POST-SEAL INTERNATIONAL, INC.

North Stonington, CT 06359

LOCA & SEISMIC ANALYSIS

Stone & Webster Engineering J.O. No. 12177 Spec. No.
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CUSTOMER: Niagara Mohawk Power Corp.

UNIT: Nine Mile Point Nuclear Station - Unit 2

P.O. NO.: NMP2-P304D Ch. 14

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(4) Posi-Seal Technical Bulletin No. 1A, dated June 1982

REFERENCES (a) DuPont Tefzel Catalog, A-95151, dated 1973
(b) "Flow of Fluids through Valves, Fittings and Pipe", Technical Paper No. 410, Crane
(c) Nuclear Seismic Analysis 19157SQ-01, Rev. A dated July 18, 1983
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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. The preferred direction is with the stem side of the disc upstream and the retaining ring downstream. See Figure 1 on Page 2.

For the purpose of this report the orientation of the valves relative to the flow will be based on the flow going from containment to outside containment.

If a Loss of Coolant Accident (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>

1. Valves AOV 106, 108 and 109 which are inside containment and are presently installed in the preferred direction.

   Due to the large flow resulting from the LOCA and the corresponding aerodynamic torque, these valves will partially close. Upon receiving a signal to close, these valves will fully close providing proper shut-off.

2. Valve AOV 107, which is inside the containment and presently installed in the nonpreferred direction.

   Upon receiving a signal to close, this valve will fully close and provide proper shut-off.

3. Valves AOV 104, 110 and 111 which are outside containment and are presently installed in the nonpreferred direction.

   The aerodynamic torques resulting from a LOCA event will be so large that the Bettis actuators will not be able to overcome the torque. As a consequence, these valves will remain in the open position until which time the pressure inside containment reduces to a point where the resulting torque is less than that of the actuator.

4. Valve AOV 105 which is outside containment and presently installed in the nonpreferred direction.

   Upon receiving the signal, this valve will close, however, the closing time will exceed the 5 second requirement.

B. If the recommendations made in this report are incorporated -

Upon receiving the closing signal all the valves will full close providing a proper shut off.

Preferred Direction

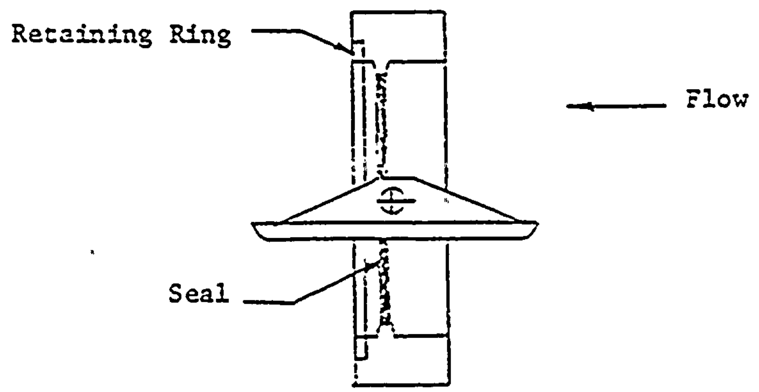


Figure 1

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 of magnitude as given in customer's specification 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 determining the natural frequencies and stresses of the valve assembly, assuming the basic valve body to be rigid and the actuator to act as a lumped mass concentrated at its C.G. and rigidly connected to the valve bracket through the bracket bolting.

Those critical sections of the valve assembly such as the bolting, neck, stem and pin are analyzed assuming a g static load (magnitude per customer specification) applied at either actuator or disc C.G., in each of the orthogonal directions simultaneously. Seismic stresses are combined with operating stresses as well as the stresses due to the LOCA aerodynamic torque.

Section modulus of the valve body and deflection of the actuator relative to the valve due to seismic loading are also analyzed.

