI = 0.020555 IN OF WATER

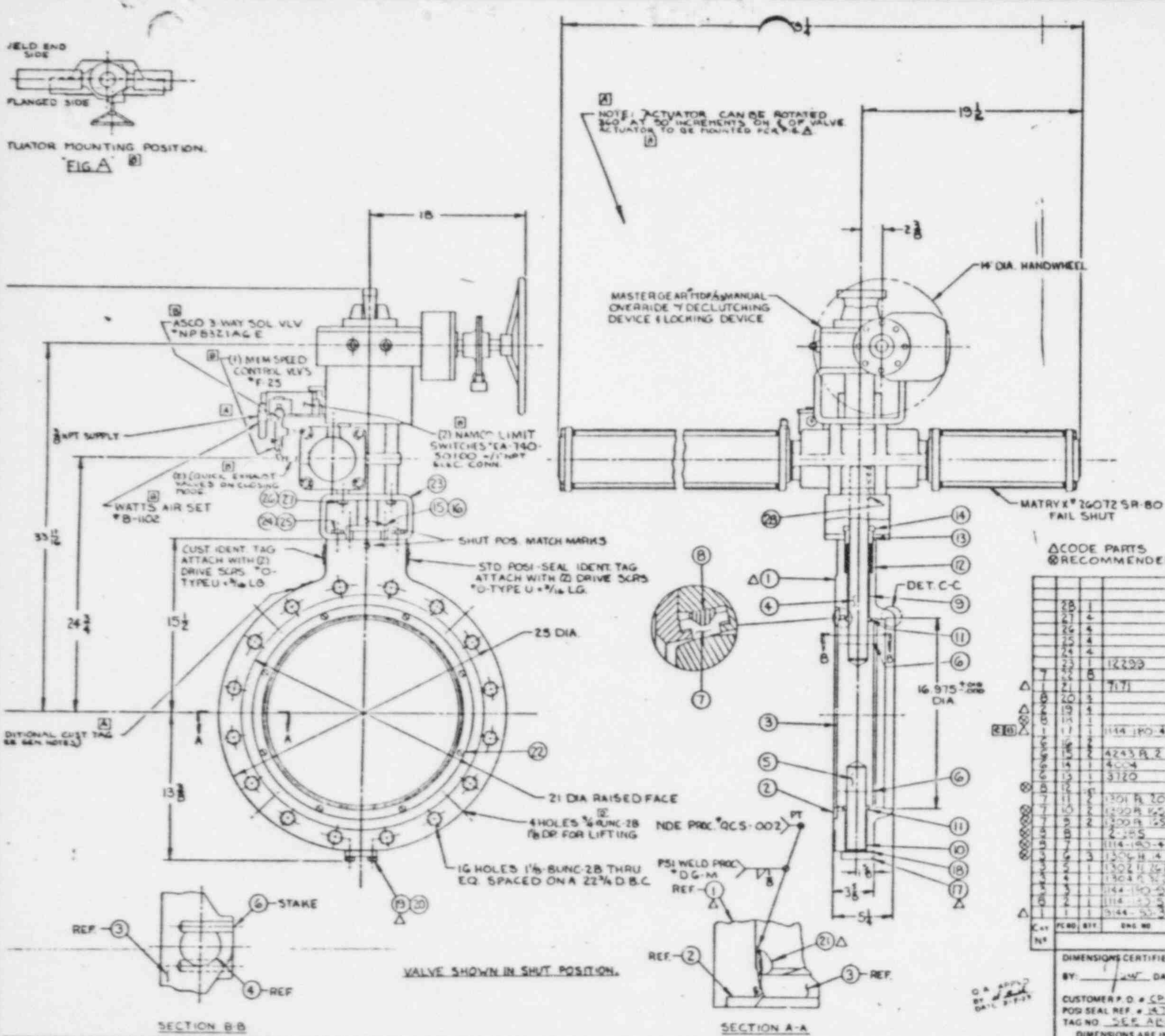
VALVE SIZE= 18 IN. CLASS=150

Valve Angle 60°

Q= 120000 CV= 4974 P1= 164.7 Fp= 1

Fk= 1 Xt= .46 G= 1 °F= 300 Z= 1

DELTA P= 0.00145424 PSI = 0.040282 IN OF WATER



GENERAL NOTES:

TEXAS UTILITIES GENERATING COMPANY
% BROWN & ROOT INC.
COMANCHE PEAK STEAM ELECTRIC STATION UNIT #1
GLEN ROSE, TEXAS

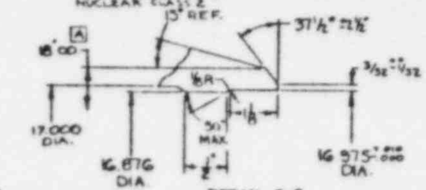
CUST. P.O. N° CP-0086

[A] TAG N°:
CP1-VADPBC-09 (HV-5549)
CP1-VADPBC-10 (HV-5548)

DESIGN PRESS: 50 PSIG
DESIGN TEMP: 300°F
MEDIA: AIR

THIS VALVE ASS'Y IS DESIGNED & MANUFACTURED IN ACCORDANCE WITH THE ASME B&PV CODE SECT. III, SUBSECTION NC CLASS 2, 1974 EDITION INCLUDING WINTER 1975 ADDENDA, INCLUDING CODE CASE 1621-1.

[A] ADDITIONAL TAGGING (USE BACK OF SB54)
PO NO. CP-0086
SERVICE "CONTAINMENT VENTILATION ISOLATION VALVES"
SIZE OF VALVE: INLET 18.00, OUTLET 16.975, SEAT BORE 16.561
MAT'L BODY CS, DISC 316SS
RATED FLOW 8,200 SCFM, PRESSURE DROP 0.5 IN. WG.
SEISMIC CATEGORY I
NUCLEAR CLASS 2



DETAIL C-C

△ CODE PARTS
⊗ RECOMMENDED SPARE PARTS

CAT N°	PC NO.	QTY.	DWG NO	DESCRIPTION	MATERIAL	MAT'L SPECIFICATION
	28	1		KEY ⅜ SQ. × 2" LG.	KEYSTOCK	
	27	4		LOCKWASHER ½ SIZE	CS	
	26	4		HEX HD BOLT ½-13UNC-2A × 1½	CS	ASTM A193 GR B
	25	4		LOCKWASHER ⅜ SIZE	CS	
	24	4		HEX HD BOLT ⅜-16UNC-2A × 1½	CS	ASTM A193 GR B
	23	1	12299	MOUNTING BRACKET	CS	
7	22	8		FL HD MACH SCR #10-24UNC × ⅜	316SS	ASTM A193 GR B
△ 1	21	1	7171	STOP	CS	ASME SA216 GR
8	20	4		LOCKWASHER ⅝ SIZE	316SS	
△ 2	19	4		HEX HD BOLT ⅝-11UNC-2A × 1¾	410SS	ASME SA193 GR
⊗ 8	18	1		GASKET 7½ OD × 1/8 THK	ASBESTOS	
△ 1	17	1	1114-190-4	LOWER BONNET	CS	ASME SA516
6	16	2		HEX NUT ⅝-11UNC-2B	316SS	ASTM A194 GR
6	15	2	4243 R.2	STUD	316SS (STRAIN HDN)	ASTM A193
6	14	1	4004	GLAND FOLLOWER	316SS	ASTM A[illegible]
6	13	1	3720	PACKING GLAND	316SS	ASTM A316
⊗ 8	12	5		PACKING TRINGS ⅜CS 1⅝ID	ASBESTOS	NUCLEAR GR
7	11	2	1301 R.20	THRUST WASHER	316SS	MICROSEAL
⊗ 7	10	2	1300 R.65	LOWER BEARING	316SS	MICROSEAL
⊗ 7	9	2	1300 R.65	UPPER BEARING	316SS	MICROSEAL
⊗ 8	8	1	2-385	O-RING	EPR	
⊗ 3	7	1	1114-195-4	SEAL RING	TEFZEL	
⊗ 4	6	3	1304 H.4	DISC PIN	17-4PH COND H1150	ASME SA564 GR
4	5	1	1302 R.267	LOWER STEM	17-4PH COND H1150	ASME SA564 GR
4	4	1	1304 [illegible]	STEM	17-4PH COND H1150	[illegible]
3	3	1	1144-190-5	DISC	316SS	[illegible]
3	2	1	1114-[illegible]	SEAT RING	CS	[illegible]
△ 1	1	1	3144-55-3	BODY	CS	[illegible]

LIST OF MATERIAL FOR ONE ASSY.

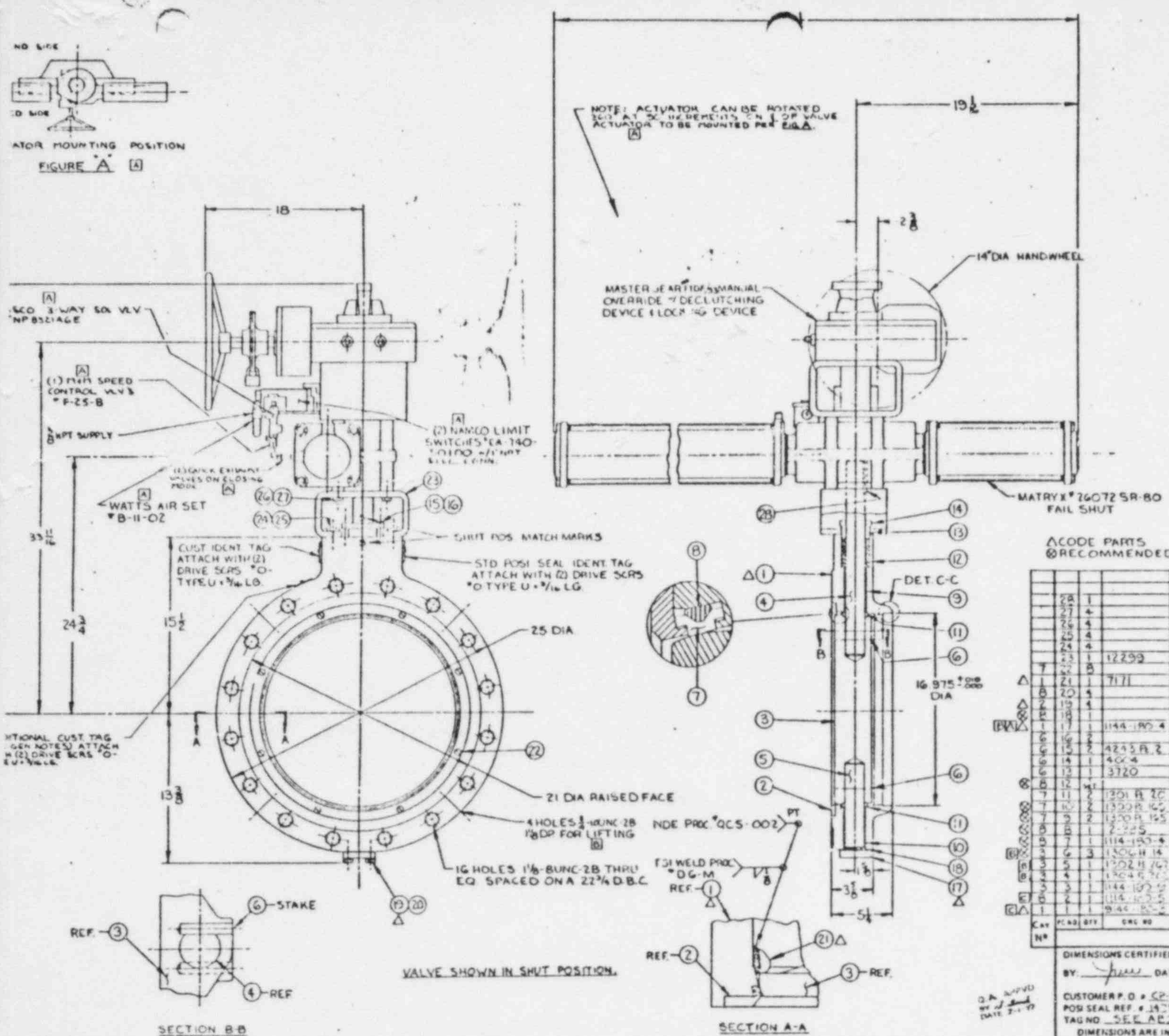
DIMENSIONS CERTIFIED CORRECT
BY: [signature] DATE: 3/1/77
CUSTOMER P.O. # CP-0086
POSI SEAL REF. # 14755 Z-2
TAG NO. SEE ABOVE
DIMENSIONS ARE IN INCHES

DRAWN PD 3-3-77
CHECKED KS 3-9-77
APPROVED [signature]

POSI SEAL INTERNATIONAL INC.
NORTH STONINGTON, CT. 06359

ASSY TITLE: 18"-CLASS 150 SINGLE FLG. WELD VLV ASS'Y & MATRYX® 26072 SR-80

D | DATE 3-3-77 | DRAWING NUMBER 14758-2



GENERAL NOTES:

TEXAS UTILITIES GENERATING COMPANY
% BROWN & ROOT INC.
COMANCHE PEAK STEAM ELECTRIC STATION UNIT #2
GLEN ROSE, TEXAS

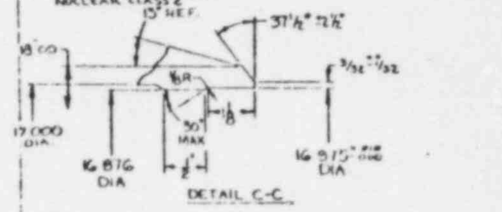
CUST. P.O. Nº CP-0086

TAG Nº: [A]
CP2-VADPBC-05 (HV-5549)
CP2-VADPBC-10 (HV-5548)

DESIGN PRESS: 50 PSIG
DESIGN TEMP: 300°F
MEDIA: AIR

THIS VALVE ASS'Y IS DESIGNED & MANUFACTURED IN ACCORDANCE WITH THE ASME B&PV CODE SECT. III, SUBSECTION NC CLASS 2, 1974 EDITION INCLUDING WINTER 1975 ADDENDA, INCLUDING CODE CASE 1621-1.

ADDITIONAL TAGGING (USE BACK OF 5854)



△ CODE PARTS
⊗ RECOMMENDED SPARE PARTS

	CAT Nº	PC NO	QTY	DWG NO	DESCRIPTION	MATERIAL	MAT'L SPECIFICATION
		28	1		KEY 3/8 SQ × 2" LG.	KEYSTOCK	
		27	4		LOCKWASHER ½ SIZE	CS	
		26	4		HEX HD BOLT ½-13UNC-2A × 1½	CS	ASTM A193 GR B
		25	4		LOCKWASHER ¼ SIZE	CS	
		24	4		HEX HD BOLT [illegible]	CS	ASTM A193 GR B
		23	1	12299	MOUNTING BRACKET	CS	
	7	22	8		FL HD MACH SCR [illegible]	316 SS	ASTM A193 GR B
△	1	21	1	7171	STOP	CS	ASME SA216 GR [illegible]
	8	20	4		LOCKWASHER ⅝ SIZE	316 SS	
△	2	19	4		HEX HD BOLT ⅝-11UNC-2A [illegible]	410 SS	ASME SA193 GR [illegible]
⊗	8	18	1		GASKET 22 OD × ⅛ THK	ASBESTOS	
[B][A]△	1	17	1	1144-180-4	LOWER BONNET	CS	[illegible]
	6	16	2		HEX NUT ⅝-11UNC-2B	316 SS	[illegible]
	6	15	2	4243 R 2	STUD	316 SS (STRAIN HDN)	ASTM A193 GR [illegible]
	6	14	1	4004	GLAND FOLLOWER	316 SS	[illegible]
	6	13	1	3720	PACKING GLAND	316 SS	[illegible]
⊗	8	12	[illegible]		PACKING [illegible]	ASBESTOS	NUCLEAR GRAD[illegible]
	7	11	2	1301 R 2C	THRUST WASHER	[illegible] SS	MICROSEAL
⊗	7	10	2	1300 R 165	LOWER BEARING	316 SS	MICROSEAL
⊗	7	9	2	1300 R 165	UPPER BEARING	316 SS	MICROSEAL
⊗	8	8	1	2-325	O-RING	EPR	
⊗	8	7	1	1114-180-4	SEAL RING	[illegible]	
[B]⊗	3	6	3	1306 H 14	[illegible] PIN	[illegible] PH COND H1100	[illegible]
[B]	3	5	1	1302 H 767	LOWER STEM	17-4 PH COND H1100	[illegible]
[B]	3	4	1	[illegible]	[illegible] STEM	17-4 PH COND H1100	[illegible]
	3	3	1	1144-180-[illegible]	[illegible]	[illegible] SS	[illegible]
[E]	6	2	1	1114-180-5	[illegible] RING	CS	[illegible]
[C]△	1	1	1	9144-180-2	BODY	CS	[illegible]

LIST OF MATERIAL FOR ONE ASSY.

DIMENSIONS CERTIFIED CORRECT BY: [signature] DATE 7-1-77	DRAWN HC	POSI SEAL INTERNATIONAL IN[C.] NORTH STONINGTON, CT. 06359
CUSTOMER P.O. # CP-0086		18"-CLASS 150 SINGLE FLG. WELD[ED] VLV ASS'Y & MATRYX #26072 SR-[80]
POSI SEAL REF. # 14759-2-2		D
TAG NO. SEE ABOVE		14759-2
DIMENSIONS ARE IN INCHES		

Q.A. APPVD [signature] DATE 7-1-77

POSI-SEAL
INTERNATIONAL, INC.

TECHNICAL BULLETIN NO. 2
VALVE SIZING

JUNE 82

I. INTRODUCTION

This technical bulletin is intended to assist in the selection of Posi-Seal trunnion valves to control a given set of flow conditions.

II. FLOW COEFFICIENT - C_V

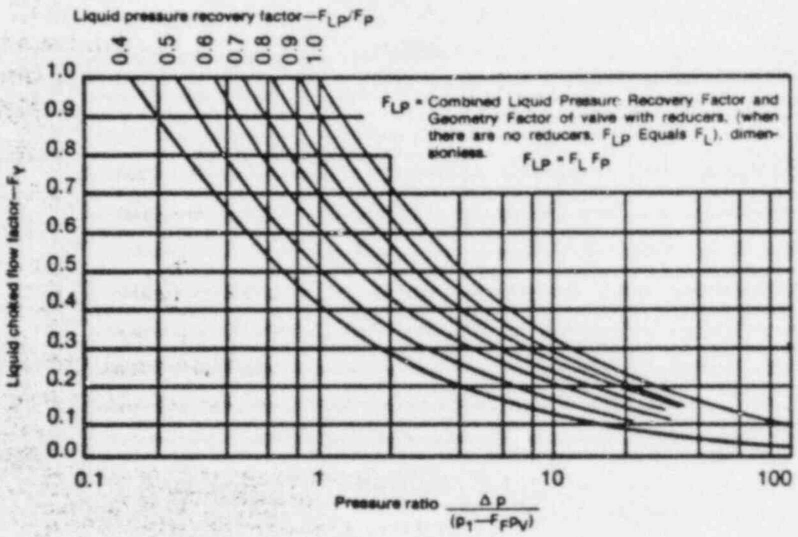
The flow coefficient or C_V of a valve is used to describe its inherent flow capacity. This value is defined as the number of U.S. gallons of water per minute at standard conditions (60°F and 14.7PSIA) that will flow thru a valve at a constant 1.0PSI pressure drop. Accordingly, a C_V value based on extensive flow testing of valves at these conditions has been assigned to each Posi-Seal trunnion valve. Using this C_V value, the capacity of each valve with regard to other fluids under various conditions can be related to this basic C_V value.

III. VALVE SIZING AND SELECTION

Proper valve sizing and selection of Posi-Seal trunnion valves are to be based on the following criteria.

1. Throttling control valves should be sized between the 15° and 80° disc open position.
2. To prevent actuator/valve instability resulting from a hydrodynamic torque reversal when flowing liquids for throttling service, valves should be installed with the retaining ring side of the valve downstream. Complete information on this torque reversal phenomenon can be found in Posi-Seal Technical Bulletin No. 1A.
3. The maximum recommended operating differential pressures and pipeline velocities noted in Posi-Seal Technical Bulletin No. 6 are to be used in valve selection.
4. Valve materials of construction are governed by media and operating conditions.
5. Liquid, gas and steam gas flow limitations are governed by the parameters noted in this technical bulletin.

FIGURE 1



PIPING EFFECTS

For valves that are installed in piping where the connecting pipe diameter is greater or less than the nominal valve diameter, the factor F_p is utilized in the sizing equations to account for additional friction losses due to piping reducers or expanders directly adjacent to the valve.

$$F_p = \sqrt{\frac{C^2_{vp}}{C^2_v + C^2_{vp}}}$$

$$C_{vp} = \frac{29.8D^2}{\sqrt{\left(1 - \frac{D^2}{D^2_2}\right)^2 + .5\left(1 - \frac{D^2}{D^2_1}\right)}}$$

WHERE:

C_{vp} = flow coefficient of pipe enlargement and contraction combined.

C_v = valve flow coefficient

D = ID of pipe equal to valve size, inches

D_1 = ID of upstream pipe, inches

D_2 = ID of downstream pipe, inches

FOR INSTALLATIONS WHERE D_1 EQUALS D_2:

WHERE:

$C_{vp} = KD^2$ D = ID of pipe equal to valve size, inches

K = Refer to Fig. 2

FIGURE 2

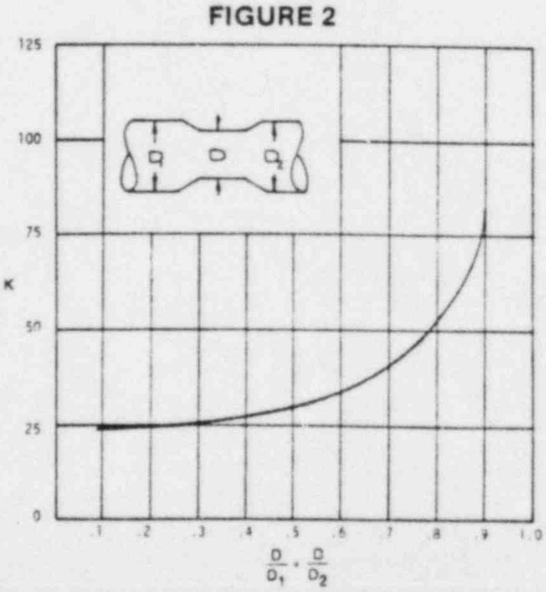


FIGURE 4

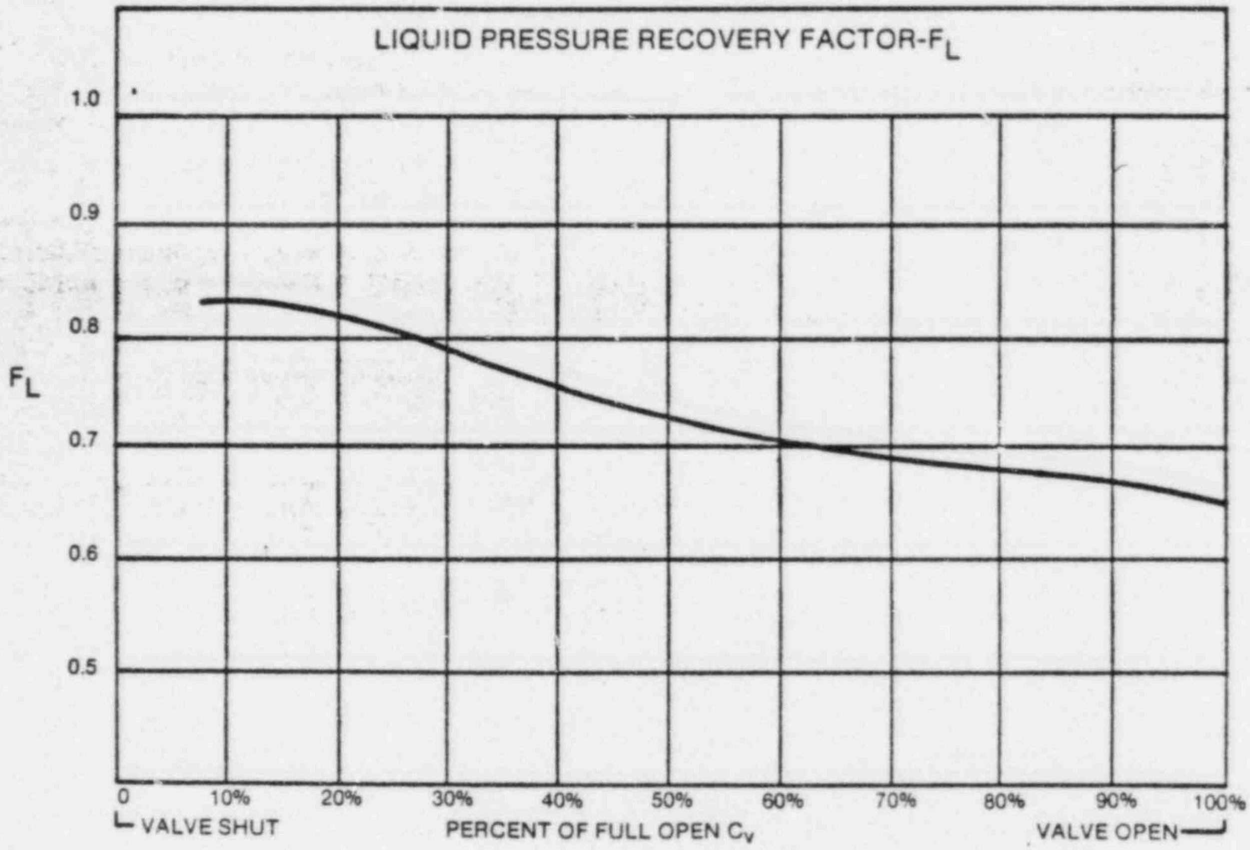
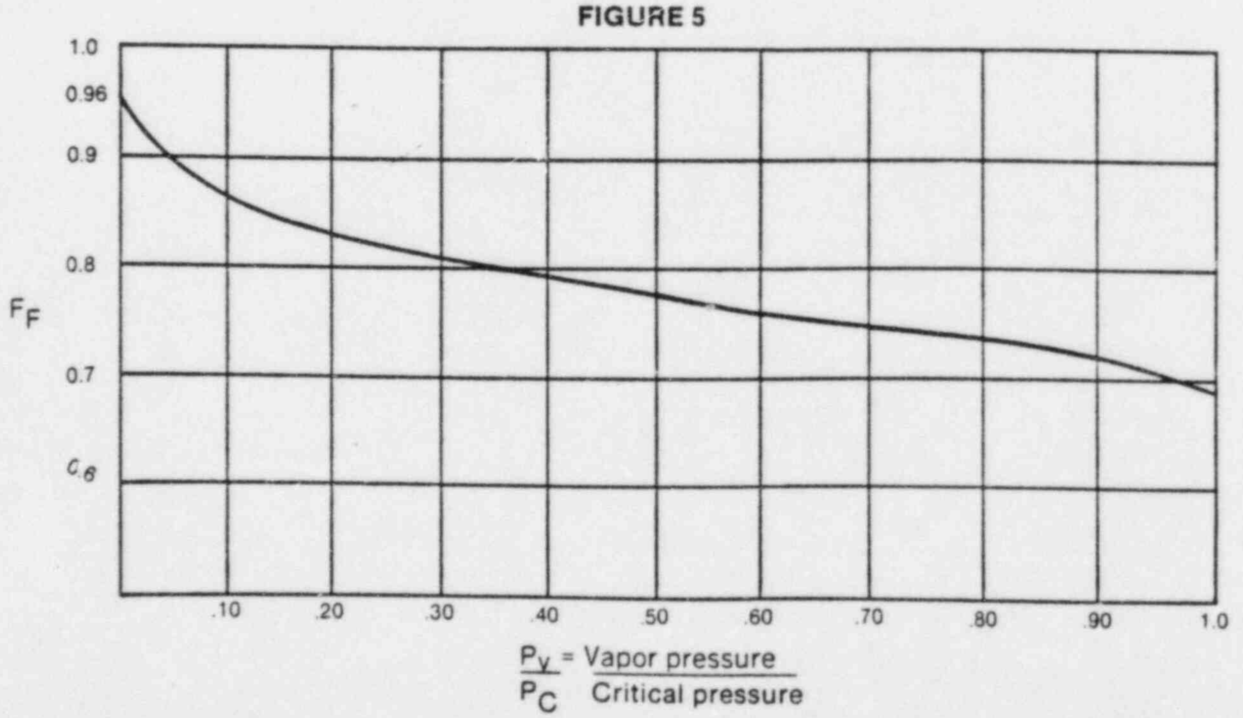


FIGURE 5



CRITICAL FLOW

$$Q_{MAX} = 907.12\, F_P C_v P_1 \sqrt{\frac{F_K X_T}{GT_1 Z}}$$

OR

$$C_{V\,MIN} = \frac{Q}{907.12\, F_P P_1 \sqrt{\frac{F_K X_T}{GT_1 Z}}}$$

$$\Delta_{Pc} = F_K X_T P_1$$

Q_{MAX} = Max Flow that can pass through valve at the stated conditions.

$C_{v\,MIN}$ = Minimum Required C_V in order to pass flow at the stated conditions.

Δ_{Pc} = Max usuable differential pressure drop above which no increase in flow will occur.

F_L = Rated Liquid Pressure Recovery Factor (See Figure 4).