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

PSI Item No.	Description	Tag No.
19157-3	14"-150 Cl with Bettis N721C-SR80-M3HW	AOV104
		AOV106
		AOV108
		AOV110
-4	12"-150 Cl with Bettis N721C-SR80-M3HW	AOV107
		AOV109
-5	12"-150 Cl with Bettis N721C-SR80-M3HW	AOV105
		AOV111

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

RESULTS

Maximum Torques Resulting from a LOCA
and Closing Times

'ag No.	AOV106	AOV104	AOV108	AOV110
'SL Item No.	3	3	3	3
:ase No.	1A	1B	2A	2B
'alve Size	14"	14"	14"	14"
'ettis Actuator Model	N721C-SR80	N721C-SR80	N721C-SR80	N721C-SR80
ctuator Max Allow Torque	22,500	22,500	22,500	22,500
lax Torque Resulting from a LOCA (in.lbs)				
'referred Direction				
80°	6170	6519	5848	9584
70° Max Opening	-	-	-	-
lonpreferred Direction				
90°	-	7339	-	7287
70° Max Opening	-	3101 (Seating Torque)	-	3101 (Seating Torque)
Calculated Closing Times (Sec.)				
No Flow	1.5	1.5	1.5	1.5
Preferred Direction				
Valve Opened to 90°	.8	1.00	.8	.6
Valve Opened to 70°	-	-	-	-
Nonpreferred Direction				
Valve Opened to 90°	-	Will Not Close	-	Will Not Close
Valve Opened to 70°	-	1.4	-	2.6
Required Closing Time	5.0	5.0	5.0	5.0

RESULTS

Maximum Torques Resulting from a LOCA
and Closing Times

Tag No.	AOV107	AOV105	AOV109	AOV111
PSI Item No.	4	5	4	5
Case No.	3A	3B	4A	4B
Valve Size	12"	12"	12"	12"
Bettis Actuator Model	N721C-SR80	N721C-SR80	N721C-SR80	N721C-SR80
Actuator Max Allow Torque	22,500	22,500	22,500	22,500
Max Torque Resulting from a LOCA (in.lbs)				
Preferred Direction				
80°	3237	4100	3330	6776
70° Max Opening	-	-	-	4729
Nonpreferred Direction				
90°	3998	4485	-	5174
70° Max Opening	2542 (Seating Torque)	2542 (Seating Torque)	-	2542 (Seating Torque
Calculated Closing Times (Sec.)				
No Flow	1.5	1.5	1.5	1.5
Preferred Direction				
Valve Opened to 90°	.75	1.15	.8	.85
Valve Opened to 70°	-	-	-	.65
Nonpreferred Direction				
Valve Opened to 90°	3.9	5.75	-	Will Not Close
Valve Opened to 70°	1.5	1.5	-	2.1
Required Closing Time	5.0	5.0	5.0	5.0

RESULTS

LOCA AND SEISMIC STRESSES (PSI)

Tag No.	Size	Valve Opening	Flow Direction	Actuator Bolt		Bracket Bolt		Bracket		Valve Neck		Stem		Disc Pin	
				Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow	Calc	Allow
AOV106	14"	80°	Preferred	15019	37500	20400	37500	3765	18900	1722	23400	14522	52800	14808	31680
AOV104	14"	90°	Non-Preferred	17018	37500	21557	37500	3983	18900	1805	23400	16761	52800	17614	31680
AOV108	14"	80°	Preferred	14788	37500	20255	37500	3701	18900	1705	23400	13902	52800	14035	31680
AOV110	14"	80°	Preferred	18168	37500	24240	37500	5105	18900	2166	23400	21138	52800	23002	31680
AOV107	12"	90°	Non-Preferred	14795	37500	21162	37500	3313	18900	9640	23400	13005	52800	22977	31680
AOV105	12"	90°	Non-Preferred	15107	37500	25495	37500	3443	18900	3178	23400	14258	52800	25776	31680
AOV109	12"	80°	Preferred	14376	37500	20817	37500	3179	18900	9551	23400	11297	52800	19138	31680
AOV111	12"	80°	Preferred	16632	37500	26431	37500	3903	18900	3376	23400	20203	52800	38943	31680
		70°	Preferred	15265	37500	25590	37500	3492	18900	3198	23400	14888	52800	27178	31680

NOTE: The allowable stresses are based on 1.5 times the allowable given in Section III of the ASME Boiler and Pressure Vessel Code

RECOMMENDATIONS AND CONCLUSIONS

Based on the results of this analysis, Posi-Seal recommends that all the subject valves be installed in the preferred direction and that the amount of valve open of valve AOV111 be restricted to 70 degrees. For valves inside containment the retaining ring will be on the side of the valve closest to the containment wall. For the valves outside containment the retaining ring will be on the side the farthest from the containment wall. Valves AOV110 and AOV111 should be orientated as shown on Pages 31 and 33, respectively.

If, for some reason a valve cannot be installed in the preferred direction, then the amount of valve opening should be restricted to 70 degrees.

Posi-Seal recommends that one of the two methods shown on the following page be used to restrict the amount of valve opening.

It is concluded that if the above recommendations are incorporated the subject valves will properly operate within the required time during a combined LOCA and seismic event. Whether the amount of pressure drop across the valves under normal flow conditions is acceptable with the amount of valve opening restricted to 70 degrees remains for Stone & Webster to determine. See Page H-1 in Appendix H.

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 3×10^8 rads.

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

BETTIS ACTUATOR

Mechanical Stops for

Restricting Valve Opening to 70°

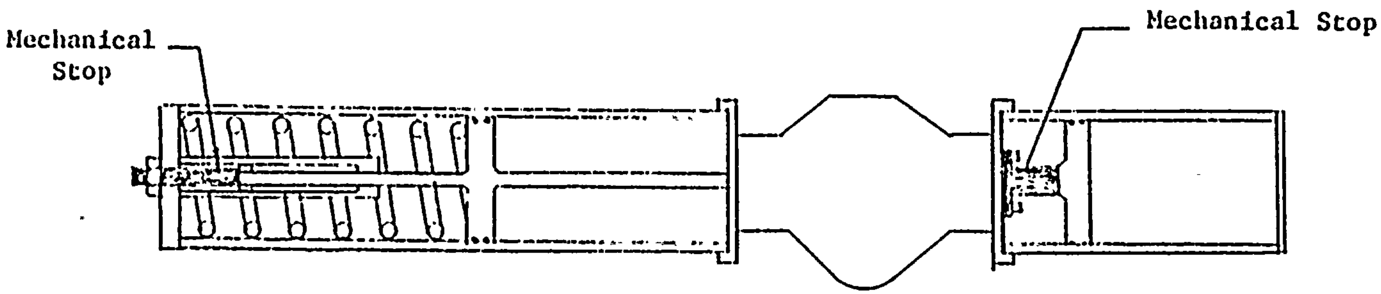


Figure 1

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 the subject order there are four piping systems which are to be investigated. They are:

Case 1	A	14" Valve	AOV106	Cycles Close
	B	14" Valve	AOV104	Cycles Close
Case 2	A	14" Valve	AOV108	Cycles Close
	B	14" Valve	AOV110	Cycles Close
Case 3	A	12" Valve	AOV107	Cycles Close
	B	12" Valve	AOV105	Cycles Close
Case 4	A	12" Valve	AOV109	Cycles Close
	B	12" Valve	AOV111	Cycles Close

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 . 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.

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

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

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)

$$\Delta P \text{ choked} = F_K X_T P_1'$$

Sonic Velocity Equation

$$V_S = \sqrt{\frac{4637\ K_1\ P'}{\rho}}$$ 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 $|\rho(I+1) - \rho| > .0005$ 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.

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

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

$T_{packing\ \&\ seal}$ = 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° from fully closed. The running torque of the packing is approximately .6 times the break away torque.

$T_{bearing}$ = Torque due to the ΔP acting across the valve which forces the stem/disc assembly into the bearings.

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:

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

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

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

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

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

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

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.

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

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

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

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

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

$$V_F = \frac{Q\, T_1}{127300\, P_1 A} \qquad R_{Steam} = 85.76$$

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

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

$$T_{Air} = .04326\, T_{4W}\, \frac{T_1}{P_1} \left(\frac{Q}{203.8\, C_v}\right)^2$$

$$T_{Steam} = .0269\, T_{4W}\, \frac{T_1}{P_1} \left(\frac{Q}{203.8\, C_v}\right)^2$$

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:

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

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

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.