FIGURE 6
X_T VS. % FLOW

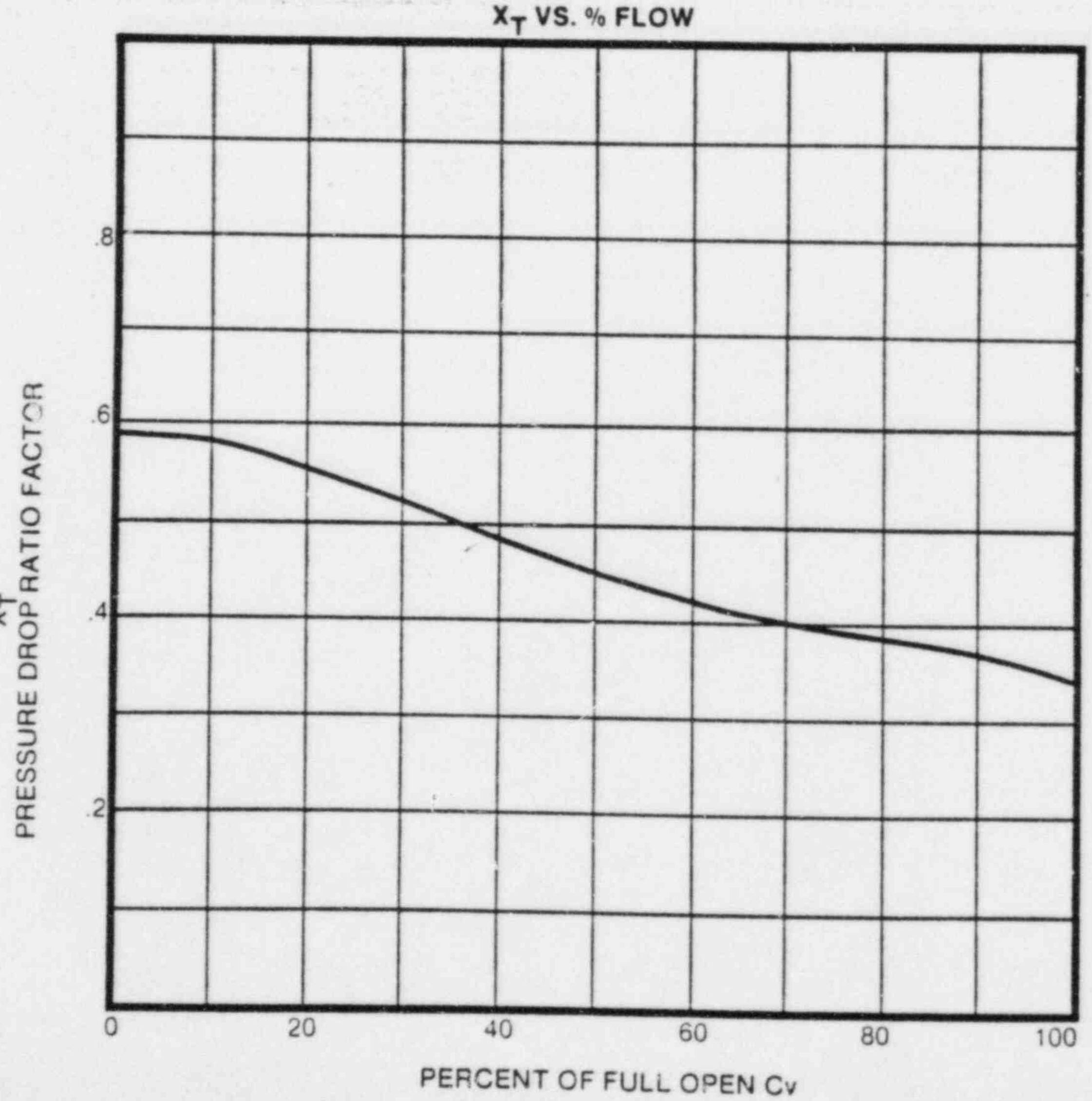


TABLE 1

PHYSICAL CONSTANTS OF VARIOUS FLUIDS

FLUID	FORMULA OR SYMBOL	MOLECULAR WEIGHT	BOILING POINT (°F @14.7 PSIA)	VAPOR PRESSURE @ 70°F (PSIG)	CRITICAL TEMPERATURE (°F)	CRITICAL PRESSURE (PSIA)	SPECIFIC GRAVITY LIQUID-G$_f$ 60°F/60°F	SPECIFIC GRAVITY GAS- G 60°F AIR=I
Acetic Acid	$HC_2H_3O_2$	60.05	245		612	841	I.05	
Acetic Anhydride	$(CH_3CO)_2O$	102.09	283			676		I.08
Acetone	C_3H_6O	58.08	I33		455	69I	0.79	2.0I
Acetylene	C_2H_2		-II9		97	9II	0.62	0.9I
Air	N_2O_2	28.97	-3I7		-22I	547	0.86	I.0
Alcohol , Ethyl	C_2H_6O	46.07	I73	2.3[I]	470	925	0.794	I.59
Alcohol , Methyl	CH_4O	32.04	I48	4.63[I]	463	II74	0.796	I.II
Ammonia	NH_3	I7.03	-28	II4	270	I636	0.62	0.59
Aniline	C_6H_7N	93.I2	365		798	770	I.02	
Argon	A	39.94	-302		-I88	705	I.65	I.38
Benzene	C_6H_6	78.II	I76	3.22[I]	552	7I0	0.88	2.69
Bromine	Br_2	I59.84	I38		575	I485	2.93	5.52
Butadiene	$CH_2CHCH:CH_2$	54.09	24			627		0.63
n-Butane	C_4H_{I0}	58.I2	3I	5I.6[I]	305	550	0.58	2.0
Butyl Alcohol	$C_2H_5CH_2CH_2OH$	74.I2	242			7II		0.8I
Carbon Dioxide	CO_2	44.0I	-I09	839	88	I072	0.80	I.52
Carbon Monoxide	CO	28.0I	-3I4		-220	507	0.80	0.97
Carbon Tetrachloride	CCL_4	I53.84	I70		542	66I	I.59	5.3I
Chlorine	CL_2	70.9I	-30	85	29I	III8	I.42	2.45
Dowtherm A						454	0.85[2]	
Dowtherm E						585	I.12[2]	
Ethane	C_2H_6	30.07	-I27		90	709	0.38	I.04
Ethyl Chloride	C_2H_5CL	64.52	55			2750	0.90	2.22
Ethylene	C_2H_4	28.05	-I54		48	742		0.97
Ethyl Ether	$C_4H_{I0}O$				383	522		0.46
Fluorine	F_2	38.00	-305	300	-200	809	I.II	I.3I
Helium	He	4.003	-454		-450	33	0.I8	0.I4
Hydrochloric Acid	HCL	36.47	-II5				I.64	
Hydrogen	H_2	2.0I6	-422		-400	I88	0.07	0.07
Hydrogen Chloride	HCL	36.47	-II5	613	I25	II98	0.86	I.26
Hydrogen Sulfide	H_2S	34.07	-76	252	213	I308	0.79	I.I7
Isobutane	C_4H_{I0}	58.I2	II	72.2	274	529	0.56	2.0I
Isopropyl Alcohol	C_3H_8O	60.09	I80		455	779	0.78	2.08
Methane	CH_4	I6.04	-258		-II6	673	0.30	0.55
Methyl Chloride	CH_3CL	50.49	-II	59	290	967	0.99	I.78
Naphthalene	$C_{I0}H_8$	I28.I6	424				I.I4	4.43
Nitric Acid	HNO_3	63.02	I87				I.5	
Nitrogen	N_2	28.02	-320		-233	492	0.8I	0.97
n-Octane	C_8H_{I8}	II4.23	258	0.54[I]	564	362	0.7I	3.94
Oxygen	O_2	32.00	-297		-I8I	730	I.I4	I.I05
n-Pentane	C_5H_{I2}	72.I4	96	I5[I]	386	485	0.63	2.49
Phenol	$C_6H_5\cdot OH$	94.II	358		786	889	I.07	
Phosphoric Acid	H_3PO_4	98.00	4I5				I.83	
Propane	C_3H_8	44.I0	-43	I90[I]	206	6I7	0.5I	I.52
Propylene	$CH_3CH:CH_2$	42.08	-54		I98	66I		0.6I
Proplyl Alcohol	$CH_3CH_2CH_2OH$	60.09	208			735		0.80
Proplyl Chloride	$CH_3CH_2CH_2CL$	78.54	II5			664		0.89
Refrigerant II	CCL_3F	I37.38	75	I3.4	388	635		5.04
Refrigerant I2	CCL_2F_2	I20.93	-22	70.2	234	597		4.2
Refrigerant 2I	$CHCL_2F$	I02.93	48	9.4	353	750		3.82
Refrigerant 22	$CHCLF_2$	86.48	-4I	I22.5	205	7I3		
Styrene	C_8H_8	I04.I5	293	0.24[I]	706	580	0.9I	3.59
Sulfur Dioxide	SO_2	64.6	I4	34.4	3I6	II42	I.39	2.2I
Toluene	C_7H_8	92.I4	23I	I.03[I]	605	6II	0.87	3.I8
Water	H_2O	I8.0I6	2I2	0.95	706	3206.2	I.00	0.62

I. Vapor Pressure in PSIA @ I00°F
2. Specific Gravity @ 494.8°F.

TABLE 3
COMPRESSIBILITY FACTORS FOR GAS

Gas	Pressure atm	psia	-100 F	0 F	200 F	1000 F	2000 F
Argon	1	14.7	0.997	0.999	1.000	1.000	1.000
	10	147	0.970	0.987	0.999	1.003	1.002
	40	588	0.877	0.952	0.995	1.011	1.009
	100	1470	0.690	0.887	0.995	1.029	1.022
Carbon monoxide	1	14.7	0.997	0.999	1.000	1.000	1.000
	10	147	0.973	0.991	1.001	1.001	1.003
	40	588		0.967	1.007	1.017	1.012
	100	1470			1.027	1.044	1.031
Carbon dioxide	1	14.7		0.991	0.997	1.000	1.000
	10	147		0.910	0.974	1.001	1.003
	40	588			0.894	1.006	1.010
	100	1470			0.721	1.018	1.026
Hydrogen	1	14.7	1.001	1.001	1.001		
	10	147	1.007	1.006	1.005		
	40	588	1.028	1.026	1.021		
	100	1470	1.076	1.067	1.052		

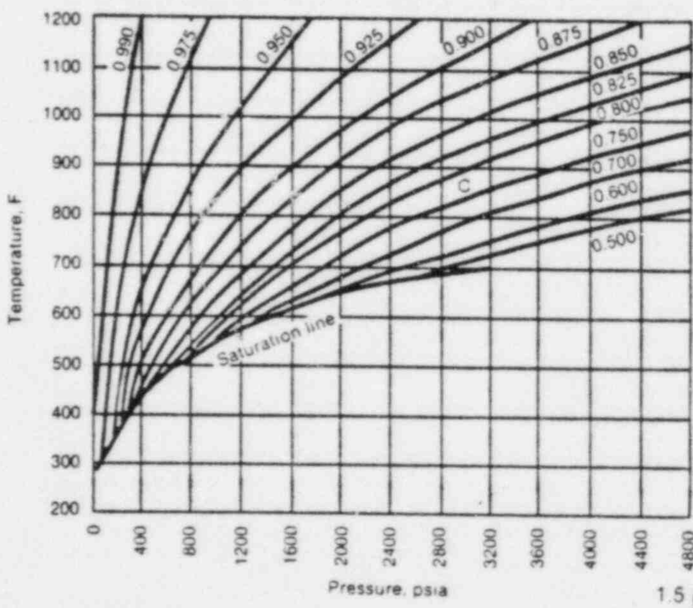


FIGURE 10
COMPRESSIBILITY FACTORS
FOR SUPERHEATED STEAM

FIGURE 11
COMPRESSIBILITY FACTORS
FOR NITROGEN

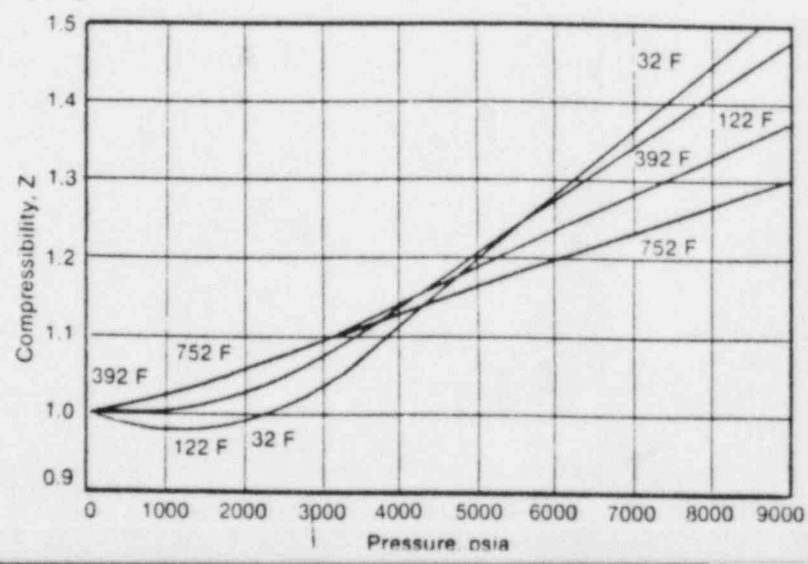


TABLE 6
SUPERHEATED VAPOR

Pressure (psia)		Temperature (°F)													
		200	260	300	360	400	460	500	600	700	800	900	1000	1100	1200
	v	38.85	42.56	45.00	48.63	51.04	54.05	57.05	63.04	69.01	74.98	80.95	86.92	92.88	98.84
10	h	1146.6	1175.1	1193.9	1221.9	1240.6	1268.7	1287.5	1335.1	1383.4	1432.5	1482.4	1533.2	1585.0	1637.6
	s	1.7927	1.8341	1.8595	1.8950	1.9172	1.9488	1.9689	2.0160	2.0596	2.1002	2.1383	2.1744	2.2086	2.2413
	v		21.11	22.36	24.21	25.43	27.25	28.46	31.47	34.47	37.46	40.45	43.44	46.42	49.41
20	h		1172.2	1191.6	1220.3	1239.2	1267.6	1286.6	1334.4	1382.9	1432.1	1482.1	1533.0	1584.7	1637.4
	s		1.7545	1.7808	1.8170	1.8396	1.8716	1.8918	1.9392	1.9829	2.0235	2.0618	2.0978	2.1321	2.1648
	v			8.773	9.557	10.065	10.815	11.309	12.532	13.744	14.950	16.152	17.352	18.550	19.747
50	h			1184.3	1215.2	1235.1	1264.5	1283.9	1332.5	1381.4	1430.9	1481.1	1532.1	1584.0	1636.8
	s			1.6721	1.7112	1.7349	1.7680	1.7887	1.8368	1.8809	1.9219	1.9602	1.9964	2.0308	2.0636
	v				4.663	4.937	5.333	5.589	6.218	6.835	7.446	8.052	8.656	9.259	9.860
100	h				1205.7	1227.6	1258.8	1279.1	1329.1	1378.9	1428.9	1479.5	1530.8	1582.9	1635.7
	s				1.6258	1.6518	1.6869	1.7085	1.7581	1.8029	1.8443	1.8829	1.9193	1.9538	1.9867
	v				3.023	3.223	3.502	3.081	4.113	4.532	4.944	5.352	5.758	6.162	6.564
150	h				1195.1	1219.4	1252.9	1274.1	1325.7	1376.3	1426.9	1477.8	1529.4	1581.7	1634.7
	s				1.5706	1.5995	1.6372	1.6599	1.7109	1.7566	1.7984	1.8374	1.8740	1.9086	1.9416
	v					2.361	2.585	2.726	3.060	3.380	3.693	4.002	4.309	4.613	4.917
200	h					1210.3	1246.5	126[illegible]9	1322.1	1373.6	1424.8	1476.2	1528.0	1580.5	1633.7
	s					1.5594	1.6001	1.6240	1.6767	1.7232	1.7655	1.8048	1.8415	1.8763	1.9094
	v						1.6638	1.7675	2.005	2.227	2.442	2.652	2.859	3.065	3.269
300	h						1232.5	1257.6	1314.7	1368.3	1420.6	1472.8	1525.2	1578.1	1631.7
	s						1.5434	1.5701	1.6268	1.6751	1.7184	1.7582	1.7954	1.8305	1.8638
	v							0.9927	1.1591	1.3044	1.4405	1.5715	1.6996	1.8256	1.9504
500	h							1231.3	1298.6	1357.0	1412.1	1466.0	1519.6	1573.4	1627.6
	s							1.4919	1.5588	1.6115	1.6571	1.6982	1.7363	1.7719	1.8056
	v								0.7934	0.9077	1.0108	1.1082	1.2024		1.3853
700	h								1280.6	1345.0	1403.2	1459.0	1513.9		1623.5
	s								1.5084	1.5665	1.6147	1.6573	1.6963		1.7666
	v								0.5140	0.6084	0.6878	0.7604	0.8294	0.8962	0.9615
1000	h								1248.8	1325.3	1389.2	1448.2	1505.1	1561.3	1617.3
	s								1.4450	1.5141	1.5670	1.6121	1.6525	1.6897	1.7245
	v									0.2489	0.3074	0.3532	0.3935	0.4311	0.4668
2000	h									1240.0	1335.5	1409.2	1474.5	1536.2	1596.1
	s									1.3783	1.4576	1.5139	1.5603	1.6012	1.6384
	v									0.0984	0.1760	0.2159	0.2476	0.2757	0.3018
3000	h									1060.7	1267.2	1365.0	1441.8	1510.0	1574.3
	s									1.1966	1.3690	1.4439	1.4984	1.5437	1.5837

TABLE 9

VALVE FLOW COEFFICIENTS C_v

CLASS 300 STD. RATING

Valve Size	DEGREES OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
1 1/2"	1	3	6	10	15	22	29	34	38
2"	2	4	9	15	23	34	43	51	57
3"	6	14	29	50	77	111	143	167	188
4"	12	30	63	107	165	238	307	359	404
6"	32	81	167	285	441	635	818	957	1076
8"	40	100	206	352	545	783	1010	1183	1329
10"	71	178	367	628	971	1398	1800	2108	2369
12"	110	276	570	975	1509	2172	2797	3276	3681
14"	136	341	704	1204	1863	2681	3454	4045	4545
16"	169	422	873	1492	2309	3323	4280	5012	5632
18"	247	617	1276	2181	3374	4856	6255	7325	8230
20"	286	714	1476	2524	3906	5620	7240	8478	9526
24"	375	938	1939	3315	5129	7381	9508	11135	12511
30"	715	1788	3696	6319	9776	14068	18121	21221	23844
36"	1104	2760	5704	9752	15087	21711	27967	32751	36799
42"	1711	4279	8843	15118	23390	33659	43358	50774	57050
48"	1867	4667	9645	16490	25513	36713	47292	55381	62226

Table 10

FLOW COEFFICIENTS C_v

CLASS 600 STD. RATING

Valve Size	DEGREES OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	5	16	31	51	84	122	151	169	182
4"	8	23	43	70	116	169	209	234	252
6"	26	78	147	242	397	579	717	803	864
8"	35	104	197	324	532	775	960	1076	1157
10"	62	185	350	576	947	1379	1709	1915	2059
12"	85	255	481	793	1302	1897	2350	2633	2831
14"	104	312	589	971	1595	2323	2878	3225	3468
16"	128	383	723	1192	1958	2851	3532	3958	4256
18"	152	456	862	1420	2332	3397	4208	4715	5070
20"	175	524	990	1630	2678	3900	4831	5413	5821
24"	349	1046	1977	3256	5349	7791	9651	10814	11628

HYDRODYNAMIC TORQUE

OF

HIGH PERFORMANCE TRUNNION VALVES

The increased use of High Performance Trunnion (Offset Buterfly) Valves has caused increased use in high flow applications and therefore, a need for a more accurate prediction of the Hydrodynamic Torque behavior of this type of valve. Improper actuator sizing, structural damage and control instability are all possible consequences of using inaccurate Hydrodynamic Torque data.

The Trunnion Valve is essentially a modified butterfly valve with the rotary stem offset from the disc sealing surface. See Figure 1. Normally, this style of valve exhibits high opening and closing torques with operating torques depreciating as the valve disc rotates 90° to the fully open position. However, on occasions where a considerable quantity of fluid is being pumped through the valve, the Hydrodynamic Torque may exceed the opening torque or be of sufficient magnitude that the actuator will be unable to further open the valve.

Realizing the importance of having accurate Hydrodynamic Torque data, Posi-Seal International, Inc. in North Stonington, Conn. launched an extensive R&D program inorder to obtain this data. At Posi-Seal's new Hydraulics Laboratory, (See Figure 2 for schematic of lab), Hydrodynamic Torque data was measured on valve sizes 1 1/2" through 14" for valve classes 150 through 600 lb. Additional data was taken on a 14" - 900 and a 14" - 1500 lb. valve. Data was recorded for both preferred and non-preferred fluid flow, measured at every 10 degrees of valve rotation. Inorder to obtain the Hydrodynamic Torque factors, the valve torque was measured while both opening and closing the valve. By averaging the above data, stem packing and bearing friction torques were negated and pure Hydrodynamic Torque was obtained. The above measured torque when divided by the differential pressure across the valve yielded the Hydrodynamic Torque factor for that particular valve at that angular location. This data was statistically analyzed on Posi-Seal's

technical mini computer and equations were developed from which Hydrodynamic Torque factors were calculated for all sizes and classes of high performance Trunnion Valves.

Based upon the flow testing performed at Posi-Seal, the following general observations concerning Hydrodynamic Torque of Trunnion Valves can be made:

(1) For preferred flow, the Hydrodynamic Torque will always want to close the valve. See Figure 3.

(2) For non-preferred flow, the Hydrodynamic Torque will, through 70° to 80° of valve rotation (the exact location varies with valve class), want to close the valve. Beyond this point, the Hydrodynamic Torque will want to open the valve. See Figure 4.

(3) Except for the 90° valve location where the Hydrodynamic Torque factors are of equal magnitude for both preferred and non-preferred flow but of opposite sign, the non-preferred Hydrodynamic Torque factors are considerably less in magnitude than those for preferred flow. See Figures 3 and 4.

(4) All of the Hydrodynamic Torque factors (for both preferred and non-preferred flow) decrease with increase in valve class. ex: Hydrodynamic Torque factors for a 600 lb. valve are significantly less than those for a 150 lb. valve. See Figures 3 and 4.

(5) The Hydrodynamic Torque factors increase approximately proportional to the cube of the valve size. (The exact amount varies depending upon valve class).

The total Trunnion Valve Torque at some angular position (other than opening or closing) is in actuality a summation of three separate torques, stem packing torque, bearing friction torque and the Hydrodynamic Torque discussed above. Except for small size valves (6" and less), the stem packing torque is a small percentage of the total valve torque. For large sized valves, above approximately 45°, the Hydrodynamic Torque is the major component of the total valve torque, below 45° bearing friction torque becomes the major contributor. All three components must be considered inorder to accurately evaluate a valve's performance.

Inorder to better understand the reason for Hydrodynamic Torque occuring, one must visualize the valve's disc as an airfoil. The Hydrodynamic Torque generated at some angle is a composite of fluid flow lift and drag forces acting over the disc's surface. The general formulas for lift and drag being:

$$F_D = C_D P \frac{AV^2}{2} \qquad \text{(Drag)}$$

and

$$F_L = C_L P \frac{AV^2}{2} \qquad \text{(Lift)}$$

Where:

C_D, C_L - Drag and lift coefficients which are related to the geometry of flow obstruction. (Disc)

P - density of the fluid medium

A - projected or surface area of flow obstruction (Disc)

V - velocity of fluid medium

Both the lift and drag forces are dependent upon the shape of the valve disc, its orientation to the flow stream and the direction of fluid flow. As the valve angle is decreased, or flow is reversed, both the magnitude and location of these forces shift causing a change in the resultant Torque. As the valve angle is further decreased the drag forces will increase while the lift forces will deteriate due to increased turbulence and a breakdown of the flow stream along the downstream side of the valve disc. See Figures 5 and 6.

FIGURE No.: 1
SCHEMATIC
OF
HIGH PERFORMANCE TRUNION VALVE

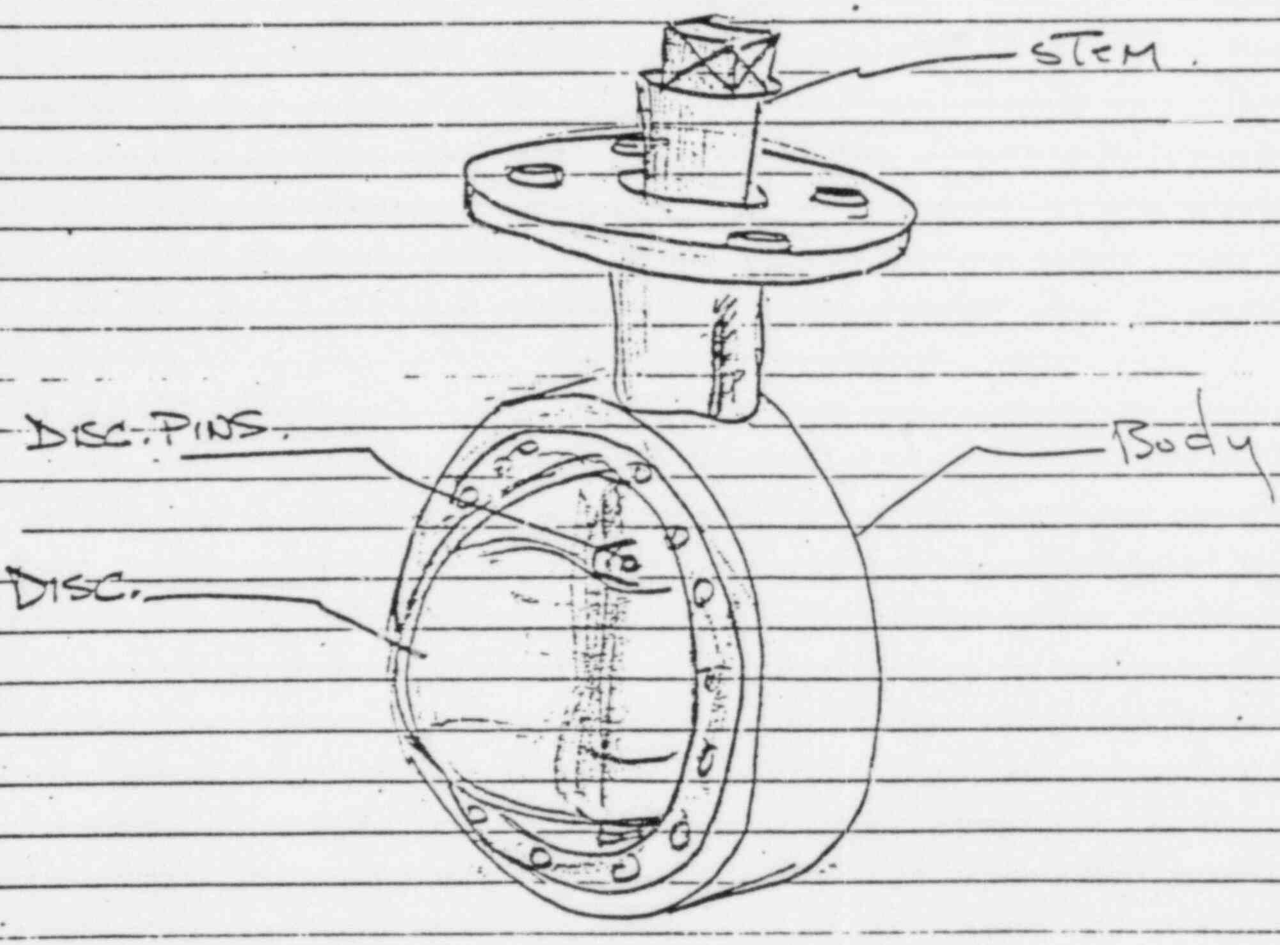
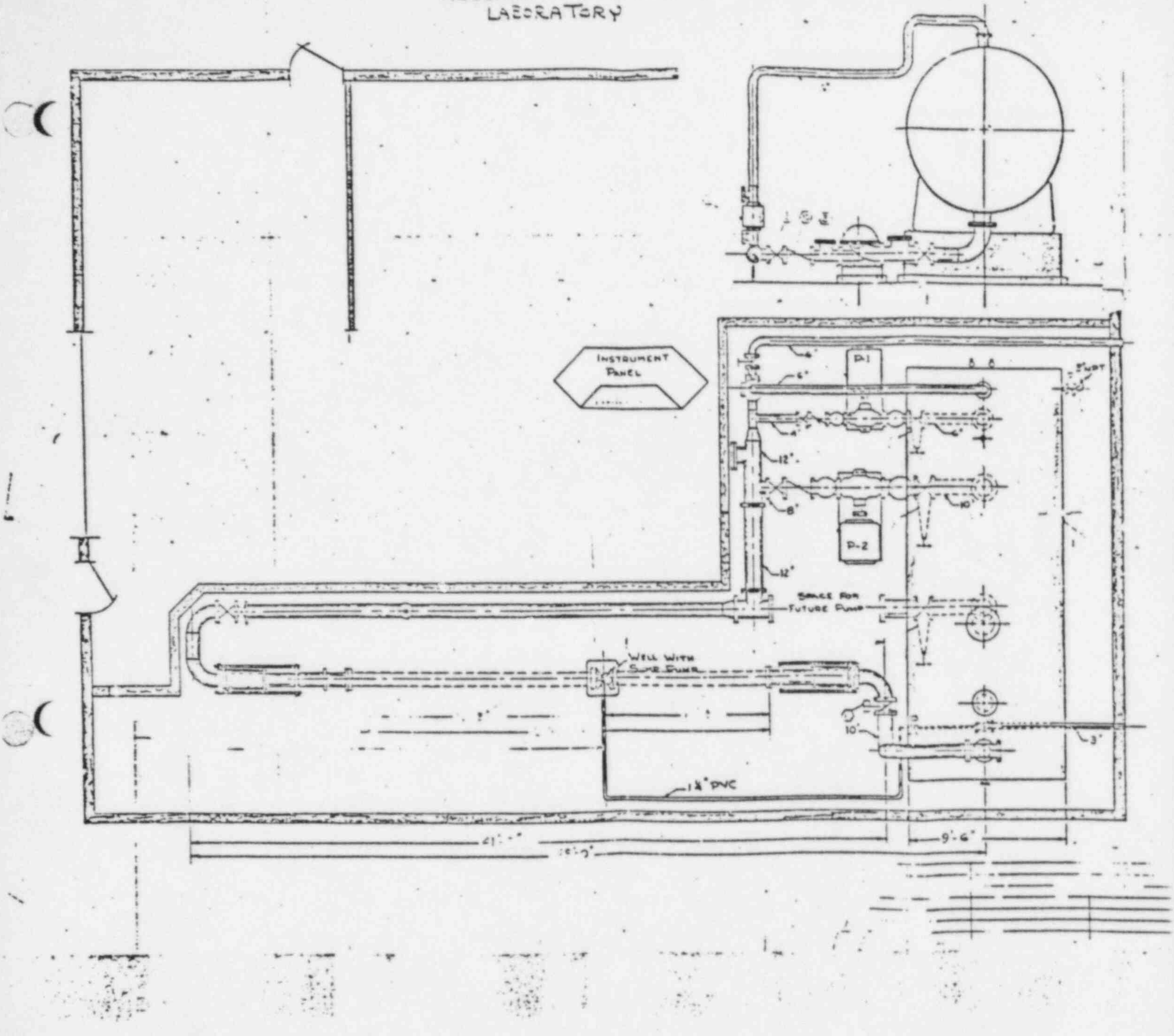