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})

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

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 = Assume equals 530°

Q = 33.62 C_v P1

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.

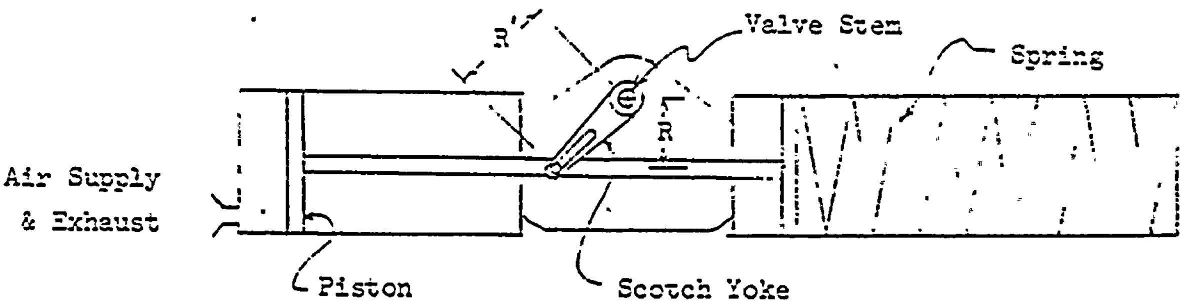


Figure 4

Forces acting on Scotch Yoke Pin

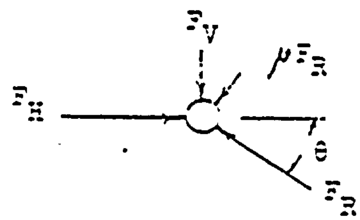


Figure 5

Summing forces in the horizontal direction

$$F_H - \cos\theta\, F_R - \mu \sin\theta\, F_R = 0$$

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

F_R = Resultant Force

F_H = Horizontal Force

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

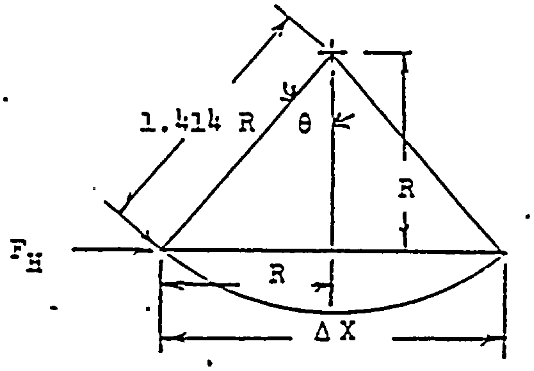
$$\therefore \quad T_R = \frac{T}{\cos\theta\,(\cos\theta + \mu \sin\theta)}$$

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

Spring Torque (T_{spring})

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

Figure 6



$\theta = 45°$

$\Delta X = 2R$

K = Springrate

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

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

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

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

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

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

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 those cases where there is a bend upstream of the valve the torque is inputted directly. The program used for this is "FLOW-CL1".

SEISMIC ANALYSIS

The equations used for the seismic analysis are those given in Reference (c). The only difference between the seismic analyses performed in this report and those performed in Reference (c) is the analyses in this report use the torque resulting from a LOCA for input rather than operational torques.

DETAILED ANALYSIS

Determination of LOCA Torques

Per Reference (d) when a Loss of Coolant Accident (LOCA) occurs the pressure inside containment will increase to 45 psig and 3.1 psig outside containment. The temperature inside of containment during an accident can range from 135 degrees F. to 340 degrees F., for outside containment the range is from 104 degrees F. to 275 degrees F.

To perform the LOCA analysis it is assumed for conservatism that the pressure drop across each piping system investigated is the full 45 psig. However, the actuators outside containment are subjected to the 3.1 psig.

Since the make up of the media is not known, three different conditions are analyzed using the first case to determine which condition results in the largest aerodynamic torques. This condition is then used in the analysis of the other piping systems. The three conditions investigated are as follows:

Condition	Media	Temperature (Degrees F)
1	Air	135
2	Air	340
3	Steam	292 (Saturated)

As can be seen in Appendix B, Condition 2 resulted in the largest torques.