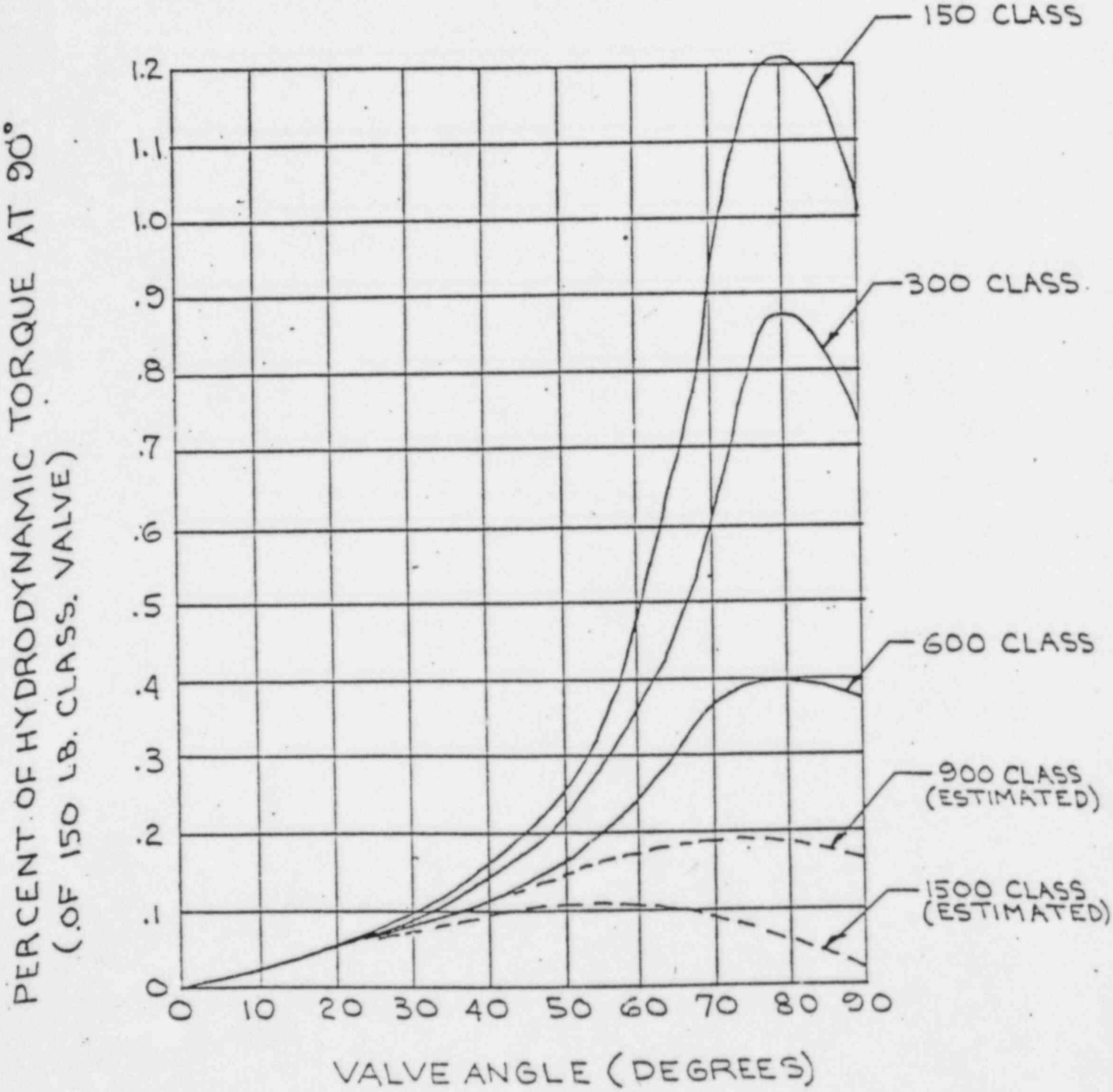
FIGURE NO. 2

SCHEMATIC OF POSI-SEAL
RESEARCH & DEVELOPMENT
LABORATORY



VS

VALVE ANGLE

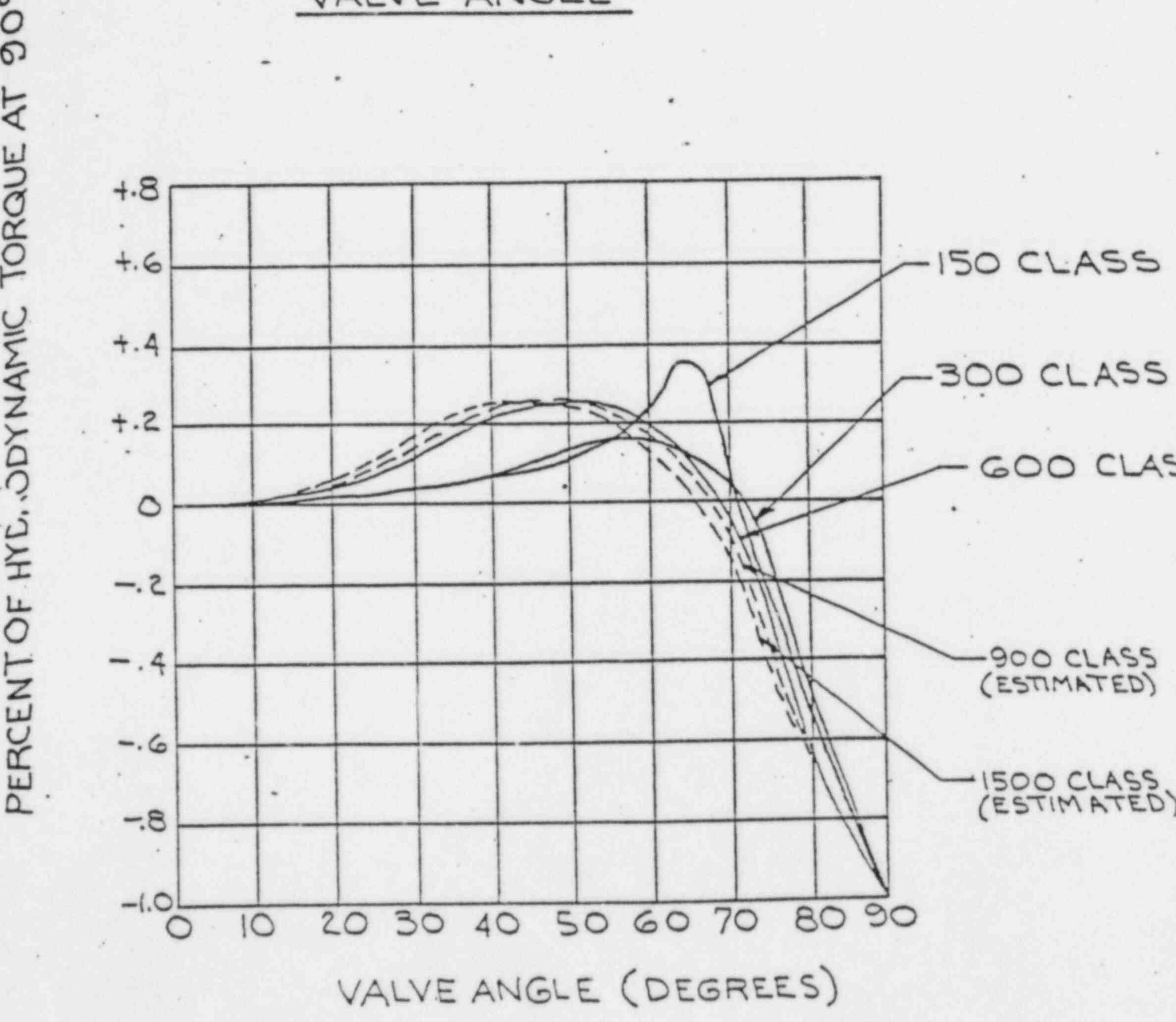


PREFERRED DIRECTION

ØANSEN

FIGURE No.: 3

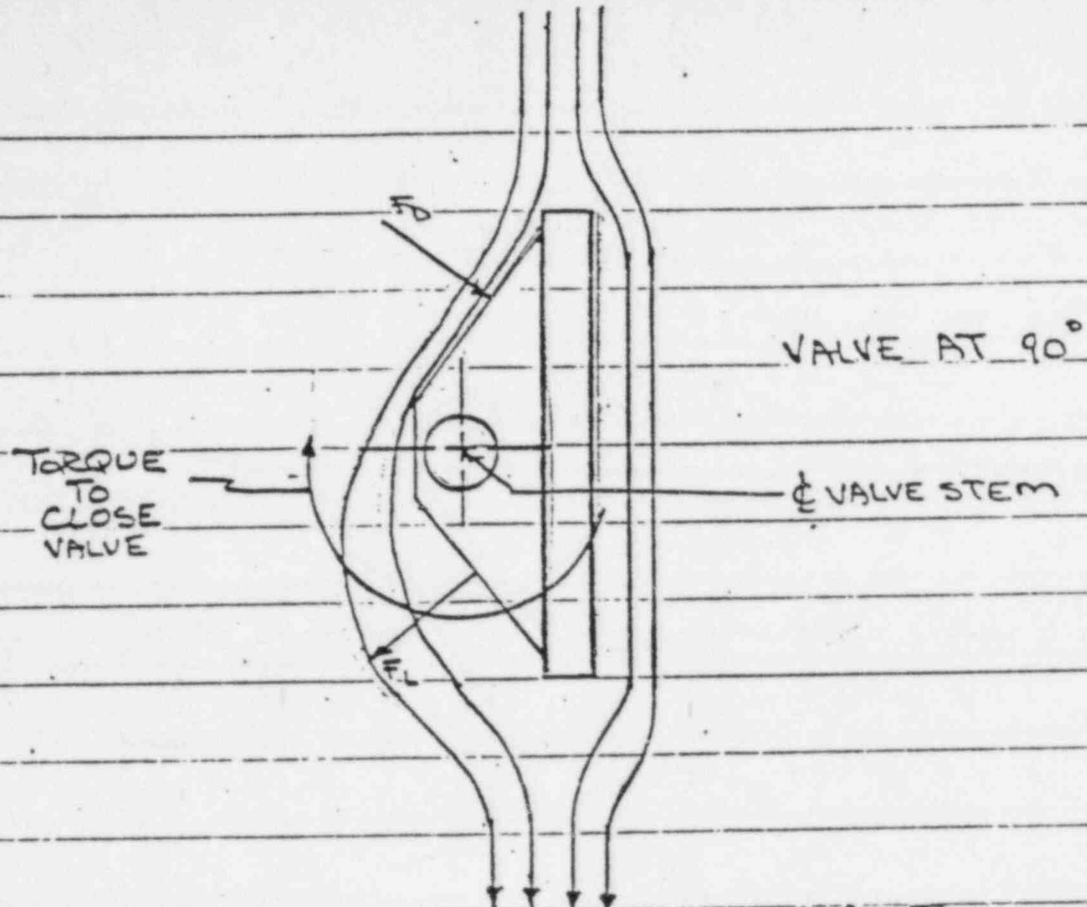
HYDRODYNAMIC TORQUE VS VALVE ANGLE



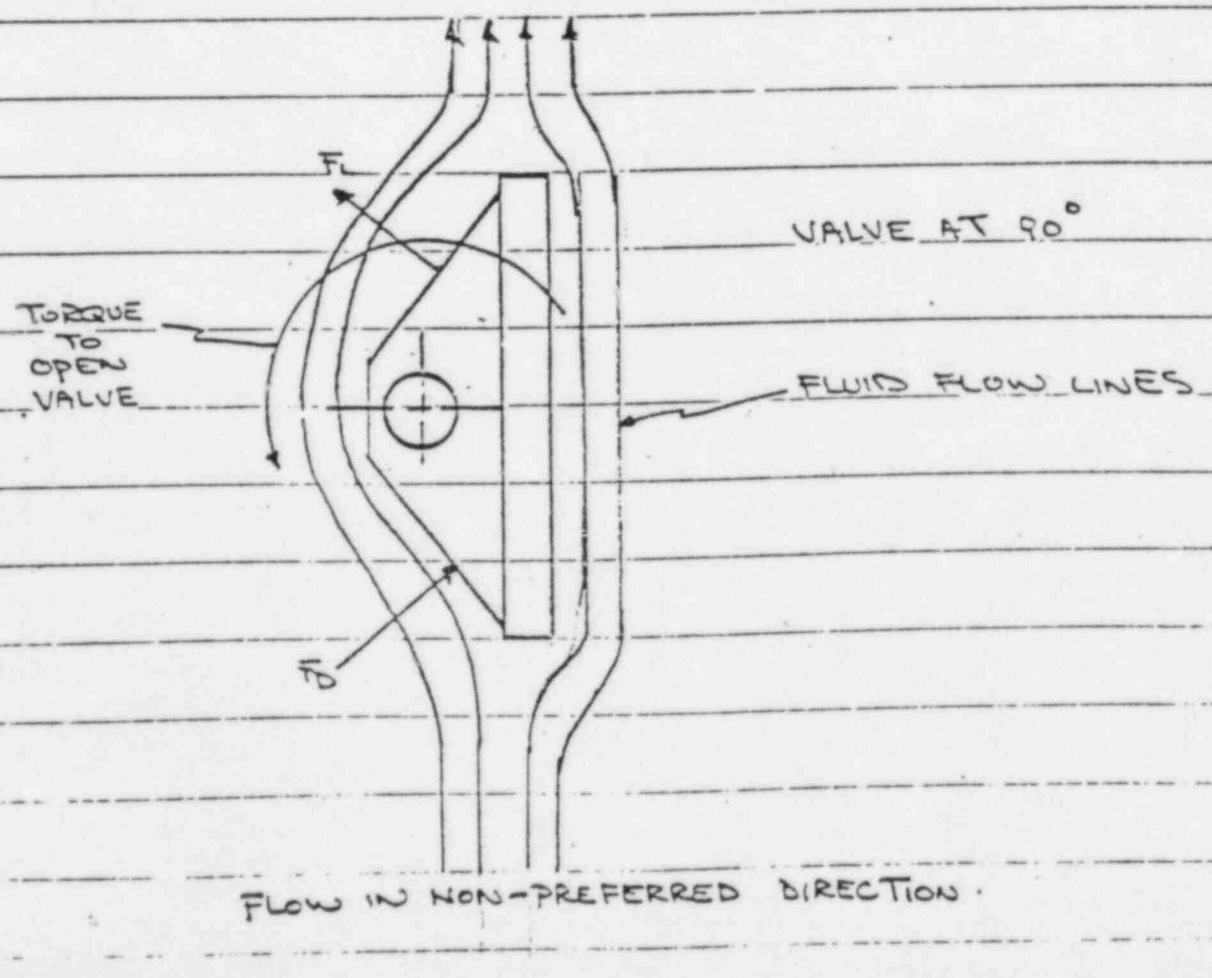
NON PREFERRED DIRECTION

ØANSEN

FIGURE No.: 4

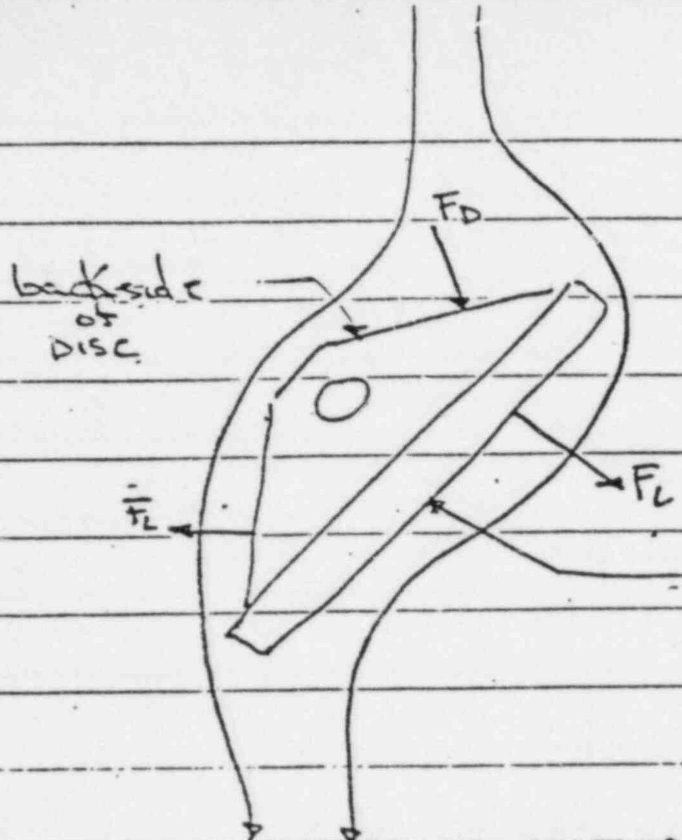


FLOW IN PREFERRED DIRECTION



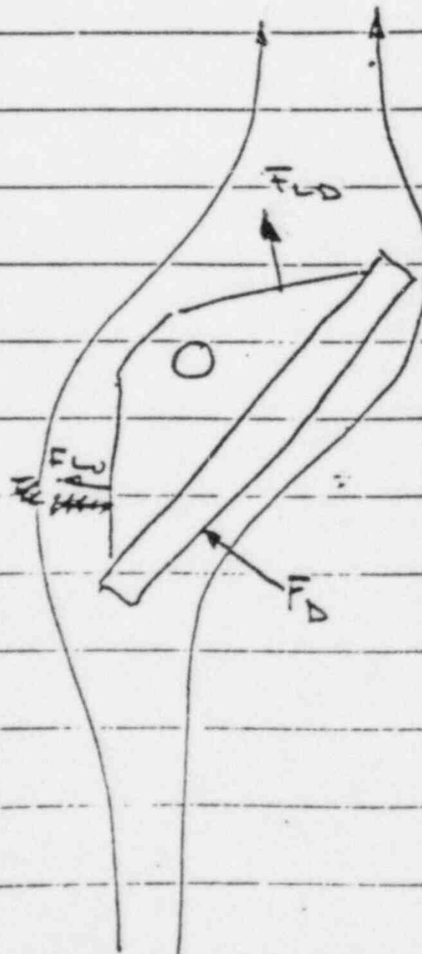
FLOW IN NON-PREFERRED DIRECTION.

FIGURE 5



VALVE ANGLE = 70°

FLOW IN PREFERRED DIRECTION.

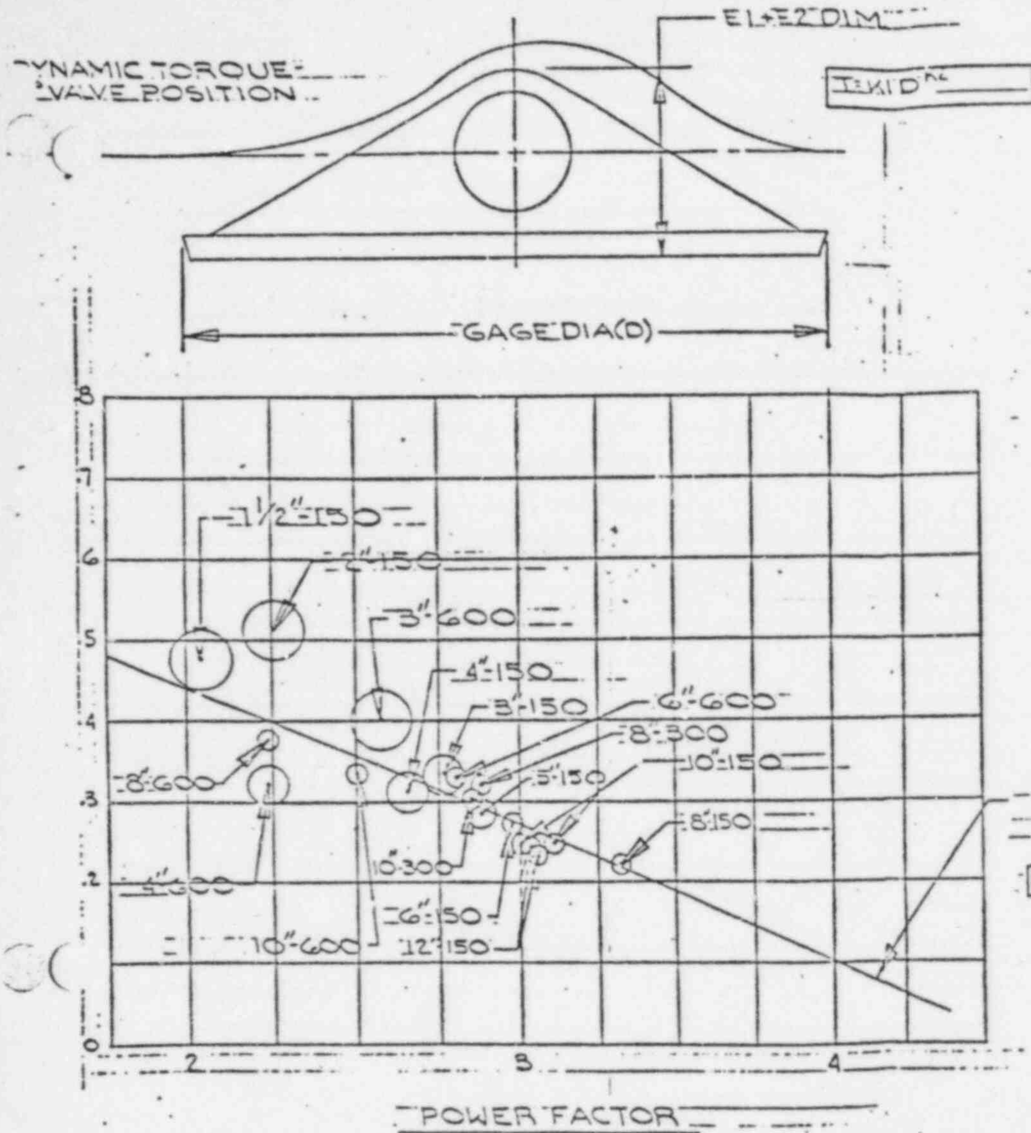


VALVE ANGLE = 70°

FLOW IN NON-PREFERRED DIRECTION

FIGURE 6

SHAPE FACTOR VS. POWER FACTOR



T = HYDRODYNAMIC TORQUE (IN-L
D = DISC. GAGE DIA. (IN).
K1 = SHAPE FACTOR

$$= \frac{E1 + E2}{D}$$

K2 = POWER FACTOR
= Bo + B1 K1

Bo, B1 = COEFFICIENTS DETERMINED BY LINEAR REGRESSION ANALYSIS OF EMPIRICAL DATA

OR:

$$K2 = \frac{LN[T/K1]}{LND}$$

Bo = +4.6098
B1 = -5.9150
PER LEAST SQUARE REGRESSION ANALYSIS

K2 = 4.6098 - 5.915 K1

FIGURE 7

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By [signature] DATE: 12/12/77 Checked By

VALVE SIZE: 3" 150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / ~~BUNA~~

WATER TEMPERATURE (TANK): 68 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	[illegible]/PSI
OPENING	0					
	10	—	42	—	+45	1.1
	20	—	41		+55	1.3
	30	—	39		+60	1.5
	40	—	36	—	+75	2.1
	50	—	33		+85	2.6
	60	—	31.5		+100	3.2
	70	—	27	27	+140 125	5.2
	80		22		+155	7.0
	90	—	19		+140	7.4
CLOSING	90	—	19	—	+120	6.7
	80	—	22		+140	6.4
	70	—	25	27	~~+145~~ 110	4.1
	60		~~34~~		+100	~~2.9~~
	50		42.5		+80	1.9
	40		40.5		+60	1.5
	30		42		+30	0.7
	20		45		+10	0.2
	10	—	46	—	0	0
	0					

PACKING TORQUE: +10 IN-LB OPENING

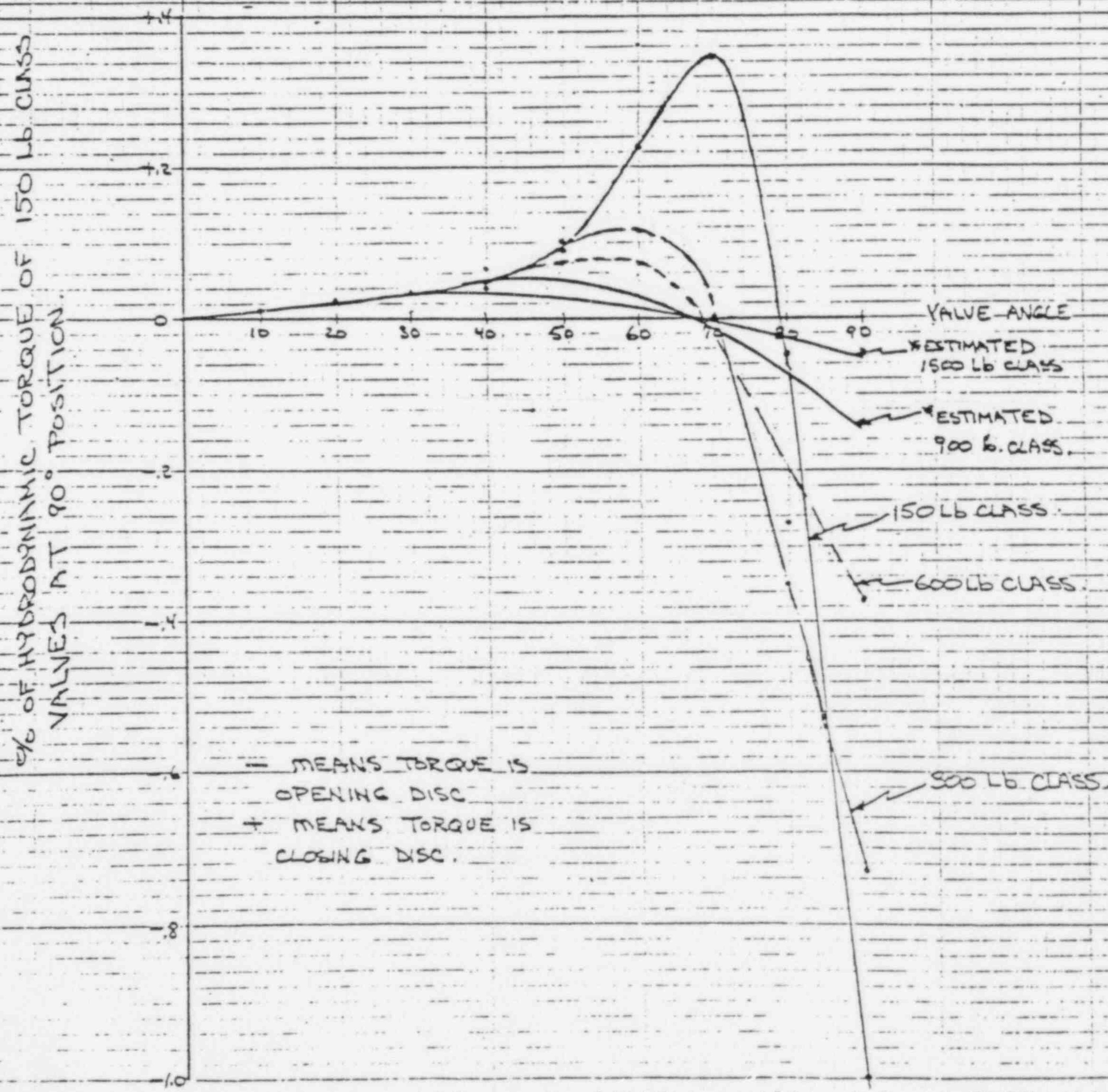
: +5 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title NON-PREFERRED DIRECTION Page

Calc. By Checked By

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE.

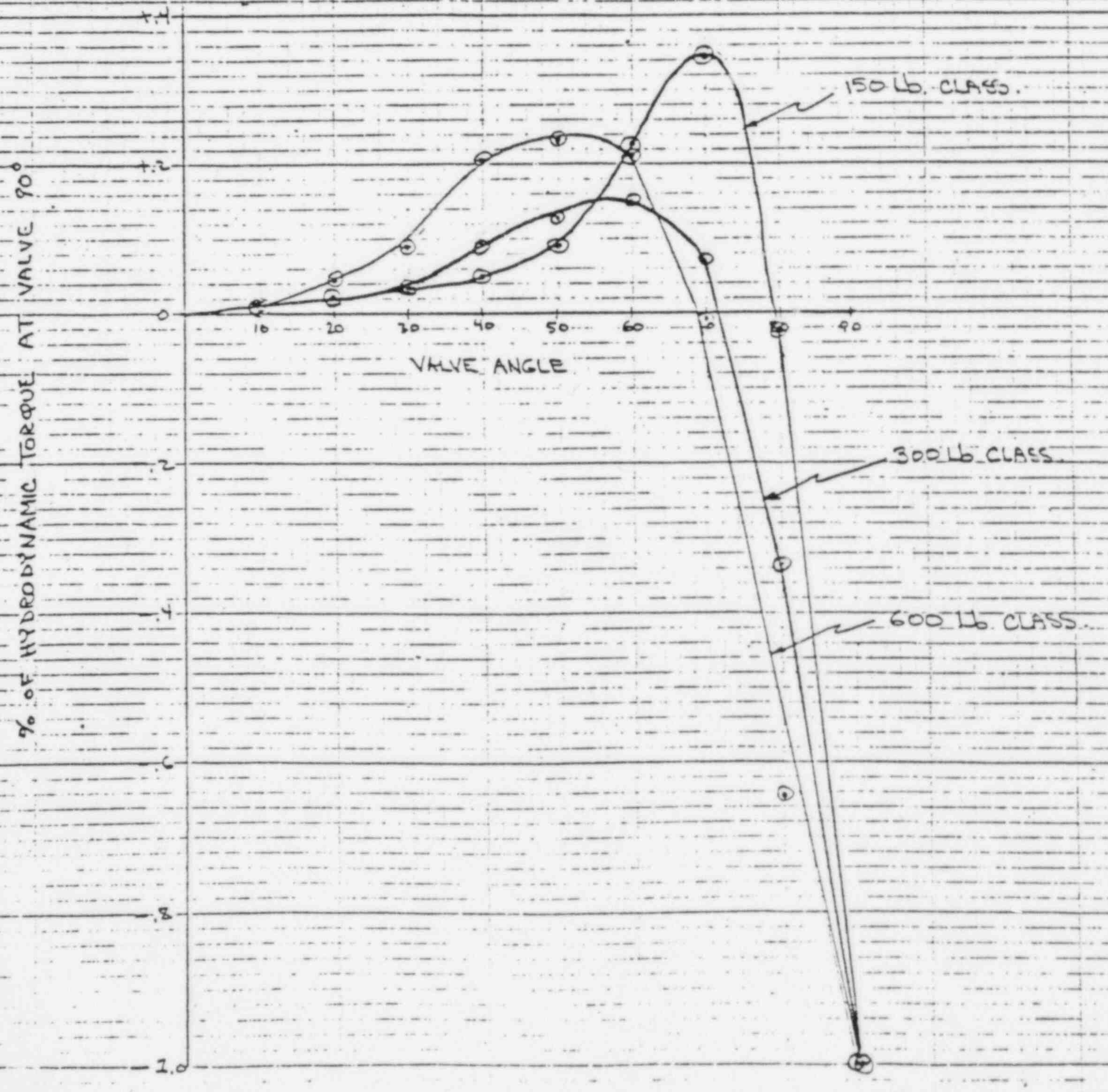


ENGINEERING CALCULATIONS

Title NON PREFERRED DIRECTION Page

Calc By Checked By

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE



Title HYDRODYNAMIC TORQUES Page

Calc. By NON-PREFERRED DIRECTION Checked By ØANSEN 8/15/78

ANGLE	VALVE SIZE - % TORQUE @ 90°				AVG.
	10"-150	8"-150	12"-150		
90	(-378.5) -1.0	(-178) -1.0	(-468.5) -1.0		-1.0
80	(-117) -.309	(+38.7) +.217	(+20.5) +.044		-.016
70	(+112) +.296	(+63.35) +.356	(+180.5) +.385		+.346
60	(+94) +.248	(+32.55) +.183	(+118.5) ~~+.336~~ +.253		+.228
50	(+43.5) +.115	(+15.05) +.085	(+37) +.079		+.093
40	(+15.5) +.041	(+8.35) +.047	(+29) +.062		+.05
30	(+14) +.037	(+4.775) +.027	(+21.5) +.046		+.037
20	(+2) +.005	(+3.125) +.018	(+24) +.051		+.025
10	(0) +0	(+2.165) +.012	(+2) +.004		+.005

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES — Page

Calc. By: NON-PREFERRED DIRECTION — Checked By: ØANSEN 8/8/78

ANGLE	VALVE SIZE - % OF TORQUE @ 90°				
	5"-150	6"-150	8"-300	10"-300	AVG.
90	-40.95 (-1.0)	-65.1 (-1.0)	-107.3 (-1.0)	-217 (-1.0)	-1.0
80	0 (0)	-28.9 (-.444)	-31.25 (-.291)	-133 (-.613)	-.337
70	+4.335 (+.106)	+1.3 (+.02)	+20.85 (+.194)	-5.5 (-.025)	+.074
60	+3.91 (+.095)	+6.55 (+.101)	+21.4 (+.199)	+44.5 (+.205)	+.15
50	+1.375 (+.034)	+4.1 (+.063)	+23.8 (+.222)	+40.5 (+.187)	+.127
40	-.27 (-.007)	+3.7 (+.057)	+11.85 (+.110)	+15.5 (+.071)	+.093
30	-.585 (-.014)	+3.25 (+.05)	+6.25 (+.058)	+1 (+.005)	+.025
20	-.45 (-.011)	-.5 (-.008)	+5.35 (+.050)	+1 (+.005)	+.009
10	-.645 (-.016)	+4.6 (+.077)	+1.65 (+.015)	+2 (+.009)	+.020

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

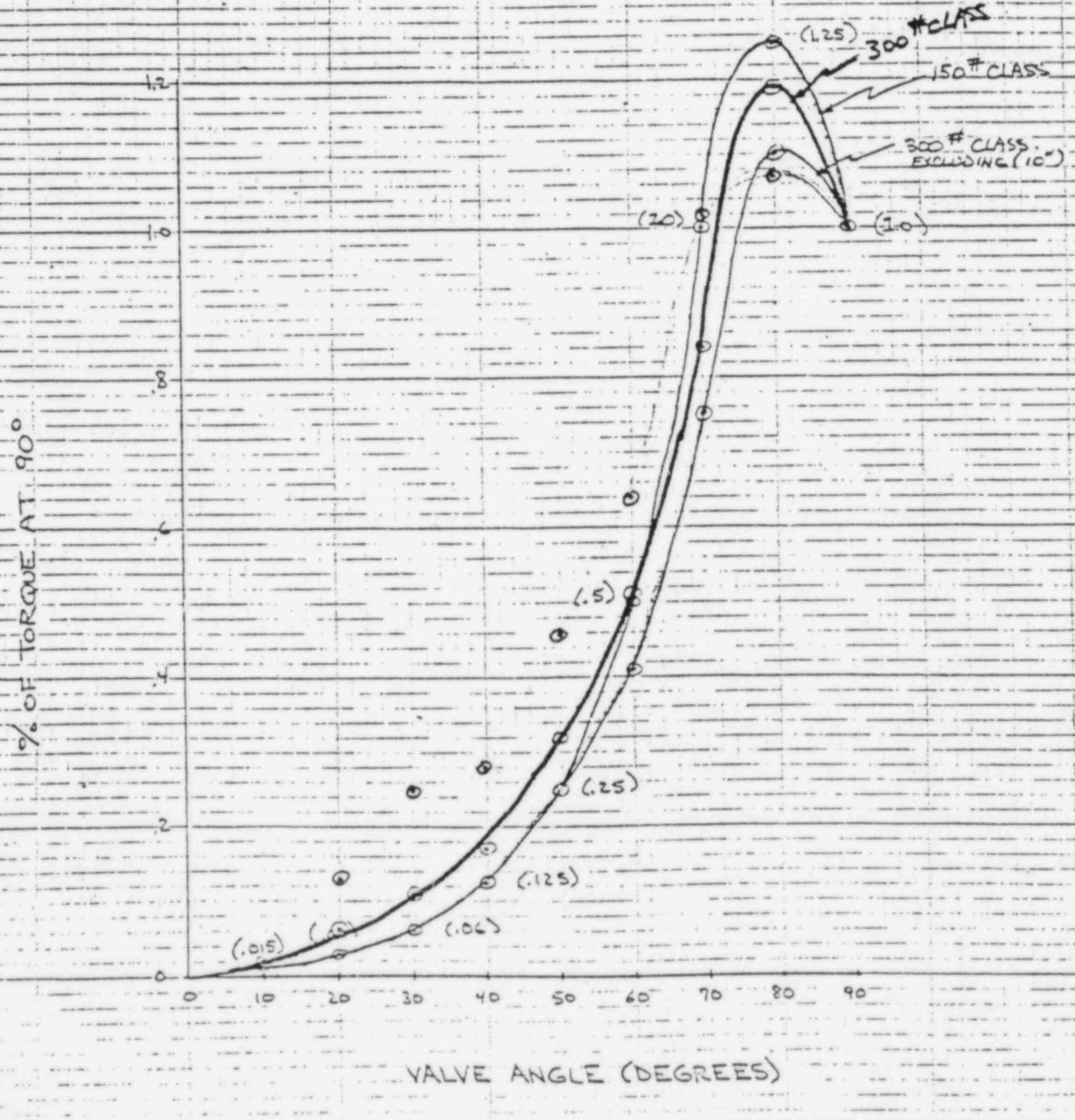
Calc. By: NON-PREFFERRED DIRECTION Checked By: [illegible]ANSEN 8/16/78

ANGLE	VALVE SIZE - % OF TORQUE AT 90°			
	6"-600	8"-600	10"-600	AVG.
90	-46.775 ~~-925~~ (-1.0)	-75 (-1.0)	-129.45 (-1.0)	(-1.0)
80	-20.57 ~~-387.5~~ (~~-.53~~ -.44)	-52.5 (-.7)	-101.2 (-.782)	-.641
70	+2.93 ~~+50~~ (~~+.069~~ +.063)	-.825 (-.11)	+8.75 (+.068)	+.007
60	+11.93 ~~+250~~ (~~+.345~~ +.255)	+13.1 (+.175)	+28.75 (+.222)	+.217
50	+12.435 ~~+250~~ (~~+.35~~ +.266)	+17.1 (+.228)	+28.885 (+.223)	+.239
40	8 (+.171)	+18.05 (+.241)	+25.9 (+.2)	+.204
30	+.191 (+.004)	+14.65 (+.195)	+9.1 (+.070)	+.09
20	-3.1095 (-.066)	+13.9 (+.185)	+2.6 (+.02)	+.046
10	-2.212 (-.047)	+7.2 (+.095)	+1.15 (+.009)	+.021

Title ______ Page ______

By PREFERRED DIRECTION. Checked By DANSEN 6/8/78.

HYDRODYNAMIC TORQUE VS. VALVE ANGLE.



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUES. Page

By PREFERRED DIRECTION Checked By ØANSEN 8/8/78

ANGLE	VALVE SIZE - % TORQUE @ 90°			
	6"-600	8"-600	10"-600	AVG.
90	(47.3) 1.0	(75) * 1.0	([illegible]) * 1.0	1.0
80	(46.2) .98	(91.7) 1.22	(138.15) 1.02	1.07
70	(33.7) .71	(101) 1.35	(134.05) .99	1.02
60	(16.8) .35	(61.45) .53	(100.2) .74	.64
50	(9.6) .20	(46.4) .62	(76.9) .57	.46
40	(6.4) .13	(25.6) .34	(52.1) .38	.28
30	(5.6) .12	(28) .37	(36.8) .27	.25
20	(3.6) .08	(9.4) .13	(24.2) .18	.13
10	(-.75) -.02	(.4) .01	(4.65) .03	.01

?

* BASED ON NONPREFERRED DIRECTION.

FUSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES. Page

Calc. By: PREFERRED DIRECTION Checked By: DANSEN 8/8/78

ANGLE	VALVE SIZE - % TORQUE @ 90°						
	5"-150	6"-150	8"-300	10"-300	AVG (ALL)	AVG. (EX. 10" 300)	
90	(28) 1.0	(54.62) 1.0	(95.45) 1.0	(180) 217 1.0	1.0	1.0	[1.0]
80	(30) 1.07	(60.44) 1.11	(103.6) 1.08	(271.5) 1.5	1.19	1.09	[1.1]
70	(18) .64	(41.15) .75	(77) .81	(205.5) 1.14	.84	.73	[.75]
60	(9) .32	(27.64) .51	(39.2) .41	(141) .78	.505	.41	[.41]
50	(5.2) .19	( ) X 45°	(30.3) .32	(79) .44	.32	.26	[.25]
40	(3.35) .12	(8.54) .16	(18.1) .19	(39) .22	.17	.16	[.15]
30	(2.05) .07	(6.32) .12	(9.6) .10	(22.5) .13	.11	.10	[.1]
20	(1.115) .04	(4.35) .08	(4.35) .05	(13.5) .08	.06	.06	[.06]
10	(-.465) -.02	(.88) .02	(3.5) .04	(4.5) .03	.02	.01	[.01]

* 5" & 6" - 150# ARE EQUIVALENT TO 300# CLASS VALVES

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES   Page

By: PREFERRED DIRECTION   Checked By: QANSEN 8/7/78

ANGLE	VALVE SIZE – % TORQUE @ 90°						
	10"-150 (2)	12"-150 (2)	8"-150	10"-150 (1)	12"-150 (1)	AVG.	
90	(245) 1.0	(~~167~~)(333) 1.0	(214) 1.0	(317) 1.0	(350) 1.0	1.0	[1.0
80	(312) 1.27	(425) ~~2.5~~ 1.28	(139) .65	(326) 1.03	(434) 1.29	1.21	[1.2
70	(227) .93	(345) 1.04	(83) .39	(234) .74	(322) .92	.91	[.9
60	(122) .50	(186) .56	( )	(118) .37	(183) .52	.49	[.5
50	(59) .24	(104) .31	( )	(59) .18	(77) .22	.24	[.25
40	(30) .12	(87) .26	( )	(32) .10	(34) .10	.15	[.15
30	(16) .07	(33) .10	( )	(25) .08	(24) .07	.08	[.08
20	(9) .03	(26) .08	( )	(14) .04	(18) .05	.05	[.05
10	(3) .01	(11) .03	( )	(8) .02	( ) .03	.02	[.0

(?)   DELETE NOT GOOD DATA.

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By [illegible] DATE: 12/16/77 Checked By

VALVE SIZE: 150

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 68 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	(in #)/PSI
OPENING	0					
	10		43		+45	1.0
	20		41		+45	1.1
	30		38.5		+40	1.0
	40		36		+45	1.3
	50		32		+55	1.7
	60		35		+60	1.7
	70		25		0	0
	80		19		−75	−3.9
	90		23		−90	−3.9
CLOSING	90		23		−90	−3.9
	80		18.5		−75	−4.5
	70		21		−40	−1.9
	60		27.5		−10	0.4
	50		36		+10	0.3
	40		28.5		0	0.0
	30		30.5		−15	0.5
	20		32		−15	0.5
	10		32		−15	0.5
	0					

PACKING TORQUE: 20 IN-LB OPENING

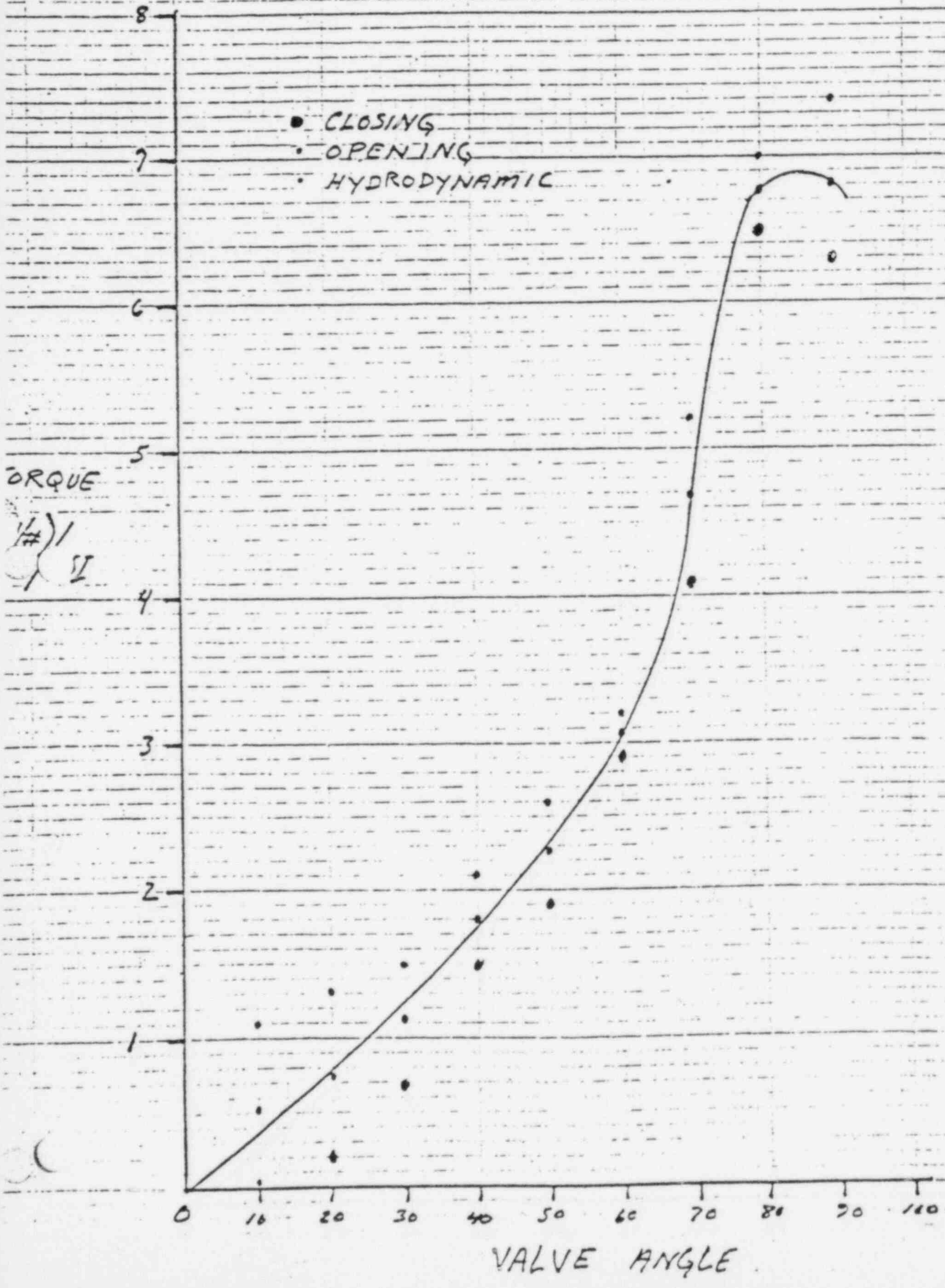
: 0 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 3-150LO HYDRODYNAMIC TORQUE CURVE Page

Calc By C.Lyarsi (STEM UP STREAM) Checked By

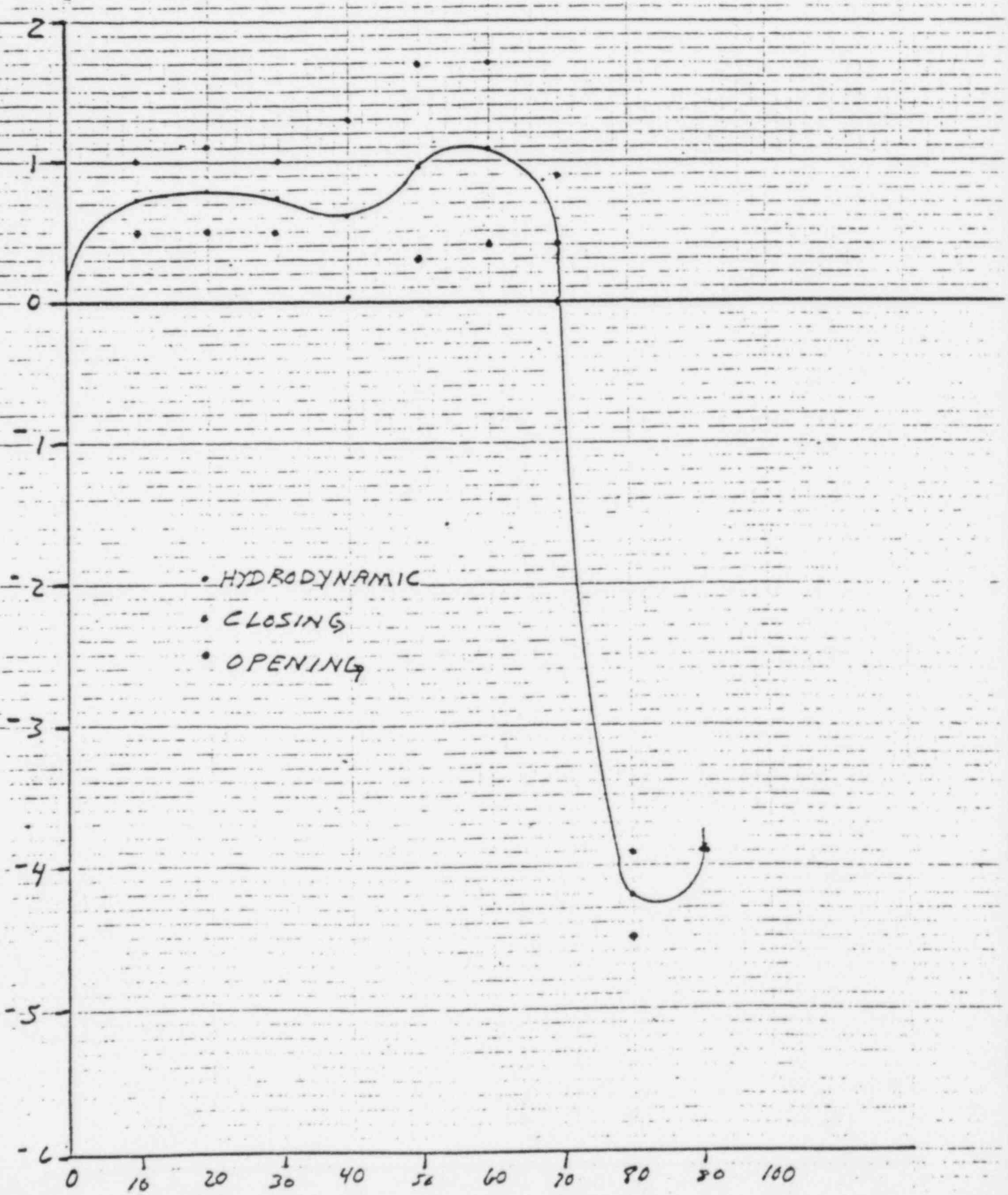


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 3" 150LB - HYDRODYNAMIC TORQUE CURVE Page

By C. LIVORSI (STEM DOWN STREAM) Checked By



ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] DATE: 12/5/77 Checked By

VALVE SIZE: 4"-150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON/BUNA

WATER TEMPERATURE (TANK): 65 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		46.5		+50	1.07
	20		42.5		+75	1.76
	30		37		+75	2.03
	40		31		+75	2.42
	50		32		+100	3.12
	60		25.5		+125	4.90
	70		17.5		+140	8.00
	80		11.5		+150	13.04
	90		8.7		+125	14.37
			X		X	
CLOSING	90		8.5		+75	8.82
	80		11		+125	11.36
	70		16.5		+125	7.57
	60		27		+125	4.63
	50		31.5		+85	2.70
	40		35		+50	1.43
	30		36.3		+40	1.10
	20		37.8		0	—
	10		38.8		−60	−1.55
	0		X		X	

PACKING TORQUE: 5 IN-LB OPENING

: 5 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 3

Calc. By RAY MARSHALL DATE: 11-17-77 Checked By

VALVE SIZE: 4"-150

VALVE DIRECTION: ~~STEM UPSTREAM~~ / (STEM DOWNSTREAM)

VALVE SEAL TYPE: TEFLON/BUNA

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		30.5		~~+35~~ +40	1.31
	20		32		+40	1.25
	30		30.5		+45	1.47
	40		30.5		+60	1.97
	50		35		+80	2.28
	60		27		+50	1.85
	70		18		+49	2.72
	80		11		−10	−.91
	90		8.5		−55	−6.47
			X		X	
CLOSING	90		8.7		−80	−9.2
	80		11		−30	−2.73
	70		17.5		0	0
	60		27		+15	.56
	50		35		+45	1.29
	40		43.5		+25	.57
	30		29.5		+10	.34
	20		29		−5	.17
	10		28		0	0
	0		X		X	

PACKING TORQUE: 10 IN-LB OPENING

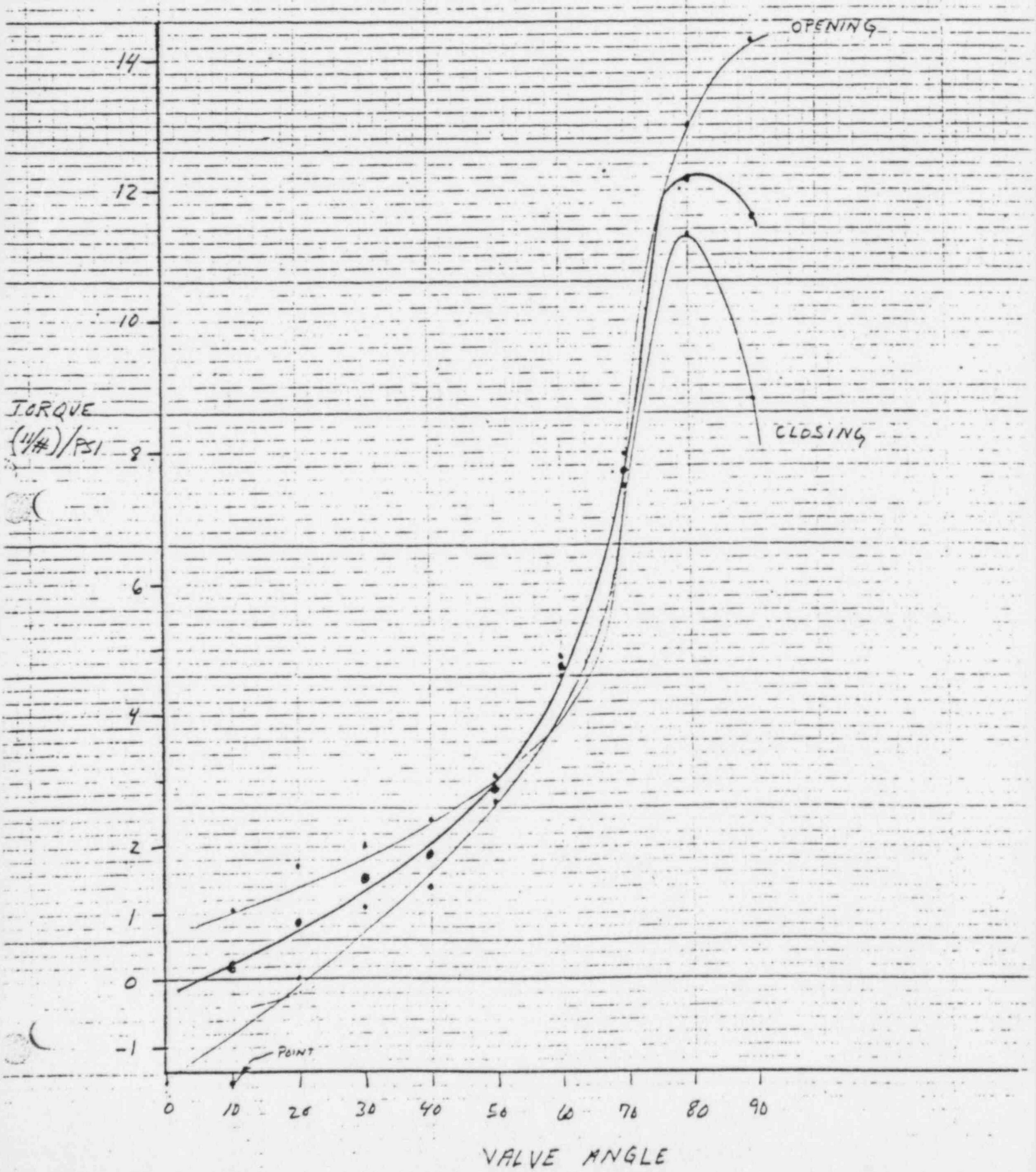
: 5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB HYDRODYNAMIC TORQUE CURVE Page

By C. LIVORSI (STEM UPSTREAM) Checked By

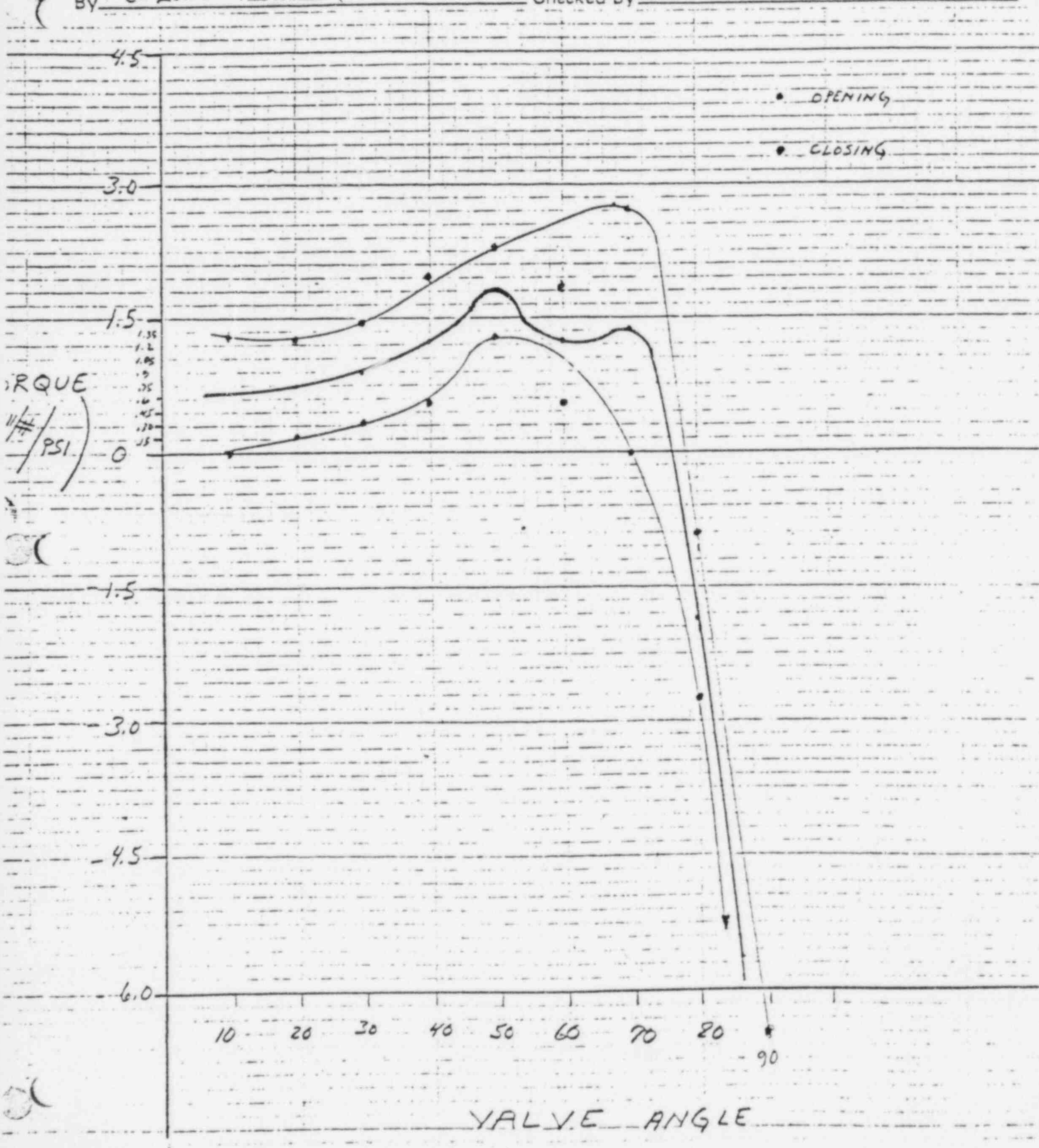


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB HYDRODYNAMIC TORQUE CURVE (STEM DOWN STREAM) Page 2 of

By C. Livorsi Checked By



ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By T CORY DATE: Checked By

~~CONST. UPSTREAM PRESS.~~

VALVE SIZE : 6" - 150 - 300

VALVE DIRECTION : STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE : TEF/BUNA

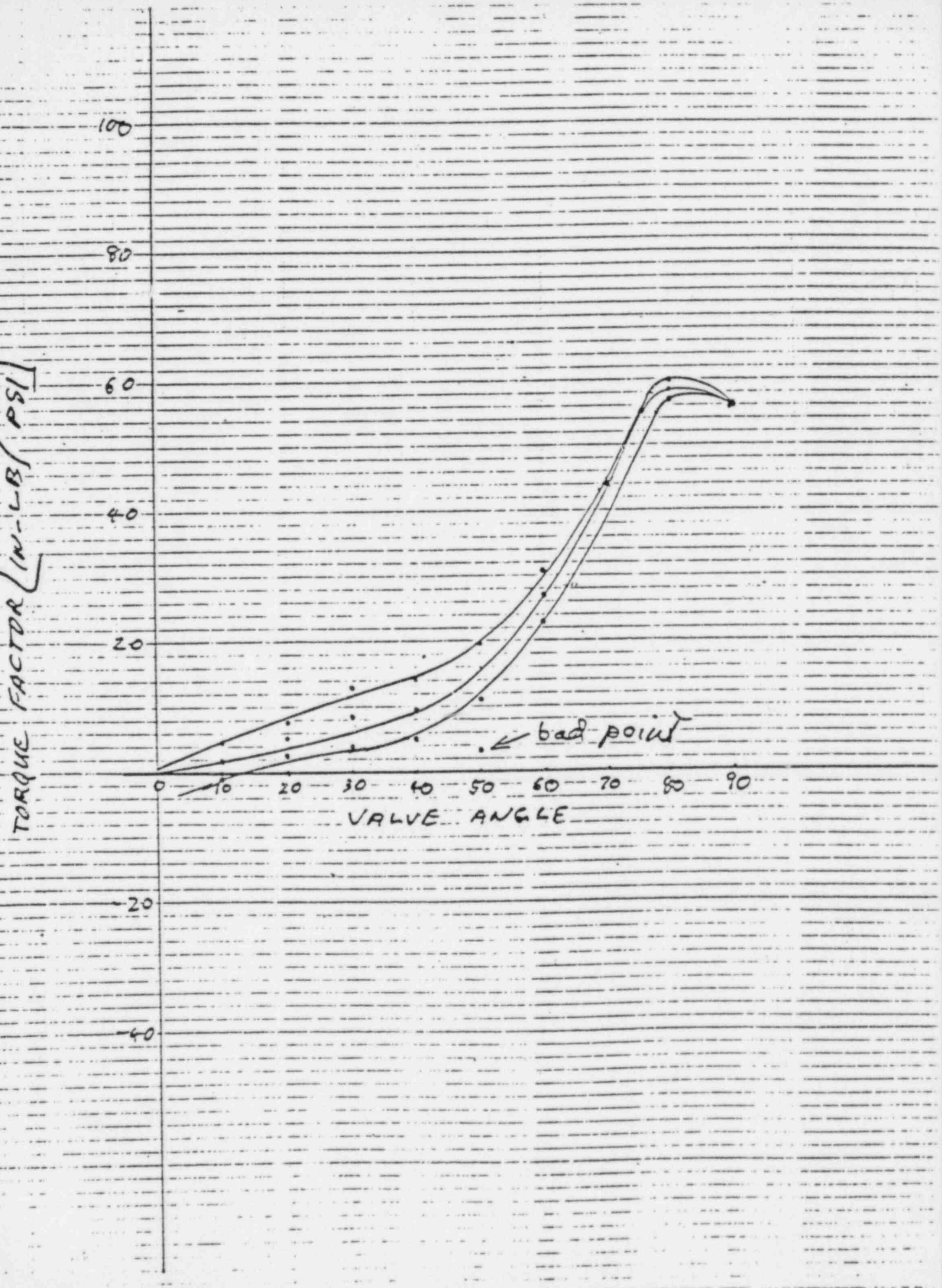
WATER TEMPERATURE (TANK) : 37 °F

DISC TYPE & DWG : 2 

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
CLOSING (~~OPENING~~)	0					
	10	18.1	12		−50	-4.17
	20	18.6	14		0	0
	30	18.6	13.5 ~~17~~		~~45~~ 50	3.7
	40	18.1	13.8		70	5.07
	~~50~~ 45	18.7	15		100	6.67
	60	18.7	14		300	21.43
	70	18.5	12.5		500	40
	80	18.3	11.5		700	60.87
	90	18.4	11		600	54.55
OPENING (~~CLOSING~~)	90	18.6	12.8		700	54.69
	80	19.4	12.5		750	60
	70	18.4	13 12.8		550 700	42.3
	60	18.4	13		440	33.85
	~~50~~ 45	19	15		300	20
	40	18.4	12.5		150	12
	30	18.4	14		125	8.93
	20	14.3	11.5		100	8.7
	10	18.1	13.5		80	5.93
	0					

PACKING TORQUE : IN-LB OPENING

: IN-LB CLOSING



TORQUE FACTOR [IN-LB/ PSI]
100
80
60
40
20
-20
-40
0
10
20
30
40
50
60
70
80
90
VALVE ANGLE
bad point

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By DATE: Checked By

VALVE SIZE: 6" 150 - 300

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 86 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
ENING	0					
	10		38.5		180	
	20		1.9		150	
	30		6.2		80	
	40		7.8		110	
	50		8.2		160	19.5
	60		6.5 23		206 540	38.8 21.5
	70		8.75 15		600 650	45.7 43.
	80		8.5 11.2		530 650	62.3 58
	90		9.1 8.5		500 500	54.9 55.
CLOSING	90		9.1 8.5		510 500	
	80		11.5 11		700 600	60.8 54.
	70		16.7 16.2		730 750	43.7 46.
	60		14.5	22.6	350 520	24.1 23.
	50		14.5		150	3.4
	40		12.5		60	
	30		15		60	
	20		34		90	
	10		50.5		25	
	0					

PACKING TORQUE: IN-LB OPENING

: IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By R. ØANSEN DATE: 9/20/77 Checked By

VALVE SIZE: 6" - 150/300

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEF/BUNA TYPE 2.