The torques resulting from a LOCA based on Condition 2 are determined using the program "FLOW-GAS". The computer results can be seen in Appendix B on the pages as described below:

Case	Page	Flow Direction
1A	B-5	Preferred
1B	B-17	Nonpreferred
2A	B-24	Preferred
2B	B-29	Nonpreferred
3A	B-34	Nonpreferred
3B	B-38	Nonpreferred
4A	B-42	Preferred

As can be seen in Appendix A just upstream from valves AOV110 and AOV111 (Cases 2B & 4B) are bends. 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 centerline.

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

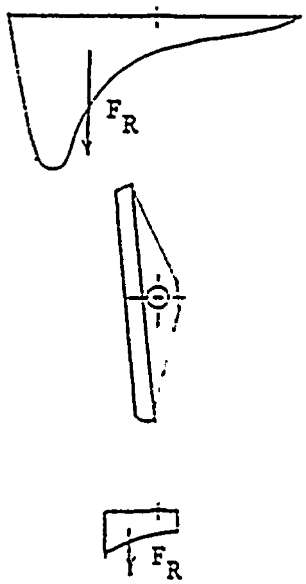
3. Calculate the resulting torque choosing the angle of attack which results in the worst case when added to the aerodynamic torque of the normal flow thru the valve.

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 7



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 THE BENDS

Valve AOV110 (Case 2A)

The valve is orientated in the pipeline as shown below with the flow in the nonpreferred direction.

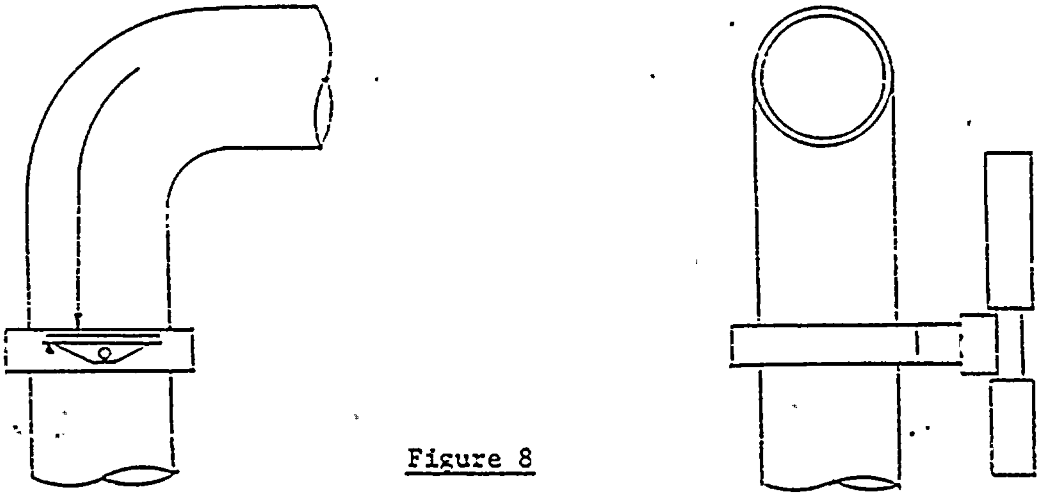


Figure 8

For this case, the resultant of the flow is assumed to be normal to the disc with the valve in the closed position. This is the most conservative assumption concerning the direction of the flow resultant since this assumes that when the valve is fully open that the flow will not assist in closing the valve.

Using this assumption the torques acting on valve AOV110 are calculated.

Degree	Q (Per Appendix B)	V	F
90	4,646,000	633.8	1941
80	4,470,000	642.2	1892
70	3,982,000	647.2	1699
60	3,068,000	619.7	1253
50	2,289,000	526.8	795
40	1,552,000	388.3	397
30	958,000	250.3	158
20	483,000	128.4	41
10	244,000	65.2	10

$$R = \frac{D}{4} \cos\theta \qquad = \frac{12.074}{4} \cos\theta$$

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	0	0	7287	7287
80	.56	-1060	1110	50
70	1.11	-1886	- 780	-1106
60	1.62	-2030	337	-1693
50	2.08	-1654	1132	- 522
40	2.48	-985	1348	363
30	2.81	-444	1414	970
20	3.05	-125	1440	1315
10	3.19	-32	1445	1413

A positive torque indicates that the valve will tend to remain open.

Valve AOV111 (Case 4B)

This valve is also presently mounted in the nonpreferred direction, orientated as shown below.

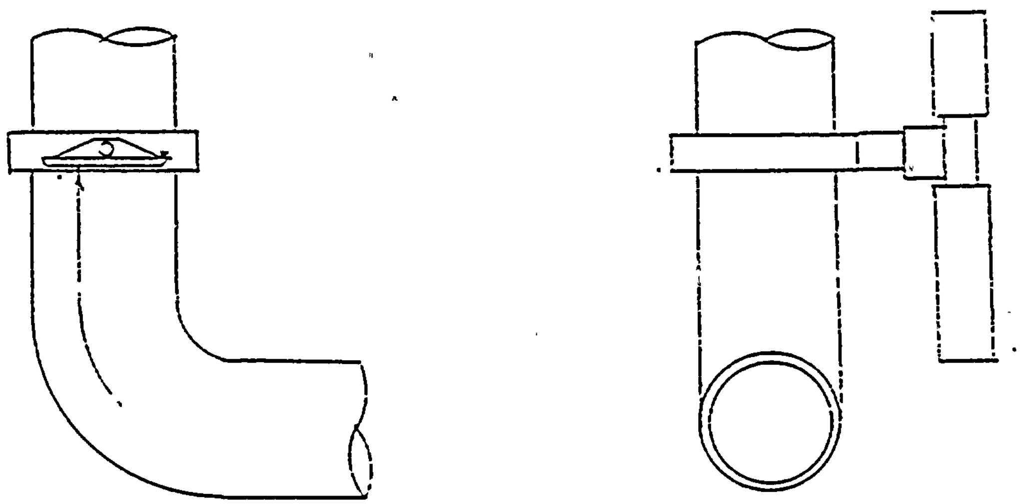


Figure 9

For this case the flow resultant is also assumed to act normal to the disc in the shut position except at 90 degrees where it is assumed to be in line with the tangent to the inside diameter of the elbow. See Figure 10 on Page 29.