WATER TEMPERATURE (TANK): 63° °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	(IN-LB)/PSI
	0					
	10		44.5		+175	3.9
	20		30.0		+75	2.5
(ENING	30		11		+75	6.8
	40		11		+90	8.2
	50		10.2		+45	4.4
	60		9.7		+45	4.6
	70		5.7		+15 2.6	75 0"=
	80		9.2		−275	−28.9
	90		8.4		−550	−65.5
	90		8.5		−550	−64.7
	80		9.0		−260	−28.9
	70		~~27.5~~		~~+200~~	0"#
	60		23.5		+200	8.5
	50		22.5		+85	3.8
CLOSING	40		18.5		−15	−.8
	30		19.0		−5	−.3
	20		31.5		−110	−3.5
	10		28.5		−150	−5.3
	0					

PACKING TORQUE: 10 IN-LB OPENING

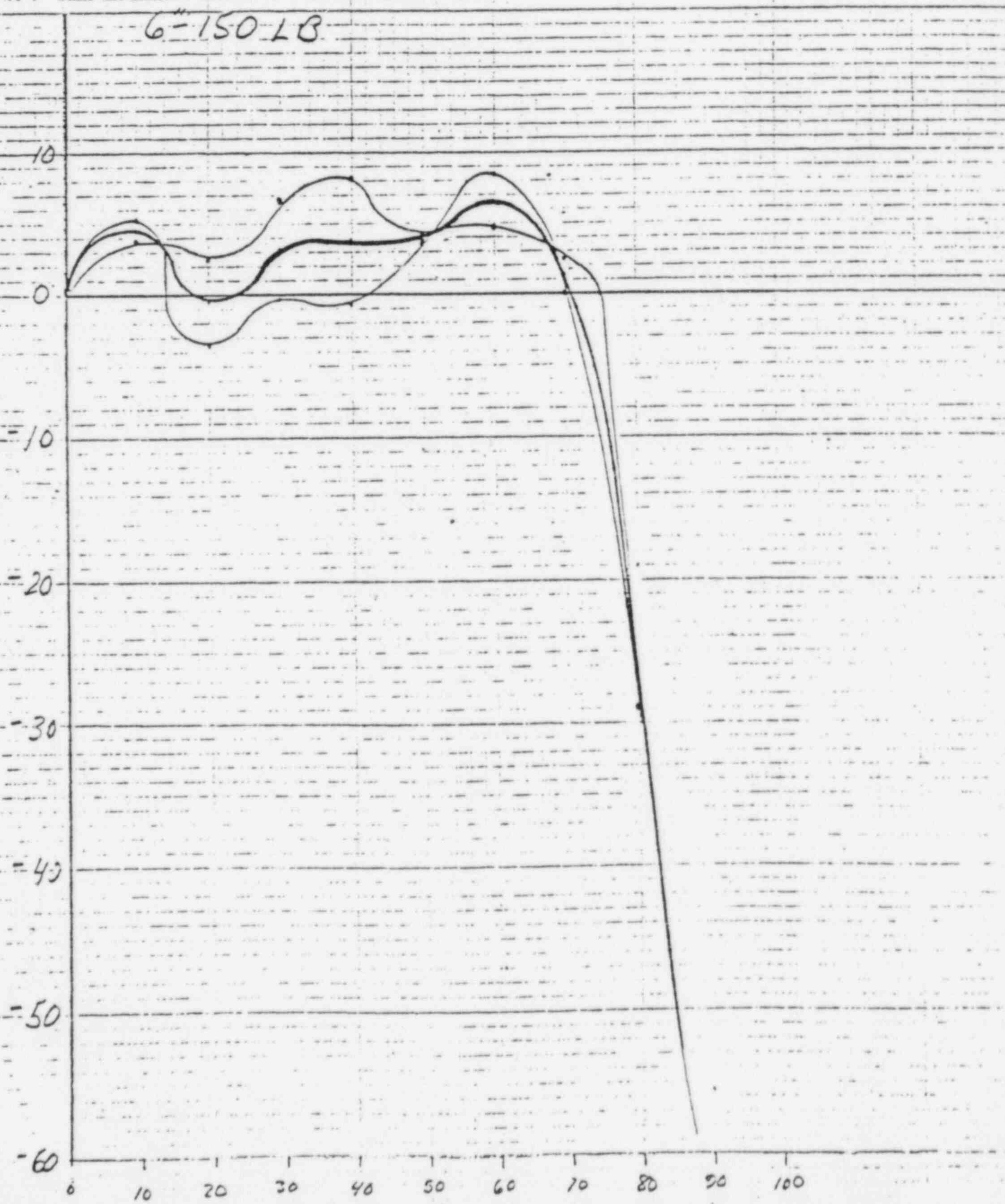
: 10 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE Page

By C. LIVORSI (STEM DOWN STM) Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 5

Calc By C. LIVORSI DATE: Checked By

VALVE SIZE: 8" 150LB

VALVE DIRECTION: STEM UPSTREAM

VALVE SEAL TYPE:

WATER TEMPERATURE (TANK): 71 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	(IN-LB/PSI)
OPENING	0	69.5	65.		400	
	10		59.5		100	1.68
	20		56		425	7.6
	30		51.5		550	10.7
	40		43		725	16.8
	50		31		775	25
	60		18		740	41.1
	70		8.5		700	82.3
	80		4.5		650	144.4
	90		2.5		600	240
CLOSING	90		2.0		375	187.5
	80		3.0		400	133.
	70		6.0		500	83.3
	60		12.5		550	44
	50		26.5		575	21.7
	40		38.5	37 400	400	10.6
	30		37.5	47 350	300	7.7
	20		41.5	54 400	300	7.3
	10		54.5		100	1.8
	0				375	

PACKING TORQUE: 160 IN-LB OPENING

: 80 IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION Page 6

By C. Livcrsi DATE: Checked By

[illegible signature]

VALVE SIZE: 8" 150

VALVE DIRECTION: ~~[illegible]~~ / STEM DOWNSTREAM

VALVE SEAL TYPE:

WATER TEMPERATURE (TANK): 70 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0				900 #/#	
	10		58		350	6.03
	20		56		350	6.25
	30		51		375	7.35
	40		40		415	10.4
	50		28.5		450	15.8
	60		15		460	30.7
	70		7.5	ΔP @ 75° = 8.5	450	60
	80		5.3	T @ 75° = 600	410	77.4
	90		2.6	ΔP @ 85° = 4.5	450	173
				T @ 85° = 0		
CLOSING	90		3.0		−550	−183
	80		3.0	ΔP @ 85° = 2.5	0	0
	70		7.5	T @ 85° = −300	500	66.7
	60		16	ΔP @ 75° = 5.5	550	34.4
	50		28	T @ 75° = 375	400	14.3
	40		39.5		250	6.3
	30		46		100	2.2
	20		54.5		0	0
	10		58		100	−1.7
	0				900 #/#	

PACKING TORQUE: 150 IN-LB OPENING

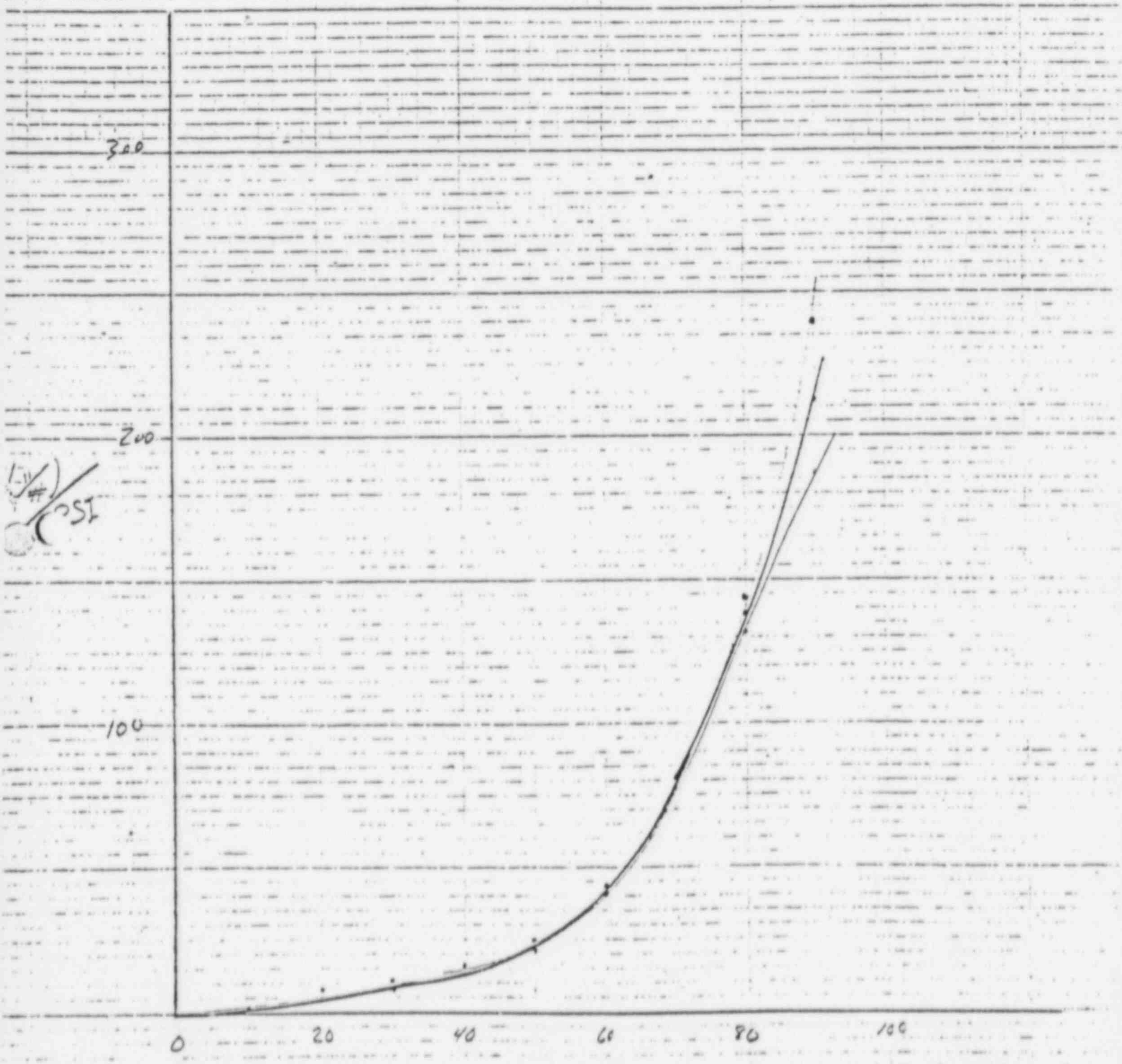
: 100 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: 8" 150 LB HYDRODYNAMIC TORQUE (PREFERED) Page: ____

By: C. LIVORSI Checked By: ____



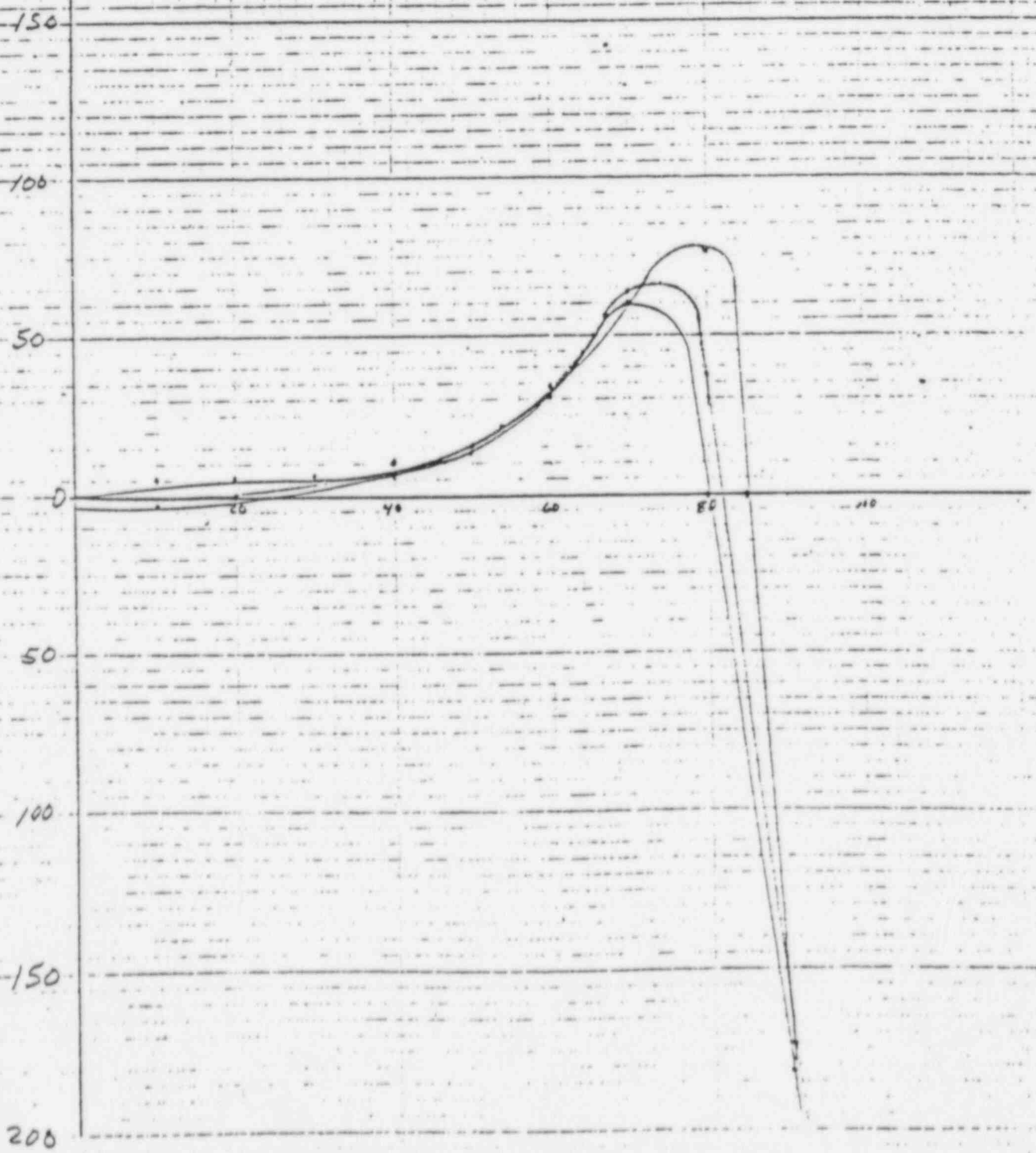
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8"-150

Title HYDRODYNAMIC TORQUE CURVE (UNPREFERED) Page

By C. Livorsi Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION (#1) Page

By RO DATE: 6/17/97 Checked By

VALVE SIZE: 10" - 150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON BUNA | DISC TYPE: 2

WATER TEMPERATURE (TANK): 78° °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	110-T / ΔPSI
OPENING	0	54.9	~~[illegible]~~ 51	0	+1250 / 1150 / 1200	
	10	54.9	50.5	395	850	16.8
	20	30	25.5	895	550	21.6
	30	16	11.5	1030	350	30.4
	~~40~~	~~8.5~~	~~3.6~~	~~1100~~	~~150~~	41.7
	50	25	15	3560	~~850~~ 900	60
	60	18.5	6.3	3590	850	134.9
	70	16.0	3.2	3590	800	250
	80	15.0	2.2	3580	800	363.6
	~~90~~	~~41~~	~~.75 to 1~~	~~2685~~	~~600~~	~~600~~
		~~40~~	~~1.5~~	~~2623~~	− 390	~~[illegible]~~
CLOSING	90	40	1.5	2623	− 150	75
	80	40	≈ 2.0	2863	− 250	125
	70	41	3.0	2720	− 275	91.7
	~~60~~	~~41~~	~~4.0~~	~~2620~~	~~300~~	~~75~~
	50	42	7.0	2538	~~[illegible]~~ − 350−400	57.2
	40	45	17.0	2260	− 375	22
	30	51	32.0	1800	− 325	10
	20	~~[illegible]~~ 54	51	1195	0	
	~~10~~	~~61~~	~~56~~	~~360~~	~~0~~	
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION (#2) Page

By NC DATE: 6/17/77 Checked By

VALVE SIZE: 10"-150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA | DISC TYPE: 2

WATER TEMPERATURE (TANK): 80 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	IN-# / ΔPSI
OPENING	0	38.8	16.5	218	329	
	10	~~44.5~~ [illegible]	~~[illegible]~~	~~[illegible]~~ 129	~~200~~ [illegible]	
	20	57.8 ~~[illegible].5~~	10.5 ~~[illegible].5~~	~~1070~~ 578	~~600~~ 400	
	30	42.8 61.4	10.5 32	10.35 1740	750 ~~425~~	23.4
	40	~~22.2~~	~~15~~	~~2217~~	~~400~~	26.7
	50	16.6	7.5	2727	450	60
	60	20.2	6.0	3587	750	125
	70	17.6	3.5	3599	700	200
	80	16.6	2.5 ~~2.0~~	3596	700	280
	90	~~16.0~~	~~1.75~~	~~3595~~	~~450~~	257.1
CLOSING	90	↓	↓	↓	300	171.4
	80	16.3	2.0	3583	650	325
	70	17.3	3.0	3597	700	233
	60	~~19.8~~	~~6.0~~	~~3599~~	~~725~~	120.8
	50	25.5	~~13.5~~ 13.0	3572	800	
	40	49.5	14.0	2140	450	
	30	57.2	11.0	1110	300	
	20	62.1	14.0	732	300	
	10	~~65.9~~	~~15.0~~	~~311~~	~~200~~	
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION #3 Page

By: DATE: 6/20/77 Checked By:

VALVE SIZE: 10"-150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON/BUNA

WATER TEMPERATURE (TANK): 78 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	IN-# / PSI
OPENING	0	37.5/37.5				
	10	~~[illegible]~~ 45.7/46.3	33/23.5	300/232	850/750 ~~[illegible]~~	1100/1175
	20	17.5 45.2	17.5		700	40
	30	8.5 →			450	53
	40	17.5 →			900	51
	50	7.0 →			575	82
	60	5.0 →			675	135
	70	2.5 →			625	250
	80	2.0 →			725	363
	90	1.5 →			550	367
CLOSING	90		1.5		400	267
	80		2.0		575	288
	70		3.0		650	217
	60		6.0		600	100
	50		13.0		450	35
	40		26.0/18.5		300 150	12/8
	30		23		−100	−4
	20		23		−275	−12
	10		33.5		−600	−18
	0					

PACKING TORQUE: 50 X IN-LB OPENING

: 50 X IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION #4 Page

By DATE: 6/20/77 Checked By

CAVITATION measurements - Contro valve wide open.

VALVE SIZE: 10" - 150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 77 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		51		1200	24
	20		50.5		1400	25
	30		43.5		1575	36
	40		28.5		1450	51
	50		13.5		1100	81
	60		6.25		925	142
	70		3.0		825	275
	80		2.25		800	356
	90		2.0		550	275
CLOSING	90		1.75		375	214
	80		2.25		600	267
	70		3.5		625	179
	60		6.75		650	96
	50		14.25		525	37
	40		29.5		275	9
	30		44.5		-200	-4
	20		51.5		-550	-11
	10		58.5		-1100	-19
	0					

PACKING TORQUE: 50 X IN-LB OPENING

: 50 X IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc By [illegible signature] DATE: 6/21/77 Checked By

VALVE SIZE: 10" - 150

VALVE DIRECTION: ~~[illegible]~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON/IS[illegible]A

WATER TEMPERATURE (TANK): 76 °F

DISC TYPE & DWG: 2 

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0					
	10		42.5		-800	19
	20		28		650	23
	30		11.5		425	37
	40		13.0		525	40
	50		10.5		700	67
	60		6.5		775	119 T=0
	70		3.5		550 157	75° 2.4
	80		1.7		-175	-103 ΔP
	90		1.7		-625	-368
CLOSING	90		1.8		-700	-389
	80		1.8		-50	-28
	70		3.0		+200	67
	60		6.5		+450	69
	50		13.5		+275	20
	40		~~[illegible]~~ 8.5		-75	-9
	30		16.5/19/30.5		-50	5.3
	20		17.5		-325	-19
	10		18.5		-350	-19
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By [signature] DATE: 6/2/77 Checked By:

Full open – Control valve.

VALVE SIZE: 10"-150

VALVE DIRECTION: ~~[illegible] UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON/ BUNA.

WATER TEMPERATURE (TANK): 80 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		57.5		+1050
	20		47.7		+850
	30		39.5		+750
	40		26.5		+800
	50		14.5		+925
	60		7.0		+800
	70				
	80				
	90				
CLOSING	90				
	80				
	70				
	60		6.5		+350
	50		13.5		+200
	40		25		0
	30		39.5		−450
	20		51.0		−700
	10		58.5		−800
	0				

PACKING TORQUE: 50 IN-LB OPENING

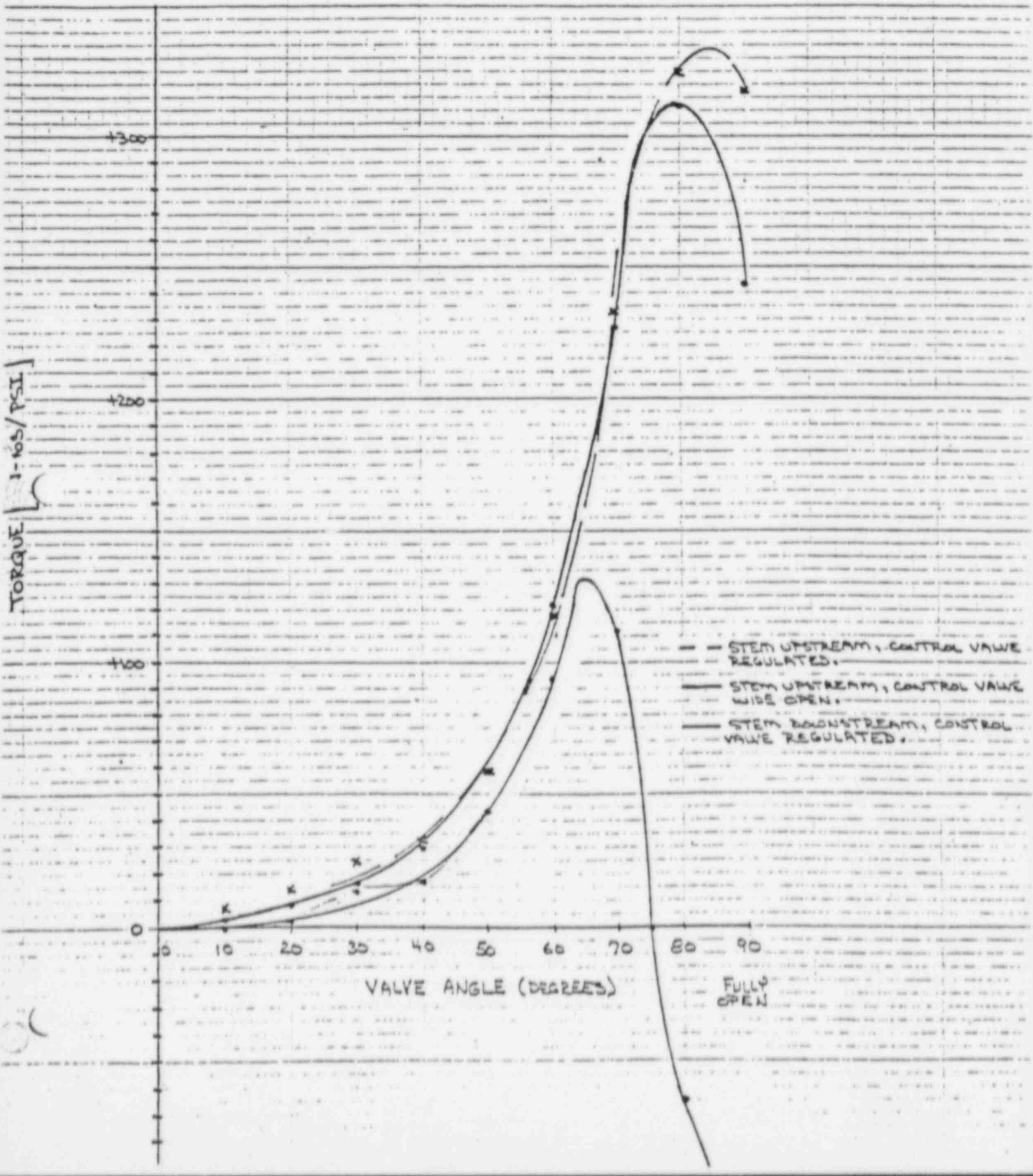
: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: TORQUE VS. VALVE ANGLE 10"-150 Page

By: R. QANSEN. Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By C. LIVORSI DATE: Checked By

VALVE SIZE: 12" - 150

VALVE DIRECTION: STEM UPSTREAM [X] / STEM DOWNSTREAM [ ]

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0				
	10	50	1400	28	
	20	36.5	1300	36	
	30	20.5	850	41	
	40	20.5	1000	49	
	50	8.5	850	100	
	60	3.5	825	236	
	70	2.3	750	326	
	80	1.5	700	467	
	90	1.0	500	500	
CLOSING	90	1.0	200	200	
	80	1.0	400	400	
	70	1.5	475	317	
	60	3.5	450	129	
	50	8.0	425	53	
	40	17.5	325	19	
	30	36.5	225	6	
	20	48.5	0	0	
	10	55	550	-10	
	0				

PACKING TORQUE: 150 IN-LB OPENING

: 200 IN-LB CLOSING

Title: HYDRODYNAMIC TORQUE DETERMINATION Page 2

By: C. Livorsi DATE: Checked By:

VALVE SIZE: 12" 150

VALVE DIRECTION: STEM UPSTREAM [X] / STEM DOWNSTREAM [ ]

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	62 / 55	1100 / 1000		
	10	41.5	950	23	
	20	25	900	36	
	30	12	550	46	
	40	2.5	350	140	
	50	3	400	133	
	60	3.5	650	186	
	70	1.8	600	333	
	80	1.2	600	500	
	90	.9	300	333	
CLOSING	90	.9	0	0	
	80	1	350	350	
	70	1.4	500	357	
	60	2.7	500	185	
	50	7.4	550	74	
	40	16.5	550	33	
	30	18.5	350	19	
	20	30.6	450	15	
	10	24.5	50	2	
	0	62	-1210		

PACKING TORQUE: 150 IN-LB OPENING
: 150 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By C. LIVORSI DATE: 7-7-78 Checked By

VALVE SIZE: 12" -150

VALVE DIRECTION: STEM UPSTREAM ☐ / STEM DOWNSTREAM ☒

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): 67 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN
OPENING	0	62	1000		
	10	21	550	26	
	20	5	300	60	
	30	10	450	45	
	40	7.7	450	58	
	50	5.5	350	63	
	60	4.0	650	162	
	70	1.9	450	236	
	80	1.2	200	166	87° = 0
	90	.8	300	375	
CLOSING	90	.8	-450	-562	
	80	.8	-100	-125	
	70	1.6	200	-125	
	60	4.0	300	75	
	50	9.5	100	11	
	40	16	0	0	
	30	30	-50	-2	
	20	44	-550	-13	
	10	53	-1150	-22	
	0	63	100	-2	

PACKING TORQUE: 125 IN-LB OPENING

: 150 IN-LB CLOSING

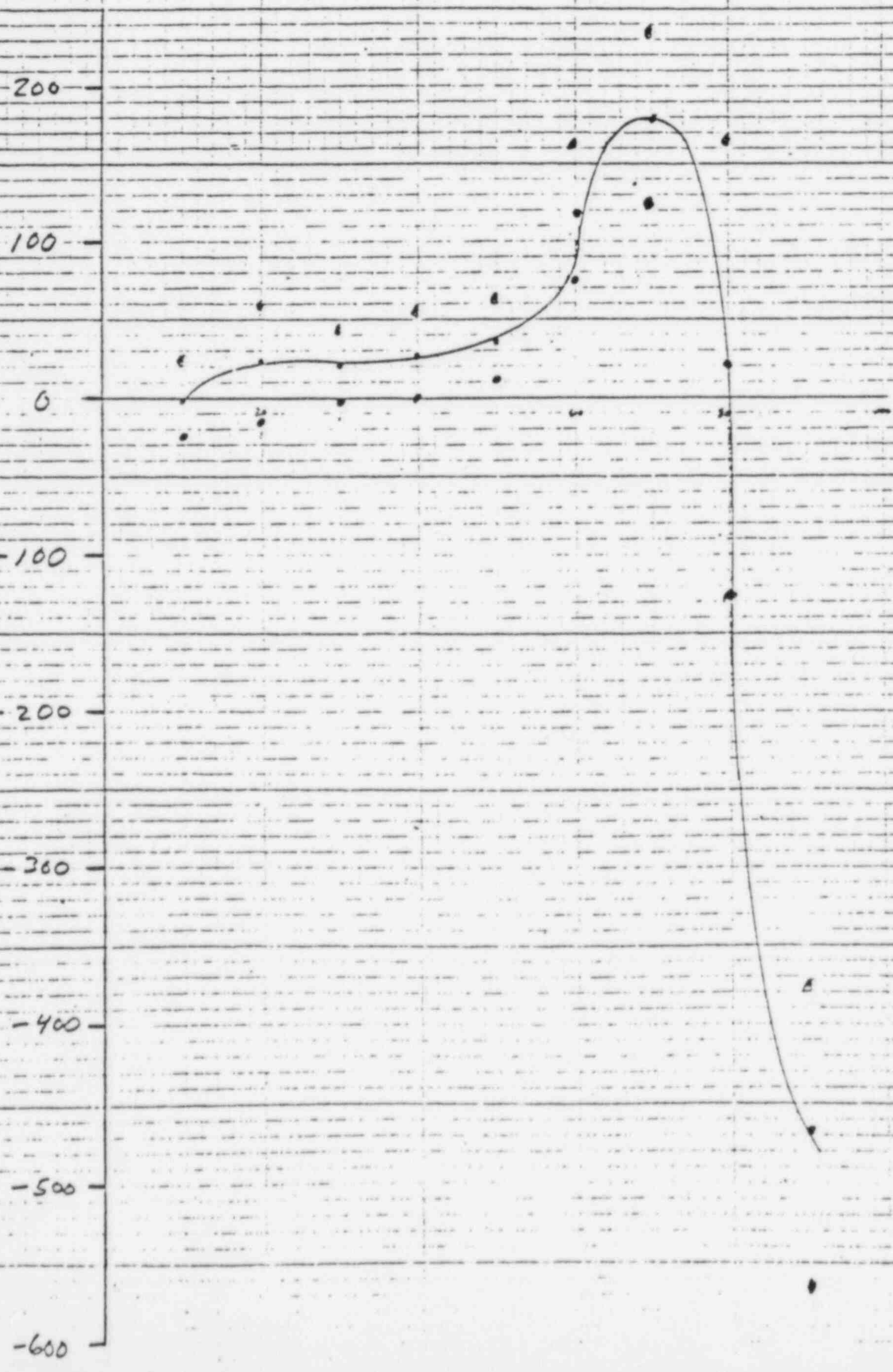
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE 12" 150 Page

By C. LIVORSI Checked By

STEM DOWNSTREAM

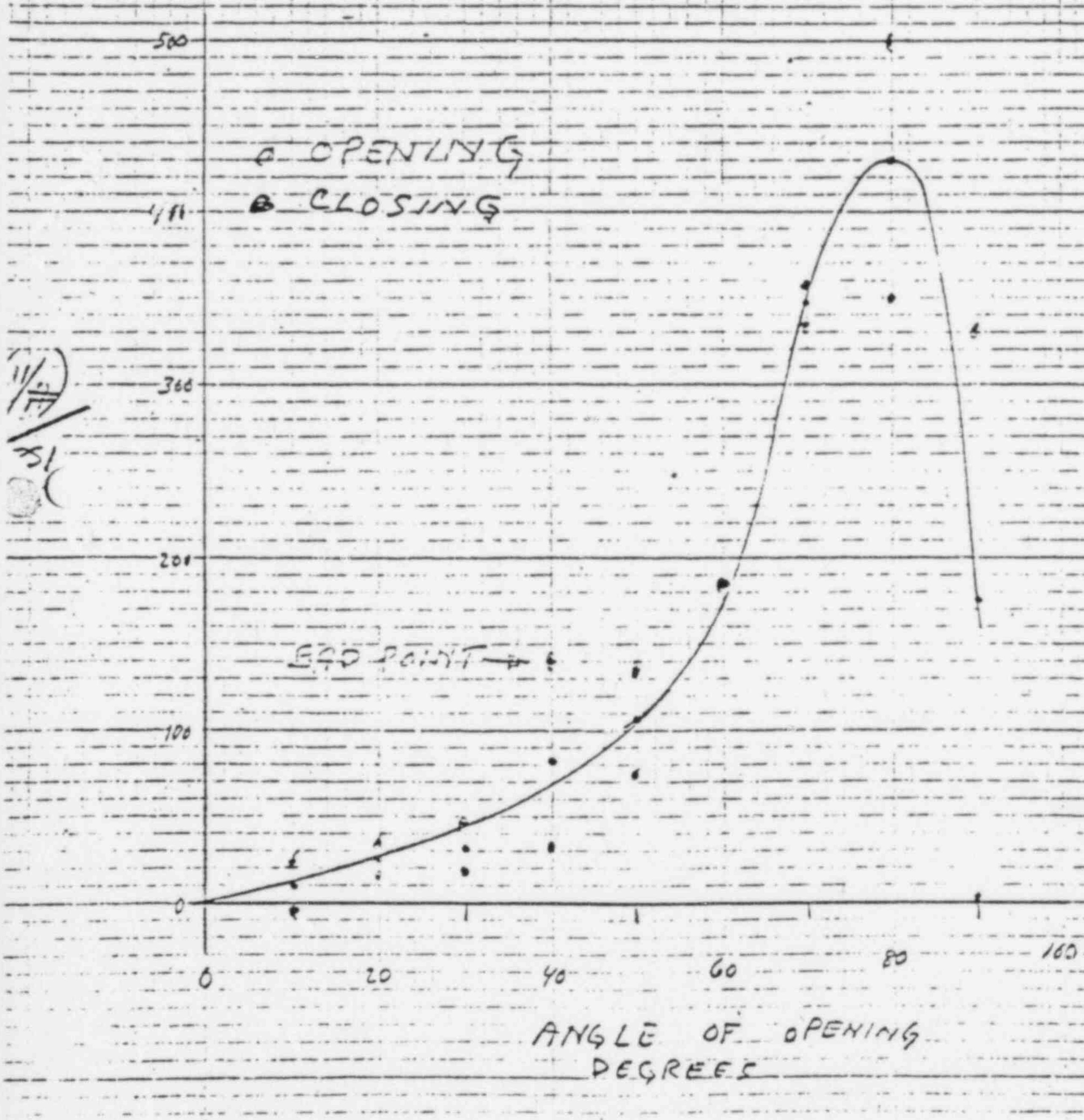


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 STEM UP STREAM HYDRO DYNAMIC TORQUE CURVE Page

By C. LIVORSI Checked By

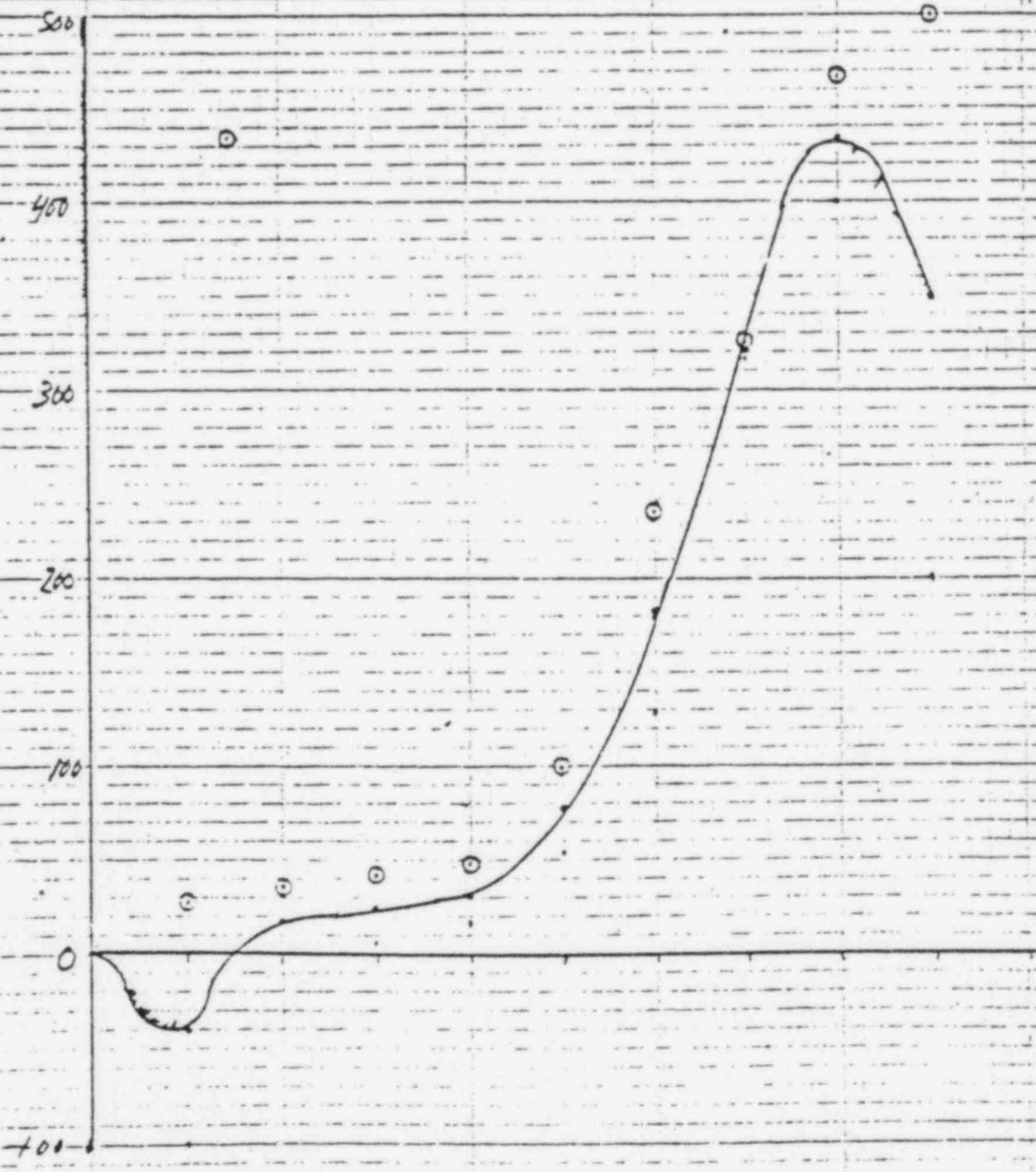


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 (PREFERED) HYDRODYNAMIC TORQUE CURVE Page

By C. Livorsi Checked By



ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc By DATE: Checked By

VALVE SIZE: 14"-150

VALVE DIRECTION: STEM UPSTREAM ☐ / STEM DOWNSTREAM ☒

VALVE SEAL TYPE:

WATER TEMPERATURE (TANK): 65 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS) ~~FT-LBS~~	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN	
OPENING	0					
	10	49.5	525	11	21.5 475	22
	20	41	700	17	7 400	57
	30	26.5	900	34	20.5 800	39
	40	16	750	47		
	50	7.2	750	104		
	60	3	700	233		
	70	1.5	600	400		
	80	1	300	300		
	90	.6	-275	-458		
CLOSING	90	.6	-275	-458		
	80	.7	-50	-71		
	70	1.3	300	231		
	60	3	500	167		
	50	7.2	450	62.5		
	40	15.6	200	13		
	30	26.6	150	6		
	20	23.6	400	17		
	10	42.5	-300	-7 ↔ 9	22 -200	
	0					

PACKING TORQUE: 5 FT-LB ~~IN-LB~~ OPENING

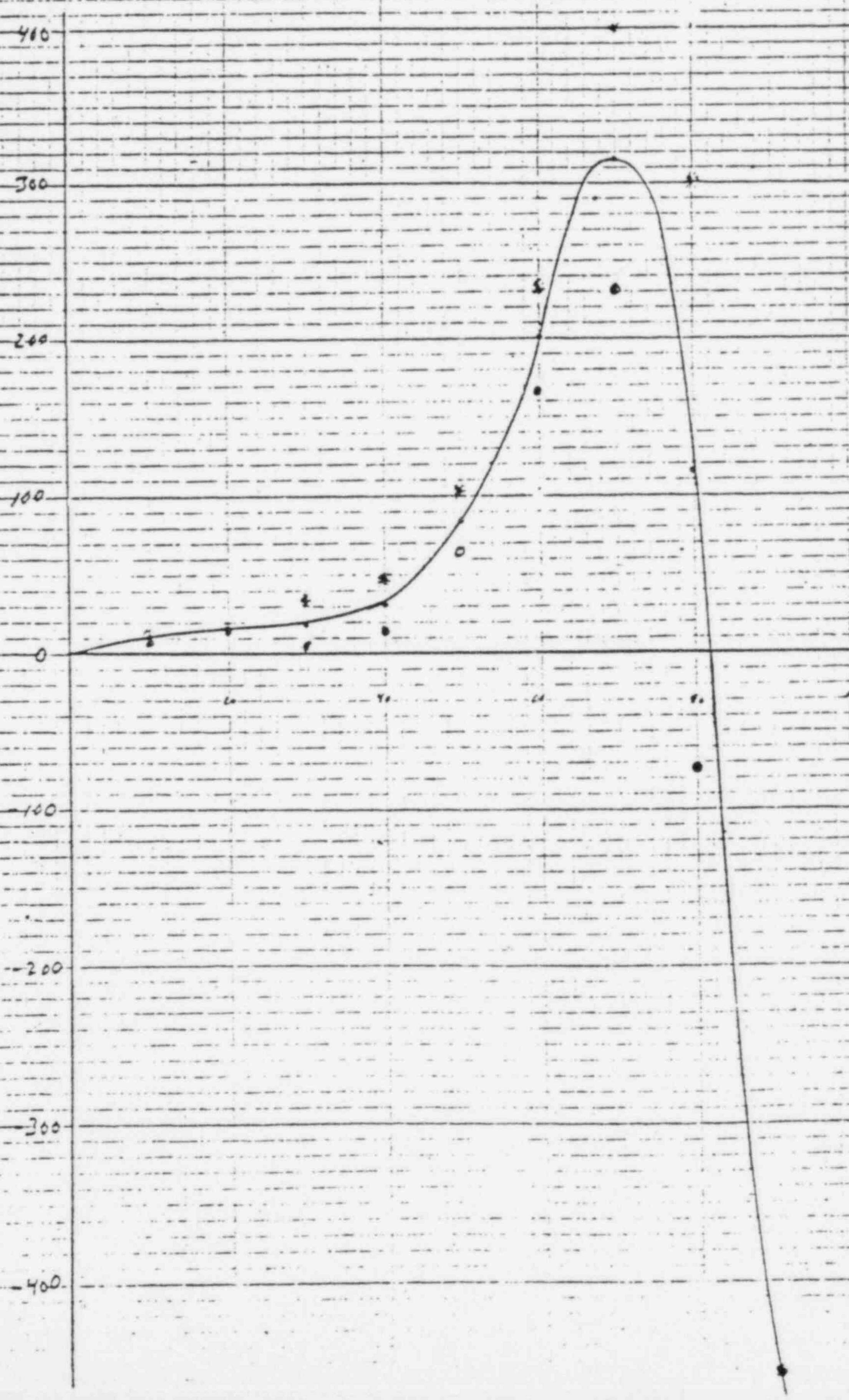
: 5 FT-LB ~~IN-LB~~ CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 14" 150 STEM DOWN STREAM Page

By C. LIVORSI Checked By



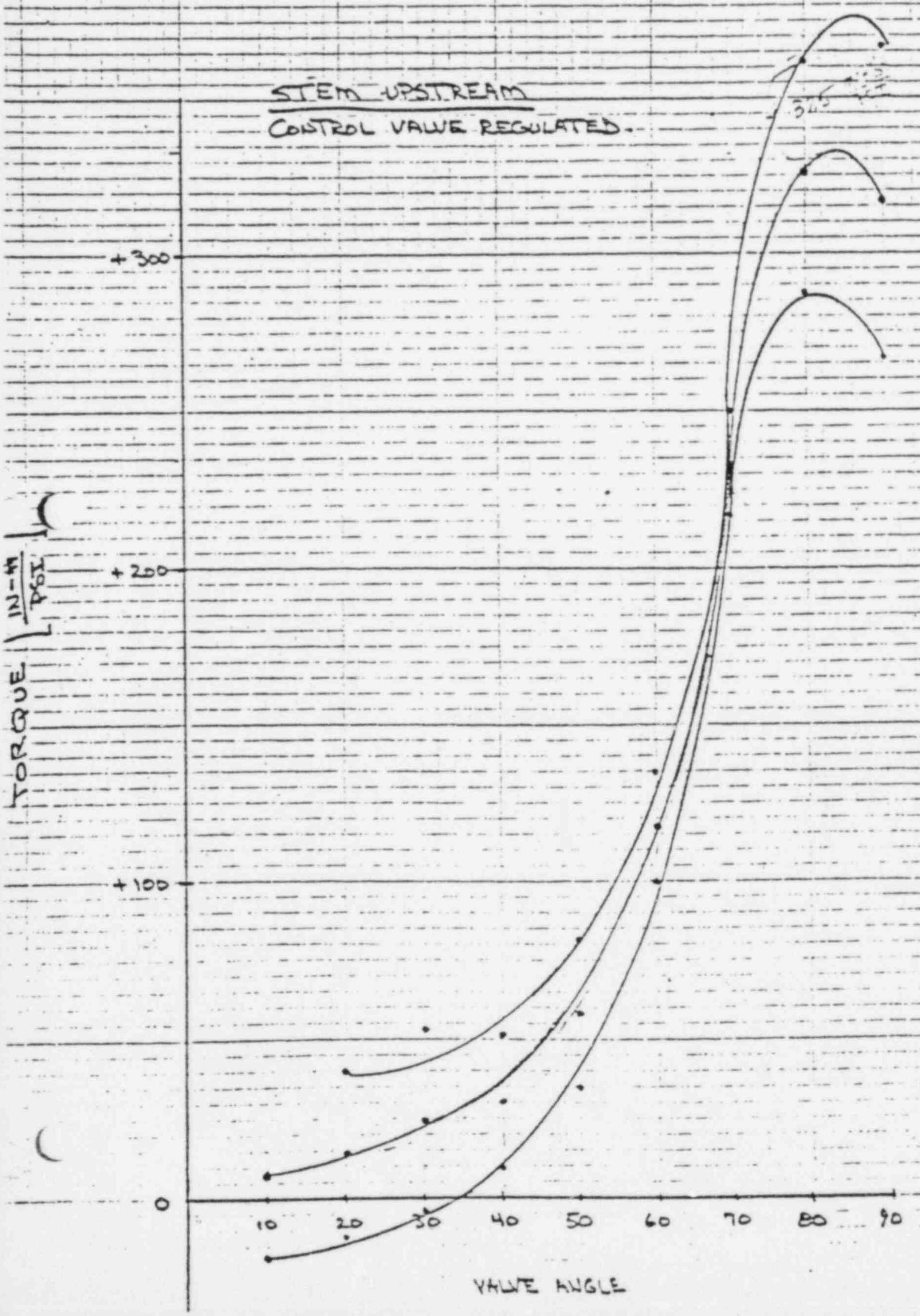
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title TORQUE VS. VALVE ANGLE Page

By R. QANSEN Checked By

10" - 150

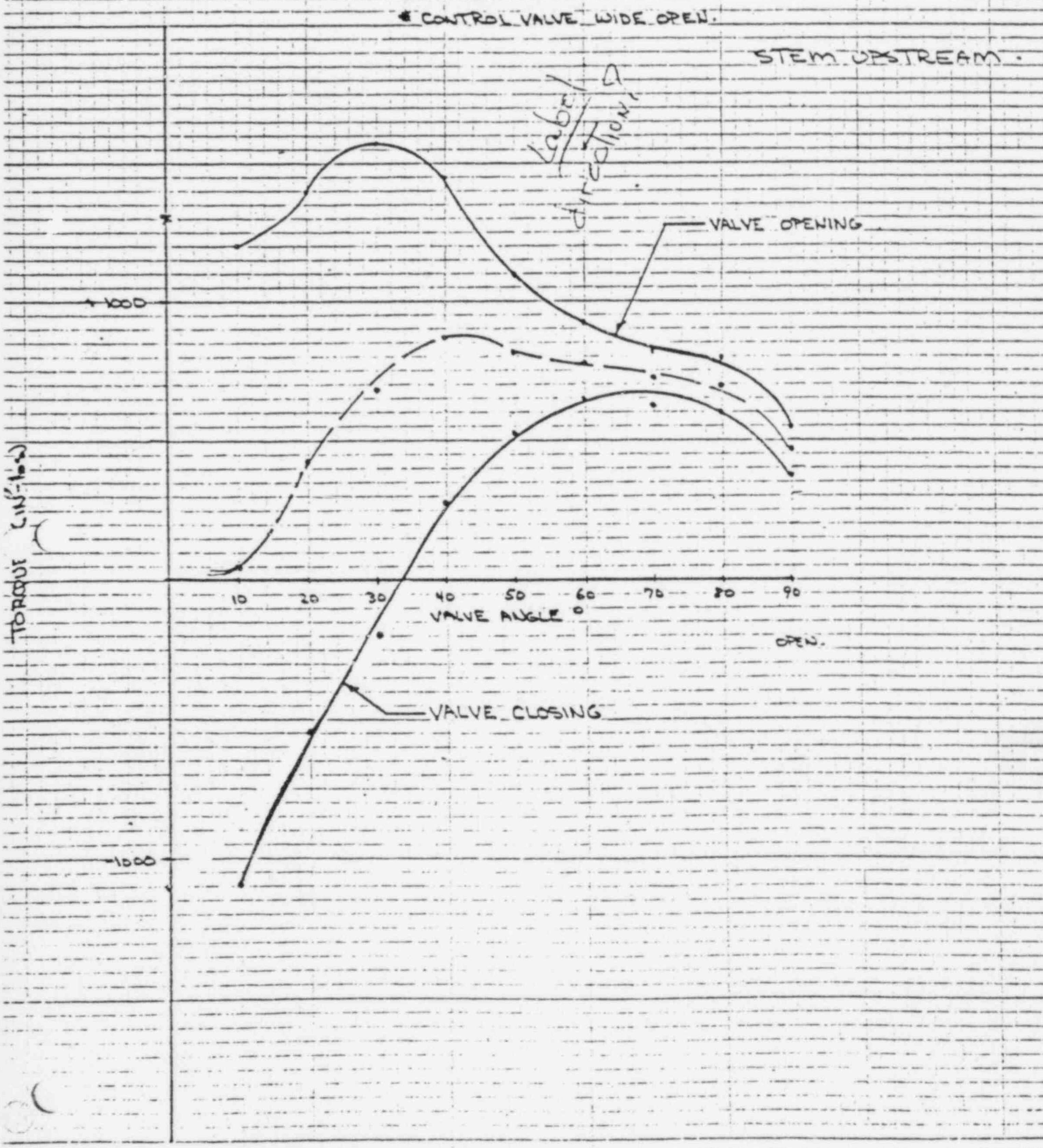


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title VALVE TORQUE - 10" - 150 Page

By: Checked By:



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By C. Livorsi DATE: 2/78 Checked By

VALVE SIZE: 8" - 300LB

VALVE DIRECTION: ☒ STEM UPSTREAM / ☐ STEM DOWNSTREAM

VALVE SEAL TYPE: STD TEFLON

WATER TEMPERATURE (TANK): 64 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	62	650		
	10	58.5	350	6.0	
	20	51.5	450	8.7	
	30	45	600	13.3	
	40	32.5	700	21.5	
	50	20	700	35	
	60	18	650	36.1	
	70	9.0	750	83.3	
	80	6.5	750	115.4	
	90	5.5	700	127.3	
CLOSING	90	5.5	350	63.6	
	80	6.0	550	91.7	
	70	8.5	600	70.6	
	60	13.0	550	42.3	
	50	19.5	500	25.6	
	40	30.5	450	14.7	
	30	43	250	5.8	
	20	52	0	0	
	10	59	−150	−2.5	
	0	62	550		

PACKING TORQUE: 200 IN-LB OPENING

: 200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By C. LIVORSI DATE: 2/78 Checked By

VALVE SIZE: 8" 300 LB

VALVE DIRECTION: STEM UPSTREAM ☐ / STEM DOWNSTREAM ☒

VALVE SEAL TYPE: STD. TEFLON

WATER TEMPERATURE (TANK): 64 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN
OPENING	0	63	600		
	10	60.5	450	7.4	
	20	51.5	550	10.7	
	30	36	450	12.5	
	40	22.5	350	15.5	
	50	10.5	350	33.3	
	60	7.0	300	42.8	
	70	7.0	250	50	
	80	5.0	0	0	0-TORQUE @ 78°
	90	5.0	-500	-100	
CLOSING	90	4.8	-550	-114.6	
	80	4.0	-250	-62.5	
	70	6.0	-50	-8.3	
	60	8.5	0	0	0-TORQUE @ 65°
	50	17.5	250	14.3	
	40	30.5	250	8.2	
	30	44	0	0	
	20	50.5	0	0	
	10	60.5	-250	-4.1	
	0	65	600		

PACKING TORQUE: 00 IN-LB OPENING

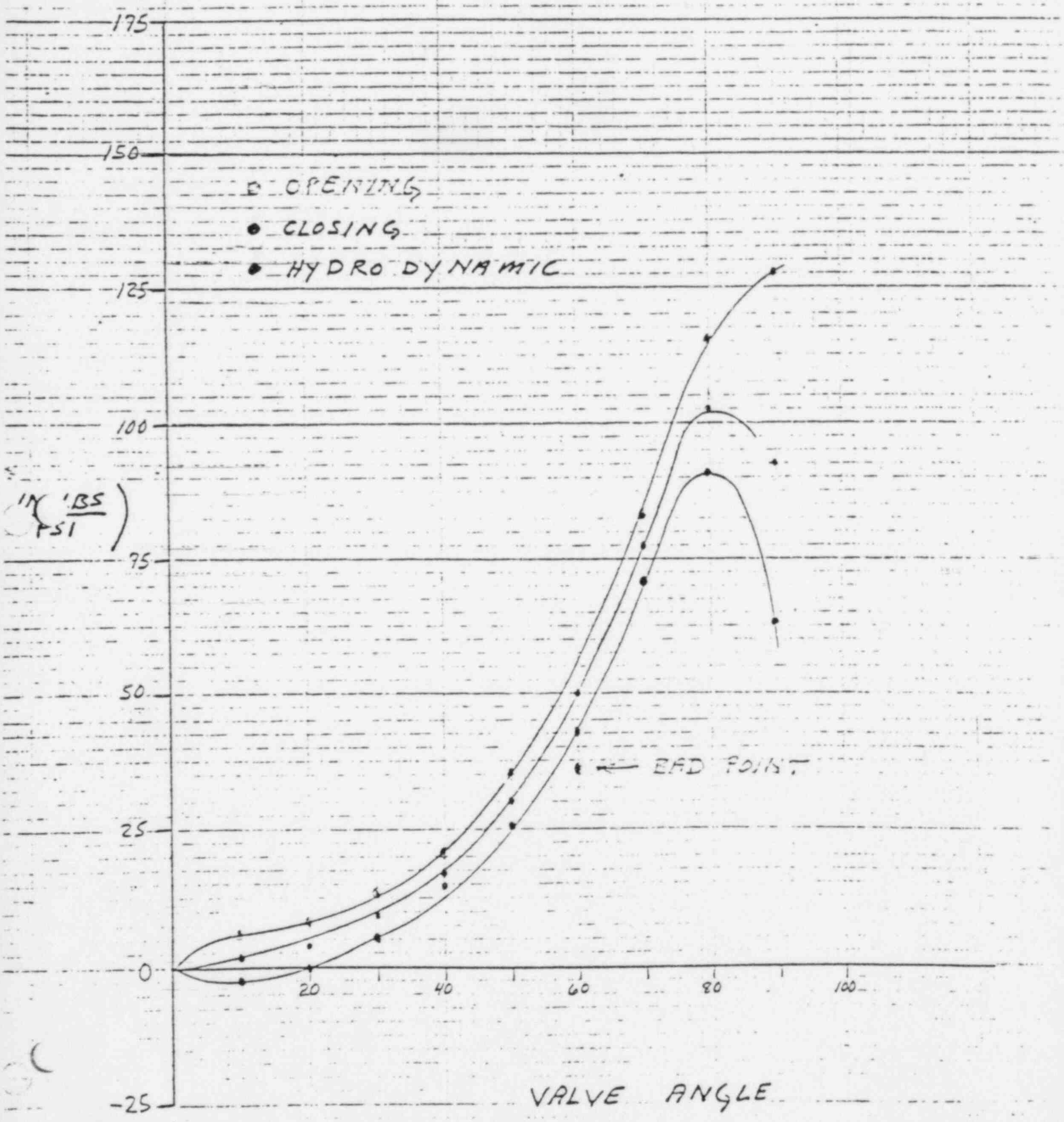
: 200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8" 300 LB HYDRO DYNAMIC TORQUE CURVE Page

By C. LIVORSI Checked By

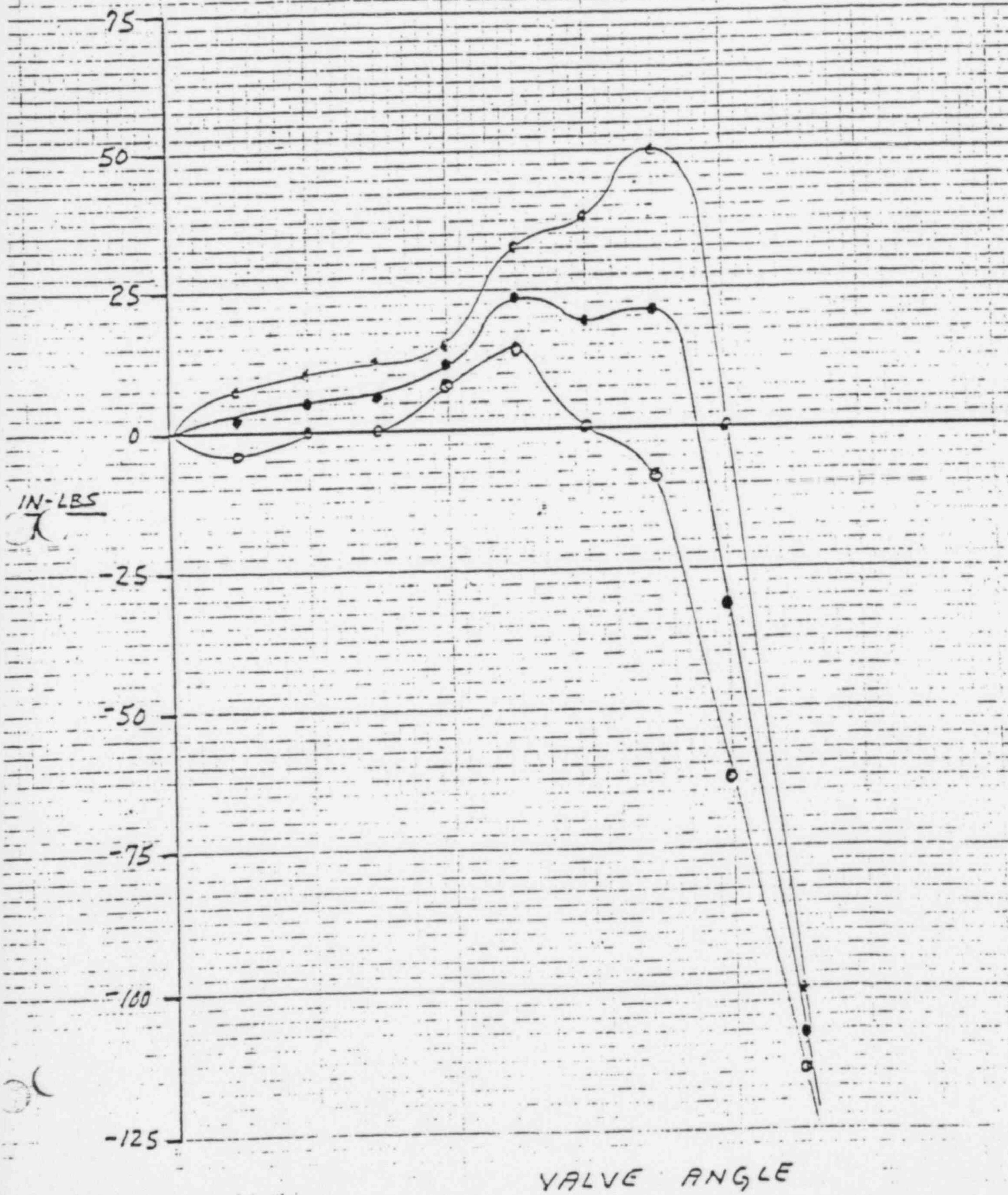


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8" 300 HYDRODYNAMIC TORQUE CURVE Page

By C. LIVORST (UNPREFERED) Checked By



Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ØANSEN DATE: 8/1/77 Checked By

VALVE SIZE: 10" 300

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTRE

VALVE SEAL TYPE: TEFLON/BUNA

WATER TEMPERATURE (TANK): 83 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0	X	X		
	10		58.5		+700
	20		47.5		+450
	30		37.5		+300
	40		25		+600
	50		14		725
	60		7.5		575
	70		4.5		200
	80		2.5		-250
	90		3		-500
CLOSING	90		3		-825
	80		3		-575
	70		4.5		-275
	60		7		0
	50		12		+175
	40		23		50
	30		37.5		-300
	20		51		-300
	10		57.5		-600
	0		X		

PACKING TORQUE: 175 IN-LB OPENING

: 250 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By QANSEN DATE: 7/20/77 Checked By

VALVE SIZE: 10" 300

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWN~~

VALVE SEAL TYPE: TEFLON/BONA

WATER TEMPERATURE (TANK): 87 °F

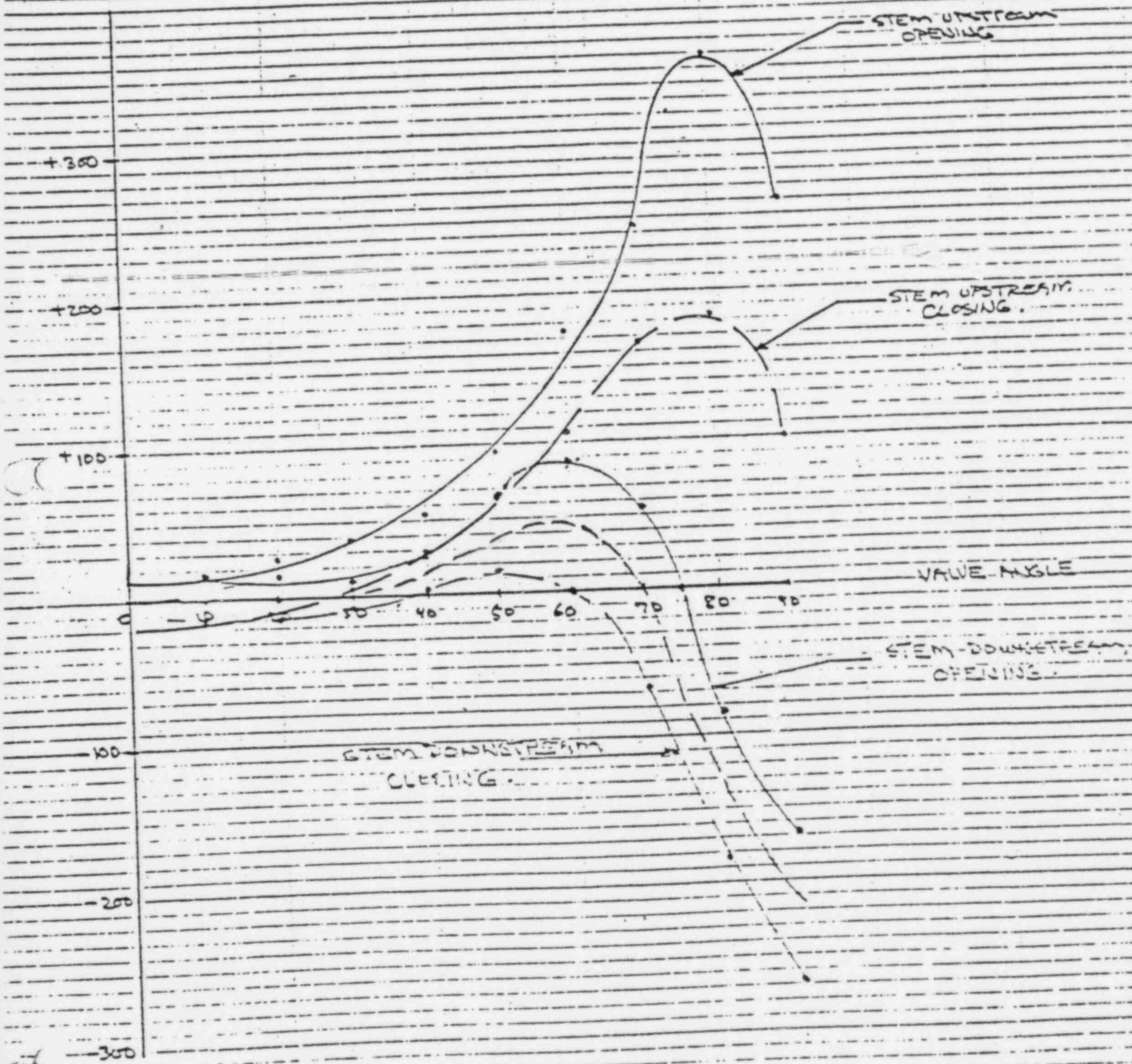
DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		36		600
	20		26		700
	30		35		1350
	40		22.5		1200
	50		11		1050
	60		6		1050
	70		4.5		1100
	80		2.5		900
	90		2.5		650
			2		2
CLOSING	90		2.5		250
	80		3		550
	70		4.5		750
	60		7.5		800
	50		12		750
	40		76		650
	30		12.5		75
	20		26		0
	10		55 20		450 300
	0	D	X	D	X

PACKING TORQUE: 200 IN-LB OPENING

: 250 IN-LB CLOSING

TORQUE VS. VALVE ANGLE



POSI-SEAL INTERNATIONAL

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By DANSEN DATE: 3/21/77 Checked By

VALVE SIZE: 3"-600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTREAM (circled)

VALVE SEAL TYPE: Teflon / Buna

WATER TEMPERATURE (TANK): 67 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		42		+60
	20		38.5		+30
	30		36.5		+30
	40		34		+25
	50		30.5		+40
	60		39		+30
	70		31.5		0
	80		25.5		−5
	90		22.5		−40
CLOSING	90		22.5		−60
	80		25		−45
	70		31.5		−25
	60		39		−5
	50		28		0
	40		30.5		0
	30		49.5		−5
	20		49.5		−
	10		49.5		+25
	0				

PACKING TORQUE: 10 IN-LB OPENING

: 5 IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 3/21/77 Checked By:

VALVE SIZE: 3"-600

VALVE DIRECTION: (STEM UPSTREAM) / STEM DOWNSTRE

VALVE SEAL TYPE: Teflon / Buna

WATER TEMPERATURE (TANK): 68 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		54		+75
	20		52		+60
	30		43.5		+75
	40		40.5		+75
	50		43.5		+115
	60		37.5		+120
	70		31.5		+145
	80		26		+160
	90		23		+145
CLOSING	90		23		+140
	80		26.5		+125
	70		31		+115
	60		36		+100
	50		43.5		+75
	40		38.5		+45
	30		41.5		0
	20		43		0
	10		44		−55
	0				

PACKING TORQUE: 10 IN-LB OPENING

: 5 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By Dawson DATE: 11/14/77 Checked By

VALVE SIZE: 4"-600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNST

VALVE SEAL TYPE: TEFLON / EPR

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		49		+275
	20		35		+275
	30		34		+250
	40		23.5		+175
	50		26.5		+175
	60		26		+250
	70		22		+275
	80		17		+250
	90		16.5		+150
CLOSING	90		16.5		+75
	80		17		+150
	70		21.5		+125
	60		27.5		+50
	50		35.5		−10
	40		25		−50
	30		39		−100
	20		48 28		−250 −200
	10		26.5		−200
	0				

PACKING TORQUE: 15 IN-LB OPENING

: 5 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

By DAWSEN DATE: 11/3/77 Checked By

VALVE SIZE: 4"-600

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON / EPR

WATER TEMPERATURE (TANK): 68 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		43		+75
	20		40.5		+25
	30		37		+50
	40		41.5		+50
	50		39		+50
	60		31		+25
	70		23.5		−25
	80		19		−75
	90		17.5		−125
			X		X
CLOSING	90		17.5		−150
	80		18.5		−100
	70		23.5		−50
	60		30.5		−25
	50		39.5		−25
	40		47		0
	30		50		−25
	20		49.5		−75
	10		50		−150
	0		X		X

PACKING TORQUE: 250 IN-LB OPENING

: 250 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 8/17/77 Checked By

VALVE SIZE : 6"-600

VALVE DIRECTION : ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE : Teflon / Buna

WATER TEMPERATURE (TANK) : 83 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE — TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		44		+200	+4.55
	20		33		+150	+4.55
	30		29.5		+250	+8.47
	40		25		+400	+16
	50		19.5		+450	+23.0
	60		20.5		+450 → 21.95	
	70		15		+250 +16.67	0 @
	80		~~10.5~~/18.5		∅ → 25.4	-13.
	90		15.5		-650	-41.
			X		X	
CLOSING	90		15.5		-800	-51.
	80		19.0		-525	-27.
	70		18.5		-200	-10.
	60		26		+50	+1.9
	50		28		+50	+1.7
	40		33		0	0
	30		34		-275	-8.0
	20		32.5		-350	-10.
	10		39		-350	-8.9
	0	⊲|	X	⊲|	X	

PACKING TORQUE : 175 IN-LB OPENING

: 225 IN-LB CLOSING

Title: HYDRODYNAMIC TORQUE DETERMINATION Page

By: [illegible signature] DATE: 8/19/77 Checked By:

VALVE SIZE: 6"-600

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 85 °F

DISC TYPE & DWG: [illegible] [illegible] REG. [illegible]

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB		
OPENING	0		X		X		X
	10		30.5	59.5	+250	6.6	+325
	20		33	58.5	+300	4.1	+50
	30		24	55.5	+300	12.5	+45
	40		25	47.5	+300	12	+55
	50		26.5	44.5	+400	15.1	+625+[illegible]
	60		20	32.5	+450	22.5	+900 [illegible]
	70		19.6	27.5	+650	33.3	+8
	80		19.2	19.0	+1025	53.4	+5
	90		14.8	14.8	+750	(50.7)	[illegible]
			X		X		X
CLOSING	90		14.8	14.8	+650	(43.9)	+5
	80		19.3	18.8	+750	38.4	+6
	70		24.2	24.4	+825	34.1	+[illegible]
	60		20.5	31.5	+225	11	+[illegible]
	50		24.5	43.5	+100	4.1	+[illegible]
	40		34.5	50.5	+25	.7	+
	30		34.5	55.5	−50	1.4	+
	20		38.5	58	−75	1.9	−
	10		34.0	60.5	−275	5.1	−[illegible]
	0		X		X		X

PACKING TORQUE: 175 IN-LB OPENING

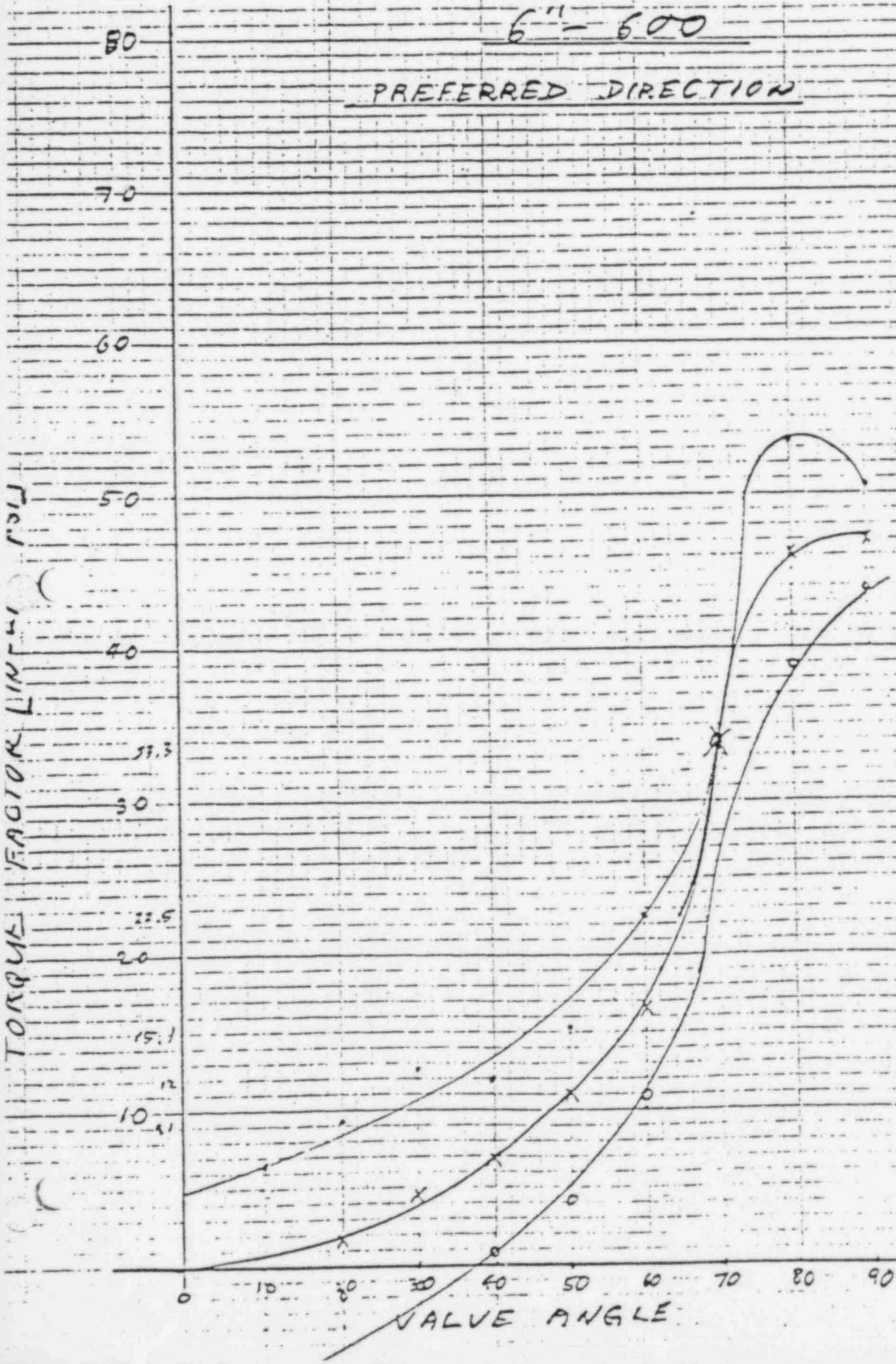
: 225 IN-LB CLOSING

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

By J CORY 8/23/77 Checked By

6" – 600

PREFERRED DIRECTION



ANGLE	FACTOR
0	0
10	.8
20	2.0
30	4.0
40	7.0
50	11.0
60	17.0
70	34.0
80	46.0
90	47.0

POSI-SEAL INTERNATIONAL, INC.

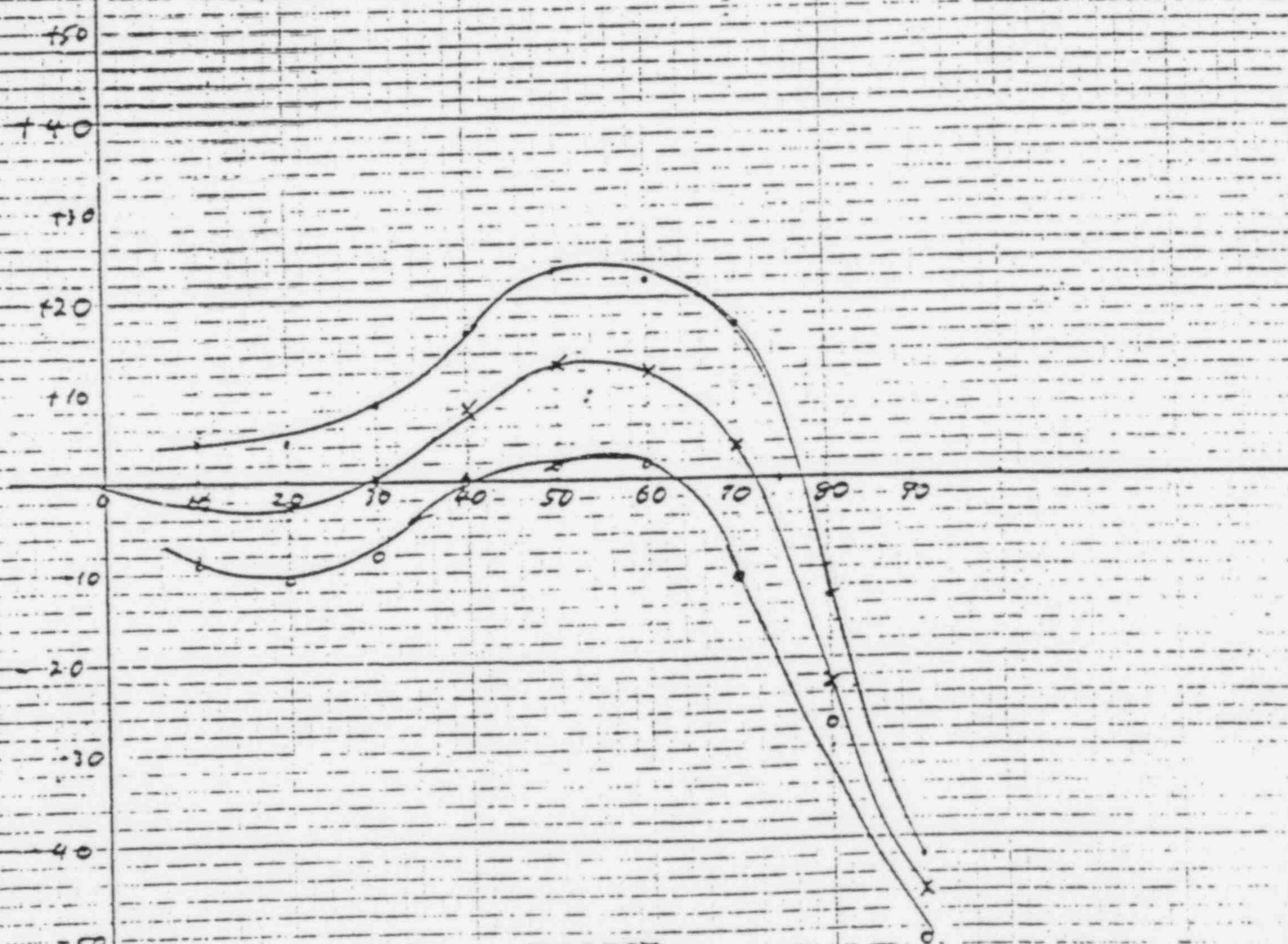
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

By J CORY 8/23/72 Checked By

6" - 600

NON PREFERRED DIRECTION



ANGLE	FACTOR
0	0
10	-3
20	-3
30	0
40	7
50	12
60	12
70	4
80	-22
[illegible]	[illegible]

Title: HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By: C. Livoksi DATE: Checked By:

VALVE SIZE : 8" 600#

VALVE DIRECTION : ☐ STEM UPSTREAM / ☒ STEM DOWNST

VALVE SEAL TYPE : URATHANE

WATER TEMPERATURE (TANK) : 69 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	0	1600		
	10	50	500	-10	
	20	11	250	22.7	
	30	11.5	300	26.1	
	40	11.0	350	31.8	
	50	9.5	325	34.2	
	60	5.7	200	35.1	
	70	6.5	-125	19.2	72° TORQUE WENT NEG
	80	5.0	-125	-25	
	90	6.0	-300	-50	
CLOSING	90	6.0	-600	-100	
	80	5.0	-400	-80	
	70	7.0	-250	-35.7	
	60	11.2	-100	-8.9	
	50	18.5	0	0	
	40	23.5	100	4.3	
	30	31.0	100	3.2	
	20	39	-200	5.1	
	10	57	-250	4.4	
	0	0	-1100		

PACKING TORQUE : 150 IN-LB OPENING

: 150 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION Page ______

Calc. By: C. Livorsi DATE: ______ Checked By: ______

VALVE SIZE: 8" 600#

VALVE DIRECTION: STEM UPSTREAM ☐ / STEM DOWNS ☒

VALVE SEAL TYPE: URATHANE

WATER TEMPERATURE (TANK): 69 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	0	1600		
	10	50	500	-10	
	20	11	250	22.7	
	30	11.5	300	26.1	
	40	11.0	350	31.8	
	50	9.5	325	34.2	
	60	5.7	200	35.1	72° TORQUE WENT
	70	6.5	-125	19.2	NEG
	80	5.0	-125	-25	
	90	6.0	-300	-50	
CLOSING	90	6.0	-600	-100	
	80	5.0	-400	-80	
	70	7.0	-250	-35.7	
	60	11.2	-100	-8.9	
	50	18.5	0	0	
	40	23.5	100	4.3	
	30	31.0	100	3.2	
	20	39	-200	5.1	
	10	57	-250	-4.4	
	0	0	-1100		

PACKING TORQUE: 150 IN-LB OPENING

: 150 IN-LB CLOSIN[G]

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION Page ______

Calc. By: C. LIVOLSI DATE: ______ Checked By ______

VALVE SIZE : 8" 600

VALVE DIRECTION : STEM UPSTREAM [X] / STEM DAWNS [ ]

VALVE SEAL TYPE : URATHANE

WATER TEMPERATURE (TANK) : 71 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN
OPENING	0	67	7800		
	10	50.5	400	7.9	
	20	16	300	18.8	
	30	5	250	50	
	40	10	400	40	
	50	9	600	66.7	
	60	6.0	500	83.3	
	70	4.2	600	142.8	
	80	3.0	400	133.3	
	90	4.6	300	65.2	
CLOSING	90	5.0	0	0	
	80	4.0	200	50	
	70	5.5	325	59.1	
	60	8.0	321	40.6	
	50	11.5	300	26.1	
	40	9.0	100	11.1	
	30	19.0	115	6.1	
	20	19.0	0	0	
	10	49.0	-350	-7.1	
	0	62	1800		

PACKING TORQUE : 150 IN-LB OPENING

: 100 IN-LB CLOSING

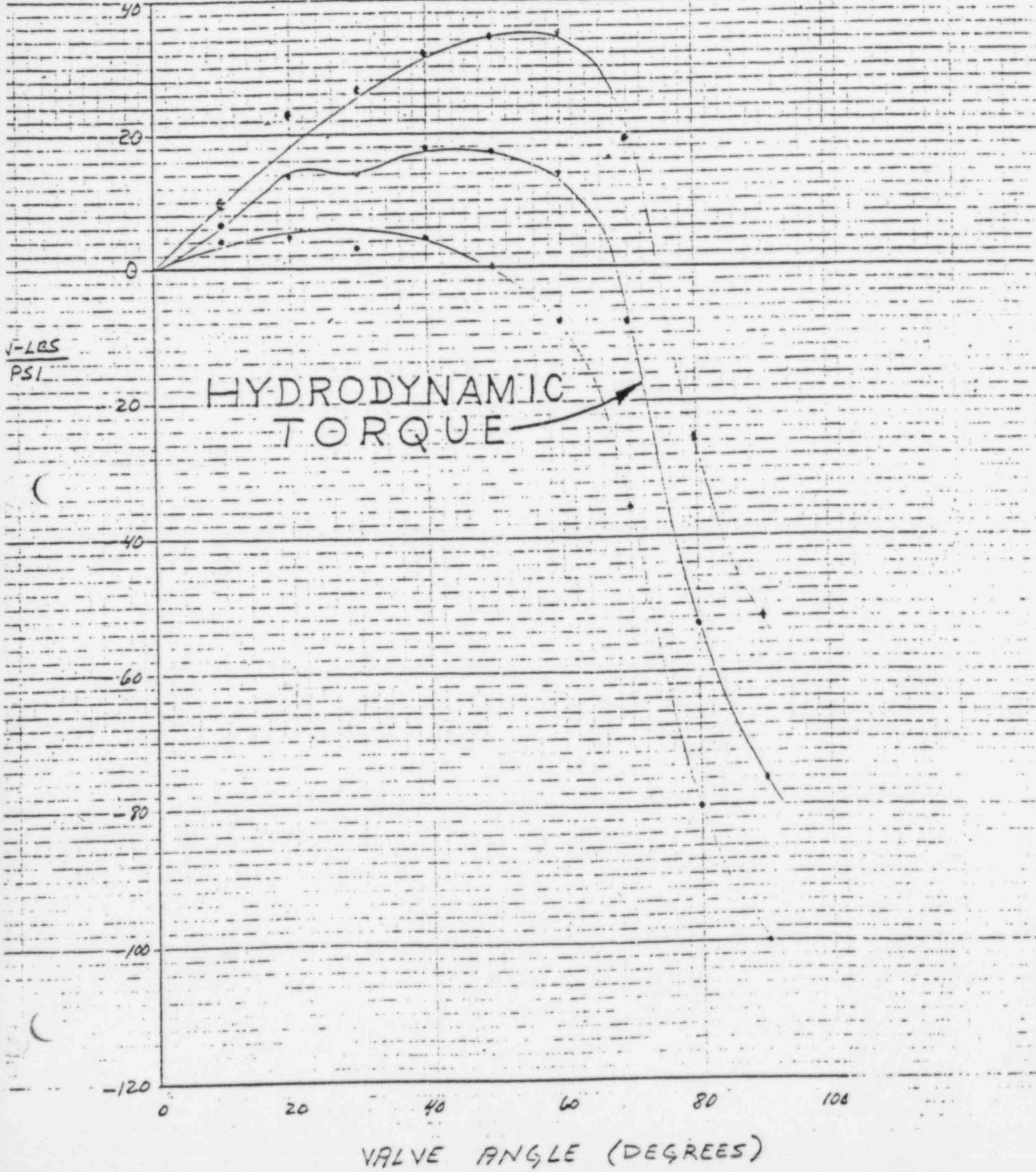
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" 600LB

Title HYDRODYNAMIC TORQUE CURVE (NON-PREF. DIRECTION) Page

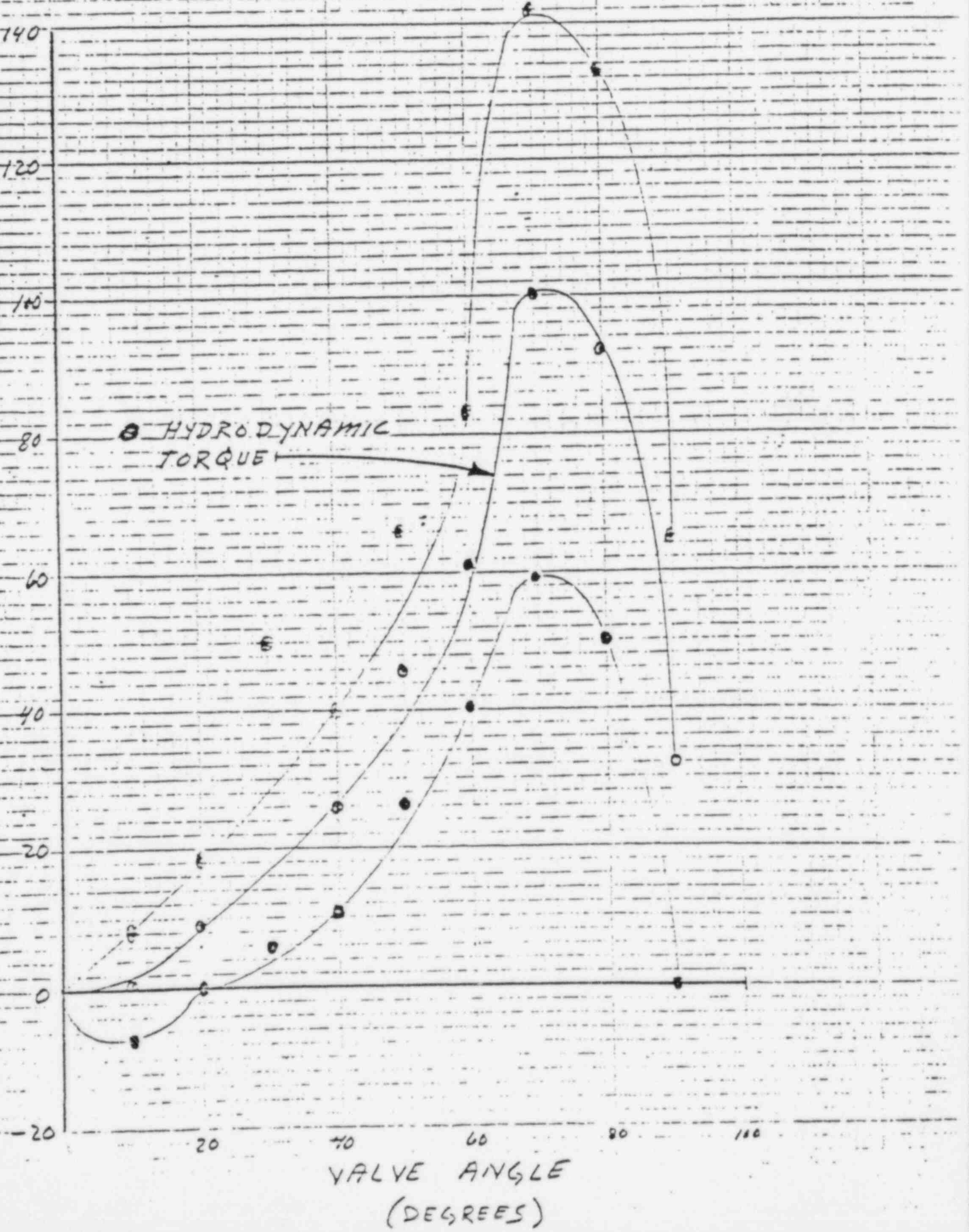
By C. Livorsi Checked By



8"-600LB ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE (PERF. DIRECTION) Page

Calc By C. LIVORSI Checked By



Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ØALSEN DATE: 8/3/77 Checked By

Control valve - regulated

VALVE SIZE: 10" - 600

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 84 °F

DISC TYPE & DWG: Z

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		~~X~~		
	10		~~47~~ 38.5		+900 ✓
	20		~~38~~ 25.5		+1200 ✓
	30		~~28.5~~ 25		~~+1580~~ 1500
	40		~~19.7~~ 24		~~+1800~~ +750
	50		~~14.9~~ 14.4		~~+1500~~ 1550
	60		~~10.5~~ 9.8		~~+1450~~ +1350
	70		7.3		+1400
	80		5.2		+1200
	90		4.4		+800
CLOSING	~~90~~ 85		4.8		0
	80		4.4		+200
	70		5.9		+450
	60		8.8		+550
	50		13.0		+600
	40		20.8		+650
	30		33		+450
	20		40.4		+50
	10		39		−550
	0		~~X~~		

PACKING TORQUE: 350 IN-LB OPENING

: 400 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 8/5/77 Checked By

Control valve regulated

VALVE SIZE: 10" 600

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNS

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 88° °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		46		+1100
	20		31.5		+900
	30		27.5		+9010
	40		24.5		~~[illegible]~~ +1500
	50		14.0		+1100
	60		9.1		+950 +800
	70		5.8		+600 +400
	80		4.3 4.2		−2381 ~~+800~~ −100
	90		4.4		−250
			X		X
CLOSING	90		4.7		−950
	80		4.2		−750
	70		6.4		−550
	60		9.6		−450
	50		14.4		−300
	40		26.5		−250
	30		27.5		−400
	20		32		−750
	10		37		−800
	0		X		X

PACKING TORQUE: ~~[illegible]~~ 450 IN-LB OPENING

: ~~400~~ 450 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By Dorsum DATE: 8/5/77 Checked By:

Control valve wide open

VALVE SIZE: 10" - 600

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNS

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 88 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		57		+1500
	20		48.5		+950
	30		37		+825
	40		25.5		+850
	50		14.5		+900
	60		9.4		+700
	70		6.5		+250
	80		4.3		0 -25
	90		4.6		-300
			X		X
CLOSING	90		4.7		-1350
	80		4.2		-800
	70		6.4		-550
	60		9.3		-500
	50		14.0		-325
	40		24		-325
	30		[illegible]		-575
	20		[illegible]		-960
	10		57.0		-1025
	0		X		X

PACKING TORQUE: ~~850~~ 450 IN-LB OPENING

: ~~400~~ 350 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 1

Calc. By C. Livorsi DATE: 9-1-78 Checked By

VALVE SIZE: 14" 1500 LB

VALVE DIRECTION: STEM UPSTREAM ☒ / STEM DOWNSTRE[AM] ☐

VALVE SEAL TYPE: METAL

WATER TEMPERATURE (TANK): 77 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE ~~(IN-LBS)~~ ft-LBS	ft ~~IN~~-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0				
	10	59.5	190	3.2	
	20	54.5	195	3.6	
	30	40.5	205	5.1	
	40	24.5	205	8.4	
	50	17.5	190	10.9	
	60	12.0	175	14.6	
	70	9.5	165	17.4	
	80	8.0	160	20.0	
	90	7.5	145	19.3	
CLOSING	90	8.0	-35	-4.4	
	80	7.5	-20	-2.7	
	70	8.0	-5	-0.6	
	60	8.5	-5	-0.6	
	50	11.5	-5	-0.4	
	40	17.5	-10	-0.6	
	30	31.0	-50	-1.6	
	20	44.5	-105	-2.4	
	10	52.5	-210	-4.0	
	0				

PACKING TORQUE: 70 ft-LBS ~~IN-LB~~ OPENING

: 70 ft-LBS ~~IN-LB~~ CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By C. LIVORSI DATE: 9-1-78 Checked By

VALVE SIZE: 14" 1500 LB

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNS[TREAM] ☒

VALVE SEAL TYPE: METAL

WATER TEMPERATURE (TANK): 77 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0				
	10	57.5	150	2.6	
	20	48.5	190	3.9	
	30	39.0	200	5.1	
	40	25.5	170	6.7	
	50	16.5	130	7.9	
	60	12.5	90	7.2	
	70	9.0	50	5.5	
	80	7.5	25	3.3	
	90	6.8	15	2.2	
CLOSING	90	7.0	-115	-16.4	
	80	7.0	-115	-16.4	
	70	7.2	-95	-13.2	
	60	8.0	-90	-11.3	
	50	11.5	-70	-6.1	
	40	19.5	-65	-3.3	
	30	32.0	-70	-2.2	
	20	45.0	-100	-2.2	
	10	54.0	-125	-2.3	
	0				

PACKING TORQUE: 70 ft-LBS ~~IN-LB~~ OPENING

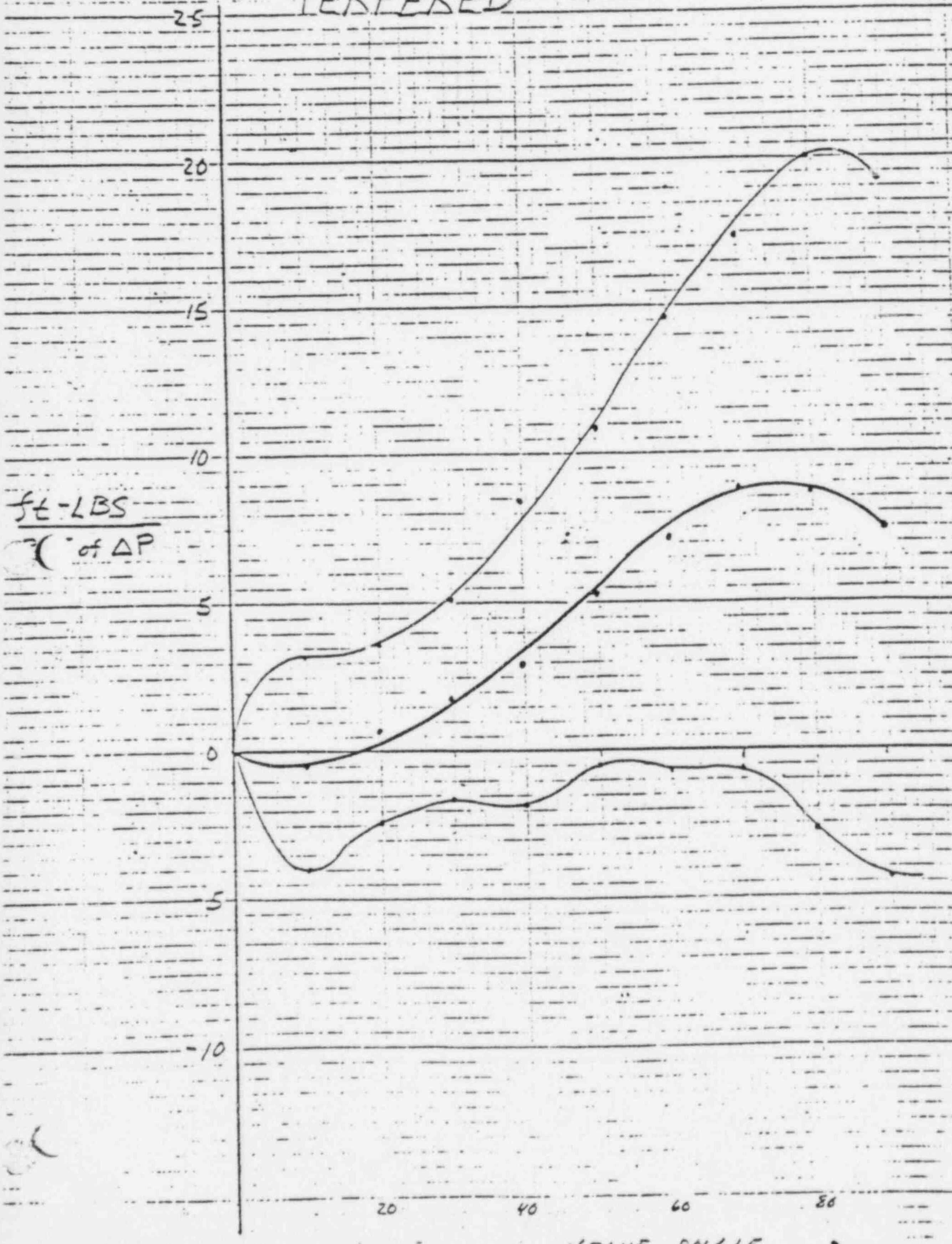
: 70 ft-LBS ~~IN-LB~~ CLOSING

ENGINEERING CALCULATIONS

Title: 14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

By: C. Livorsi Checked By

PERFERED



ENGINEERING CALCULATIONS

Title 14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

By C. LIVORSI Checked By

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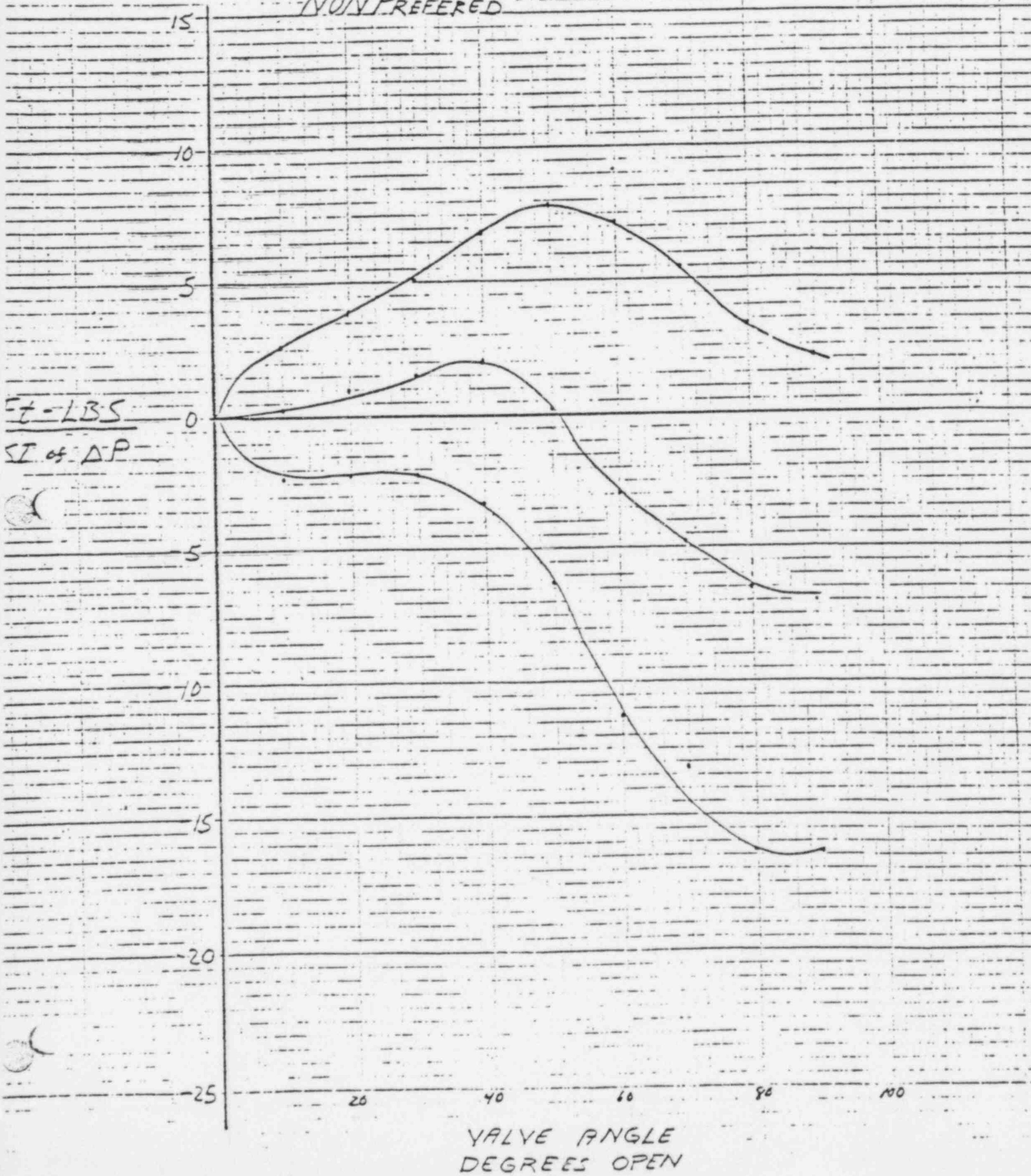


POSI-SEAL INTERNATIONAL, INC.

Innovators in Flow Control

TECHNICAL BULLETIN NO. 1
Operating torque values and Actuator sizing

JUNE 8

TORQUE VALUES TO OPEN AND SHUT

The Posi-Seal Trunnion Valve is a low torque valve which normally reaches its highest torque when opening. This torque value will vary with the seat material and stem packing selected in addition to the maximum operating differential pressure (ΔP) across the valve.

Torque values to open and shut for standard Posi-Seal Trunnion Valves are listed in Tables 1, 2 and 3, and are denoted as T_1, T_2, and T_3.

T_1 and T_2 torque values are due to the stem packing and seat material selected and are added together to determine preload torque.

The static pressure torque factor T_3 is the static pressure torque per PSIΔP. This factor (T_3) is multiplied by the maximum operating ΔP or maximum line pressure to obtain the torque value due to pressure.

To obtain the maximum torque to open or shut the T_1, T_2, and T_3 ΔP values are simply added together.

EXAMPLE:

A. Requirement — What is the maximum opening torque of a 12" Class 150 valve with teflon chevron packing, a teflon seal ring with rubber back-up ring and a maximum ΔP of 200 PSI.

B. Solution — From Table 1

T_1 = (B) = 70 in. lbs.

T_2 = (G) = 986 in. lbs.

T_3 = 10.10 in. lbs. per PSIΔP = 10.10 x 200 = 2020 in. lbs.

Total opening torque = $T_1 + T_2 + (T_3 \times \text{PSI}\Delta P) = 70 + 986 + (10.10 \times 200) = 3076$ in. lbs.

Although the valve opening torque is normally the highest operating torque used in actuator sizing, it is often necessary with flowing liquids to check for total hydrodynamic torque. Refer to Section II for data on calculating total hydrodynamic torque.

TABLE 2
CLASS 300 STD. RATING

VALVE SIZE	PRELOAD TORQUE = T_1 + T_2								STATIC PRESSURE TORQUE PER PSI T_3	
	T_1			T_2						
	A	B	C	E	F	G	H	J	316 M.S.	REXNORD
......	....	......	....	....	....	....	....	....	....	
......	....	......	....	....	....	....	....	....	....	
3"	302	28	227	122	73	61	244	280	0.24	.16
4"	338	31	254	218	131	109	436	501	0.50	.33
6"	454	42	340	510	306	255	1020	1173	1.56	1.04
8"	756	70	567	750	450	375	1500	1725	3.84	2.56
10"	907	84	680	1242	745	621	2484	2857	7.64	5.09
12"	1058	98	794	1722	1063	886	3544	4076	12.70	8.47
14"	1210	112	907	2160	1296	1080	4321	4968	17.71	11.81
16"	1361	126	1021	3164	1898	1582	6328	7277	29.16	19.44
18"	1512	140	1134	3602	2161	1801	7204	8285	36.90	24.60
20"	1814	168	1361	4534	2720	2267	9068	10428	55.74	37.16
24"	2117	196	1588	7564	4538	3782	15128	17397	108.46	72.31
30"	2722	252	2041	10764	6458	5382	21528	24757	198.45	132.30
36"	3024	280	2268	16278	9767	8139	32556	37439	333.46	222.31
42"	3175	294	2381	23402	14041	11701	46804	53825	503.30	....
48"	4234	392	3175	30383	18230	15192	60766	69881	871.40	....

Valve torque (opening) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

Valve torque (closing, on-off service) = $T_1 + T_2 + (.5T_3 \times PSI\Delta P)$

Valve torque (closing, modulating service) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

When the operating ΔP used for actuator selection is less than the maximum line pressure, contact the factory for sizing torque.

NOTES:

T_1 (A) Asbestos jam packing
(B) Teflon Chevron packing
(C) Graphite jam packing

T_2 (E) Urethane seal ring with rubber back-up ring, Metal seal ring with and without rubber back-up ring, Kel-F seal ring without rubber back-up ring
(F) Teflon seal ring with Teflon back-up ring, Tefzel seal ring with rubber back-up ring
(G) Teflon seal ring with rubber back-up ring
(H) Metal seal ring with Teflon insert and rubber back-up ring
(J) Metal seal ring with urethane, Tefzel, or Kel-F insert and rubber back-up ring

II. TOTAL VALVE OPERATING HYDRODYNAMIC TORQUE

As previously stated the valve opening torque is normally the highest operating torque used for actuator sizing and selection. However, when flowing liquids, it is often necessary to calculate the total valve operating hydrodynamic torque.

The location of the maximum valve operating torque (total hydrodynamic torque) is a result of the overall system operating parameters in addition to the particular valve disc hydrodynamic torque characteristics.

When the ratio of thru valve ΔP to total system ΔP is high, generally above 25 percent, the maximum valve operating hydrodynamic torque will occur at or about the 70° to 80° disc open position. As this ratio decreases, the maximum valve operating hydrodynamic torque will shift towards the 0° shut position.

To allow for system operating variables it is recommended that the maximum valve operating hydrodynamic torque (TH_T) be calculated at both the 20° and 80° disc open position.

The total valve operating hydrodynamic torque (TH_T) is the summation of three torque components. These components are: stem packing torque (T_1), stem bearing friction torque (static pressure torque per PSIΔP) and the disc hydrodynamic lift and drag torque. Torque values T_1 and T_3 can be found in Tables 1 thru 3.

Extensive flow testing has shown that the disc hydrodynamic lift and drag torque values are dependent upon the direction of flow entering the valve. With liquid flow entering the valve from the stem side, with the seal retaining downstream, the disc hydrodynamic lift and drag torque value (T_4) is positive to the full open position acting to return the disc to the shut position. Liquid flow entering the valve from the opposite direction, seal retaining ring up stream, results in a torque value that remains positive, acting to return the disc to the shut position, until about the 70° to 80° open position. At this point the torque value becomes negative acting to move the disc to the full open position. With liquid flow in this direction the disc hydrodynamic lift and drag torque values are designated as T_5. Also, test results have shown that flowing liquids in this direction results in a positive T_5 value that is lower than the corresponding T_4 value with flow in opposite direction.

TABLE 4

CLASS 150 STD RATING

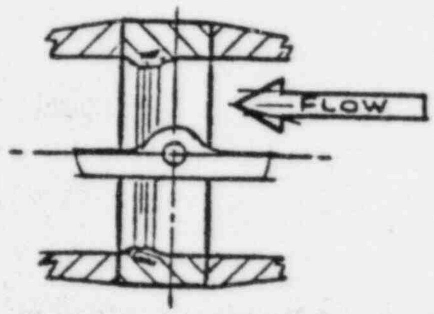
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque – T_4

VALVE SIZE	T_4 VS. OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
......	....	....	....	....	....	....	....	....	....
......	....	....	....	....	....	....	....	....	....
3″	0	0	0	0	1	2	5	6	5
4″	0	0	1	1	3	6	12	16	13
6″	1	2	4	8	13	27	51	68	56
8″	4	10	16	30	49	100	185	247	204
10″	6	16	26	49	79	161	300	399	330
12″	15	38	60	114	182	372	692	920	761
14″	23	59	94	177	283	579	1075	1430	1182
16″	41	102	164	307	492	1005	1876	2482	2052
18″	64	162	259	486	778	1590	2953	3927	3245
20″	99	248	397	746	1193	2437	4526	6019	4974
24″	214	536	858	1610	2576	5259	9768	12988	10734
30″	462	1156	1850	3469	5551	11334	21049	27988	23131
36″	1884	4710	7537	14132	22611	46164	85734	113998	94213
42″	2281	5704	9127	17114	27383	55908	103829	138058	114098
48″	3265	8164	13063	24494	39191	80016	148602	197592	163299
54″	7388	18471	29554	55414	88662	181020	336180	447008	369428
60″	11165	27913	44661	83740	133984	273552	508026	675506	558270
66″	14942	37355	59768	112066	179306	366084	679972	904005	747112
72″	22995	57488	91981	172465	275945	563388	1046293	1391225	1149773
CLASS 150 150 PSI RATING									
24″	255	637	1020	1913	3061	6251	11609	15437	12758
30″	857	2144	3431	6433	10293	21016	39030	51897	42890
36″	1792	4480	7168	13441	21505	43907	81542	108424	89607
42″	3202	8007	12811	24021	38434	78469	145729	193772	160142
48″	5412	13530	21648	40591	64946	132598	246254	327437	270609
54″	7336	18341	29346	55025	88040	179749	333820	443871	366835
60″	14428	36072	57715	108216	173146	353506	656512	872945	721442
66″	14942	37355	59768	112066	179306	366084	679872	904005	747112
72″	30124	75310	120496	225[illegible]31	361490	738044	1370653	1822516	1506212

1. T_4 values = in. lbs. per PSIΔP.
2. All T_4 values are positive acting to shut valve.
3. 0 T_4 values $\cong$ < 1.

TABLE 6

CLASS 300 STD RATING



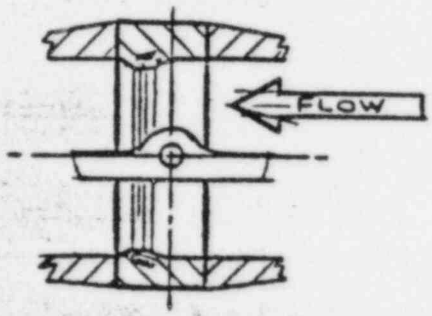
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque – T_4

VALVE SIZE	T_4 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......
3"	0	0	0	0	1	2	5	6	5
4"	0	0	1	1	3	6	12	16	13
6"	1	2	4	8	13	27	51	68	56
8"	1	4	7	11	21	34	57	81	68
10"	3	9	17	27	51	81	136	192	162
12"	7	21	39	60	113	179	298	422	355
14"	9	29	54	84	158	250	416	590	495
16"	12	37	68	105	198	313	520	737	620
18"	28	86	158	244	460	726	1208	1711	1438
20"	30	92	169	261	493	778	1294	1833	1540
24"	41	125	229	355	668	1054	1754	2485	2088
30"	143	429	788	1218	2292	3618	6019	8526	7165
36"	287	861	1579	2441	4596	7253	12065	17092	14363
42"	686	2058	3773	5381	10976	17321	28812	40817	34300
48"	429	1287	2359	3646	6864	10832	18018	25526	21451

1. T_4 values = in. lbs. per PSIΔP.
2. All T_4 values are positive acting to shut valve.
3. 0 T_4 values $\cong < 1$.

TABLE 8

CLASS 600 STD RATING



Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

VALVE SIZE	T_4 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	0	0	0	0	0	0	0	0	0
4"	0	0	0	0	0	0	0	0	0
6"	0	1	3	3	6	8	13	14	13
8"	0	5	10	12	19	27	44	46	43
10"	1	13	26	29	48	67	107	112	105
12"	1	20	38	43	71	99	158	165	154
14"	2	27	52	58	96	133	213	223	208
16"	2	36	69	78	128	178	284	298	279
18"	3	43	83	93	153	214	341	358	334
20"	3	41	79	88	146	203	324	340	317
24"	12	166	319	357	587	818	1303	1367	1278

1. T_4 values = in. lbs. per PSIΔP.
2. All T_4 values are positive acting to shut valve.
3. 0 T_4 values $\cong < 1$.

COMPARISON OF CALCULATED AERODYNAMIC TORQUES WITH TEST DATA

The purpose of this Enclosure is to compare aerodynamic torques calculated in the manner outlined in the report and compare them to measured aerodynamic torques.

Since at this time Posi-Seal does not have actual aerodynamic torque test data, use will be made of data given in ISA transaction 68-923, Ref. (a). Presented in Ref. (a) is a plot of both aerodynamic and hydrodynamic torque versus pressure drop. This plot is based on data obtained from a 4" butterfly valve with a disc rotation of 60 degrees and an upstream pressure of 214.4 psia.

Shown in Figure 1 on Page 3 of this Enclosure is a recreation of this plot. Superimposed on this plot are plots of calculated hydrodynamic torques and aerodynamic torques. The calculation of the hydrodynamic torque is nothing more than multiplying the hydrodynamic torque coefficient times the pressure drop. The hydrodynamic torque coefficient for a 4" 150 Class valve at 60 degrees is 6 per Ref. (b).

As for the aerodynamic torques, shown on Pages 4 thru 9 are computer printouts of aerodynamic torques which uses the same equations as the LOCA analysis.

As can be seen in Figure 1 relatively good correlation is obtained for both the calculated aerodynamic torque and the hydrodynamic torque.

It should also be noted that the method of calculating the aerodynamic torque presented in the ISA transaction is equivalent to the method developed by Posi-Seal as demonstrated below.

Per the ISA transaction the aerodynamic torque is calculated as follows:

$$T_D = K_1 \; D^3 \Delta P_e \qquad \text{Equation (25)}$$

$$\text{where } \Delta P_e = P_1 \; \frac{C_1 C_2}{59.64}^2 \; \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right] \text{rad}$$

Equations (16) & (26)

Posi-Seal's aerodynamic equation for air is:

$$T_{air} = .0436 \; T_{4w} \; \frac{T_1}{P_1} \left[\frac{Q}{283.8Cv} \right]^2$$

Since the expression $K_1 \; D^3$ is equivalent to Posi-Seal's hydrodynamic torque coefficient T_{4w},

$$\Delta P \text{ should equal } .0436 \; \frac{T_1}{P_1} \left[\frac{Q}{283.8Cv} \right]^2$$

To prove this, the expression for Q given is the ISA transaction, Equation (14), is substitute into the above equation.

$$Q = \sqrt{\frac{520}{GT}} \; P_1 \; C_1 \; C_2 \; C_v \sin \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right] \text{rad}$$

$$Q^2 = \frac{520}{GT} \; P_1^2 C_1^2 C_2^2 C_v^2 \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right]$$

$$\Delta Pe = \frac{.0436 \; \frac{T_1}{P_1}}{283.8^2 \; Cv^2} \left[\frac{520}{GT} \; P_1^2 \; C_1^2 C_2^2 C_v^2 \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right] \right]$$

$$\Delta Pe = .0002815 \; P_1 \; C_1^2 C_2^2 \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right]$$

$$Pe = P_1 \left[\frac{C_1 \; C_2}{59.60} \right]^2 \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right]$$

$$\approx P_1 \left[\frac{C_1 \; C_2}{59.64} \right]^2 \sin^2 \left[\frac{59.64}{C_1 \; C_2} \sqrt{\frac{\Delta P}{P_1}} \right]$$

REFERENCE (a) ISA Transaction 6 8-923 "Effect of Fluid Compressibility on Torque in Butterfly Valves", Floyd P. Harthun

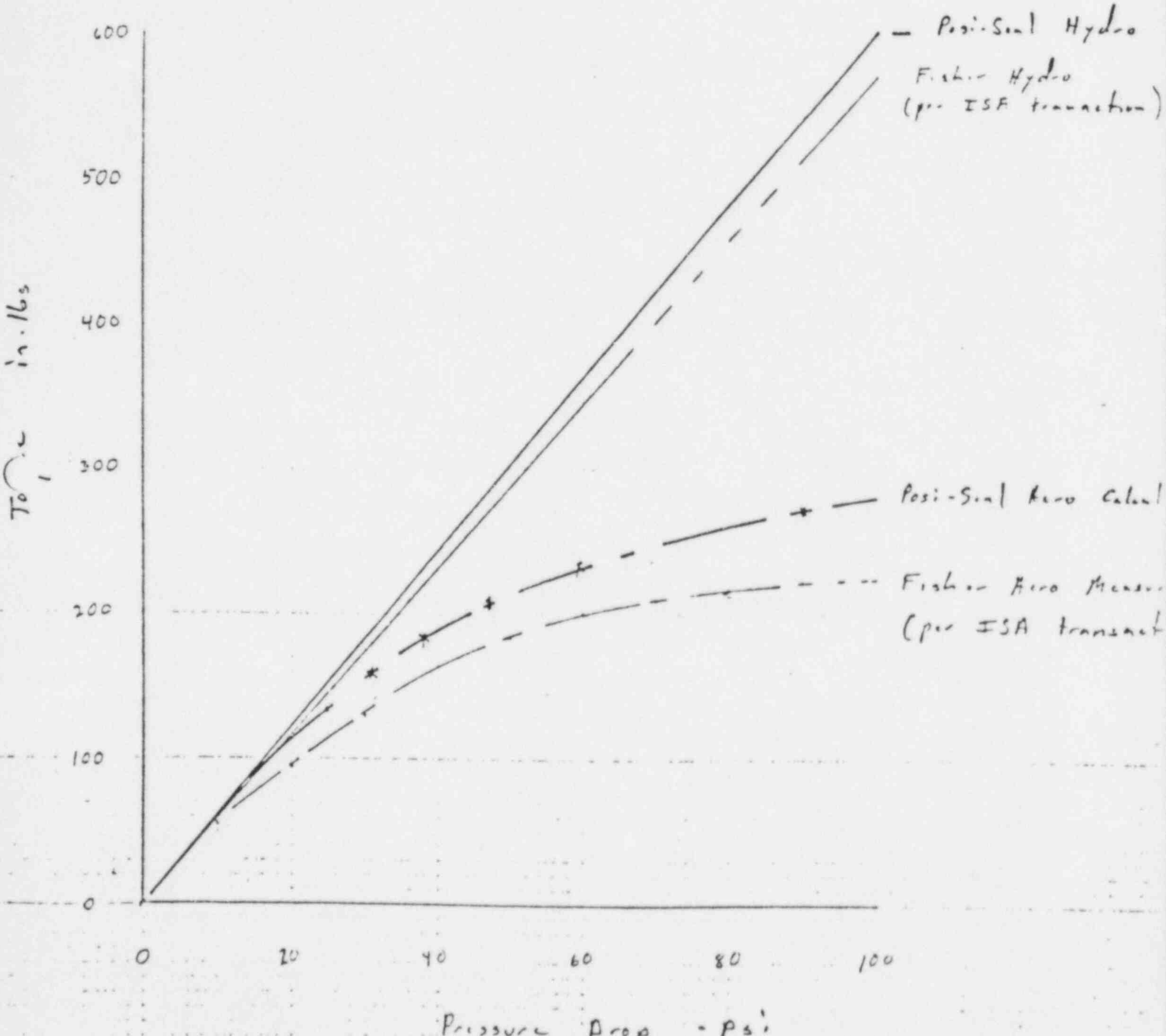
REFERENCE (b) Posi-Seal Technical Bulletin 1A, June 1982

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: 4" Butterfly Valve - Flow induced torque — Page 3

Calc. By: [signature] 1/7/85 — Checked By:



P_1 = 214.4 psia

Valve Angle - 60°

CONTROL SYSTEM ANALYSIS - CAS

VALVE SIZE= 4 VALVE CLASS=300 AERO 1

INPUT DATA

FLOW(SCFH) AT-90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
999999	214.4	214.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	CAGE DIA.	PACKING	SEAL	BEARING
.552	3.375	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.23 IN LBS P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,000,000.0	214.40	8.73	141	-87	105	
80	990,077.3	214.40	11.17	192	-113	155	
70	973,065.9	214.40	15.23	184	-106	145	
60	735,058.4?	214.40	28.01?	173	-90?	[illegible]	
50	851,215.3	214.40	50.55	202	-39	155	
40	670,364.2	214.40	113.83	199	-22	110	CRITICAL
30	383,105.3?	214.40	120.08?	187?	18	71	CRITICAL
20	207,939.4	214.40	124.35	136	51	42	CRITICAL
10	51,784.8	214.40	124.35	109	77	14	CRITICAL

CONTROL SYSTEM ANALYSIS - GAS

VALVE SIZE= 4 VALVE CLASS=300 AERO 1

INPUT DATA

FLOW(SCFH) AT 90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
1099999	214.4	214.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	CAGE DIA.	PACKING	SEAL	BEARING
.562	3.375	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.23 IN LBS P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,100,000.0	214.40	11.04	184	-90	127	
80	1,086,834.6	214.40	13.77	226	-149	187	
70	1,064,447.4	214.40	18.77	215	-133	174	
60	[illegible]	214.40	[illegible]	204	-111	148	
50	910,500.0	214.40	84.76	230	-102	166	
40	670,258.2	214.40	113.63	199	-22	110	CRITICAL
30	333,105.3	214.40	120.08	157	13	76	CRITICAL
20	207,739.4	214.40	124.35	138	51	42	CRITICAL
10	51,734.0	214.40	124.35	108	79	14	CRITICAL

Page 6

CONTROL SYSTEM ANALYSIS - CAS

VALVE SIZE= 4 VALVE CLASS=300 AERO 1

INPUT DATA

FLOW(SCFH) AT 90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
1200000	214.4	214.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	GAGE DIA.	PACKING	SEAL	BEARING
.552	3.376	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.23 IN LBS P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,200,000.0	214.40	13.48	170	-114	152	
80	1,182,765.8	214.40	16.76	262	-182	222	
70	1,154,262.1	214.40	22.90	247	-161	204	
60	1,092,270.0	214.40	33.07	233	-132	183	
50	764,820.6	214.40	93.03	265	-109	187	
40	670,364.2	214.40	113.63	199	-22	110	CRITICAL
30	383,106.3	214.40	120.08	187	13	75	CRITICAL
20	207,939.4	214.40	124.35	136	51	42	CRITICAL
10	51,784.8	214.40	124.35	108	79	14	CRITICAL

CONTROL SYSTEM ANALYSIS - GAS

VALVE SIZE= 4 VALVE CLASS=300 AERO 1

INPUT DATA

FLOW(SCFH) AT 90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
1300000	214.4	211.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	GAGE DIA.	PACKING	SEAL	BEARING
.382	3.?76	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.?? IN LBS P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,300,000.0	214.40	16.23	213	-137	178	
80	1,272,421.5	214.40	20.20	301	-218	259	
70	1,242,112.1	214.40	27.67	282	-192	237	
60	1,1??,072.1	214.40	45.91	283	-1?3	208	
50	959,??6.8	214.40	102.91	272	-105	189	CRITICAL
40	670,264.2	214.40	113.63	199	-22	110	CRITICAL
30	393,105.2	214.40	120.08	167	18	75	CRITICAL
20	207,739.4	214.40	124.35	136	51	42	CRITICAL
10	51,784.8	214.40	124.35	108	79	14	CRITICAL

CONTROL SYSTEM ANALYSIS - GAS

VALVE SIZE= 4   VALVE CLASS-300   AERO 1

INPUT DATA

FLOW(SCFH) AT 90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
1399979	214.4	214.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	GAGE DIA.	PACKING	SEAL	BEARING
.562	3.375	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.23 IN LBS   P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,400,000.0	214.40	19.48	248	-165	207	
80	1,373,155.3	214.40	24.18	343	-255	299	
70	1,328,817.3	214.40	33.34	317	-223	271	
60	1,235,813.3	214.40	53.73	295	-173	234	
50	969,476.3	214.40	102.71	272	-105	188	CRITICAL
40	670,264.2	214.40	113.63	199	-22	110	CRITICAL
30	383,105.3	214.40	120.05	167	15	75	CRITICAL
20	207,739.4	214.40	124.35	136	51	42	CRITICAL
10	51,784.3	214.40	124.35	109	79	14	CRITICAL

CONTROL SYSTEM ANALYSIS - CAS

VALVE SIZE- 4 VALVE CLASS-300 AERO 1

INPUT DATA

FLOW(SCFH) AT 90 DEG.	SHUT-OFF PRESSURE	UPSTREAM PRESSURE	DOWNSTREAM PRESSURE	TEMPERATURE
1499999	214.4	214.4	14.7	70

Sg	HF @ 90 deg.	Cv @ 90 deg	Z	Fk
1	13	404	1	1

STEM DIA.	GAGE DIA.	PACKING	SEAL	BEARING
.552	3.376	1	1	1

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 241.23 IN LBS P1= 214.40 PSIA

CONDITIONS AT THE VARIOUS VALVE ANGLES

ANGLE	FLOW SCFH	P1	DP ACROSS VALVE	Topening	Tclosing	Taero	
90	1,500,000.0	214.40	23.27	281	-174	227	
80	1,467,121.2	214.40	29.85	387	-296	341	
70	1,413,408.4	214.40	40.23	359	-255	307	
60	1,304,977.3	214.40	90.04	337	-183	260	CRITICAL
50	969,476.8	214.40	102.91	272	-105	183	CRITICAL
40	670,864.2	214.40	113.63	199	-22	110	CRITICAL
30	393,105.3	214.40	120.08	167	16	75	CRITICAL
20	207,939.4	214.40	124.35	136	51	42	CRITICAL
10	51,784.8	214.40	124.35	108	79	14	CRITICAL