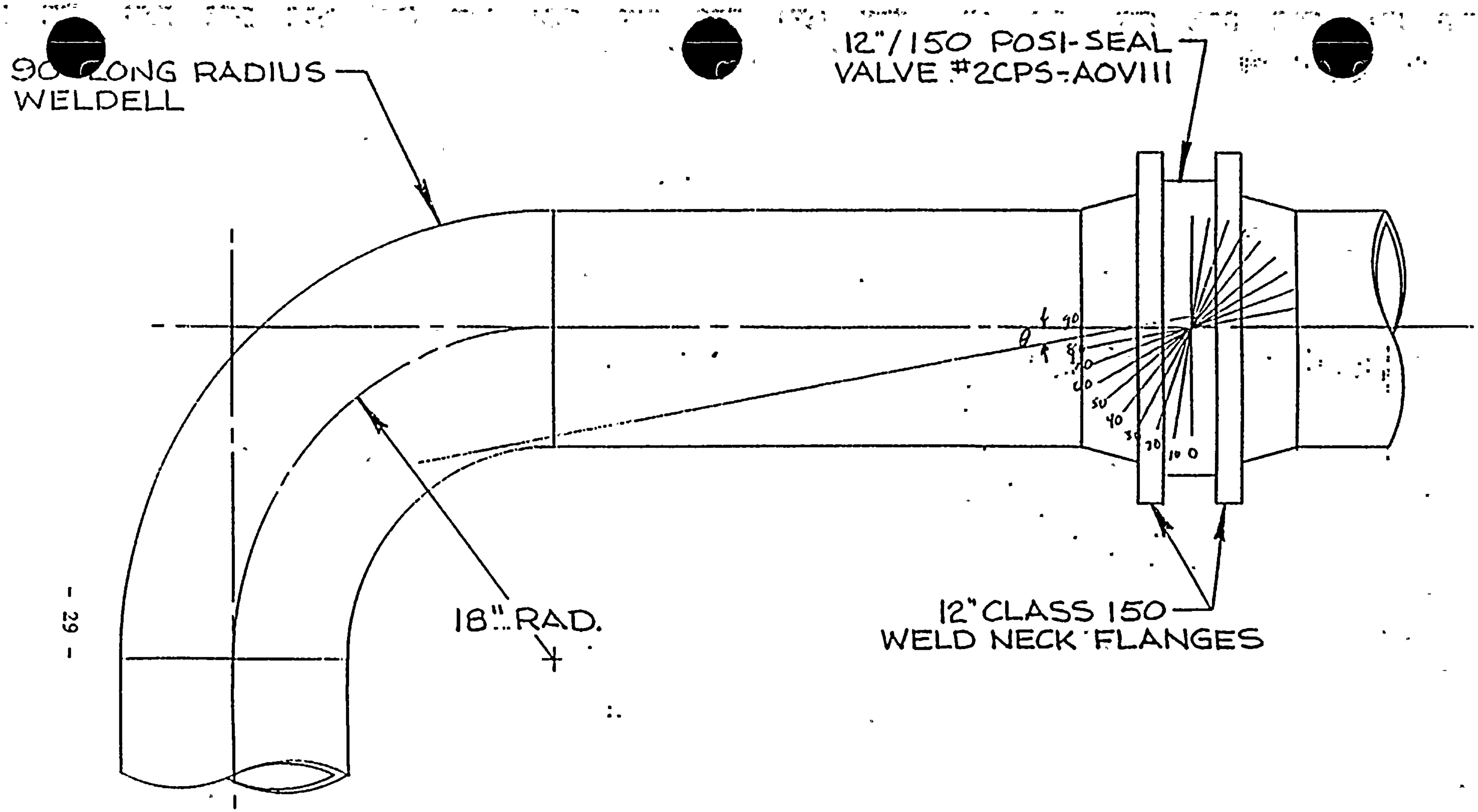


Figure 10

NINE MILE PT. NUCLEAR STA.-UNIT

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE 1/8" = 1'

The calculated torques for valve AOV111 are as follows:

Degree	Q (Per Appendix B)	V	F
90	3,444,000	631.5	1434
80	3,444,000	720.1	1635
70	3,049,000	642.5	1291
60	2,376,000	632.0	990
50	1,785,000	548.3	645
40	1,212,000	409.2	327
30	749,000	265.4	131
20	377,000	136.6	34
10	191,000	69.4	9

$$R = \frac{D}{4} \cos \theta = \frac{11.703}{4} \cos \theta$$

except at 90 degrees $R = \frac{11.703}{4} \sin (10 \text{ degrees})$

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	.51	729	4446	5174
80	.51	834	964	1798
70	1.00	1291	- 180	1111
60	1.46	1445	495	1940
50	1.88	1213	996	2209
40	2.24	732	1141	1873
30	2.53	332	1187	855
20	2.75	93	1206	1113
10	2.88	25	1209	1234

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-4, C-8 and C-16, valves AOV104, 110 and 111 will not close when subject to the torque resulting from a LOCA. Valve AOV105 takes greater than the 5 sec. closing requirement and valve AOV107, although it meets the 5 sec. requirement, takes twice as long to close as it normally does. See Pages C-10, C-12 and F-6.

All of the above valves are installed in the nonpreferred direction. Therefore, it is recommended that they be installed in the preferred direction.

The LOCA torque calculations for these valves are given on Pages B-52 thru B-73. For valves AOV110 and 111 which have bends upstream, the additional torques due to the bends are as follows:

AOV110 (Case 2B)

With this valve installed in the preferred direction it is recommended that the valve be orientated as shown below. With this orientation the direction of the flow resultant is assumed to be in line with the tangent to the inside diameter of the bend and the arc of the midpoint as the valve closes. See Figure 12 on Page 32.

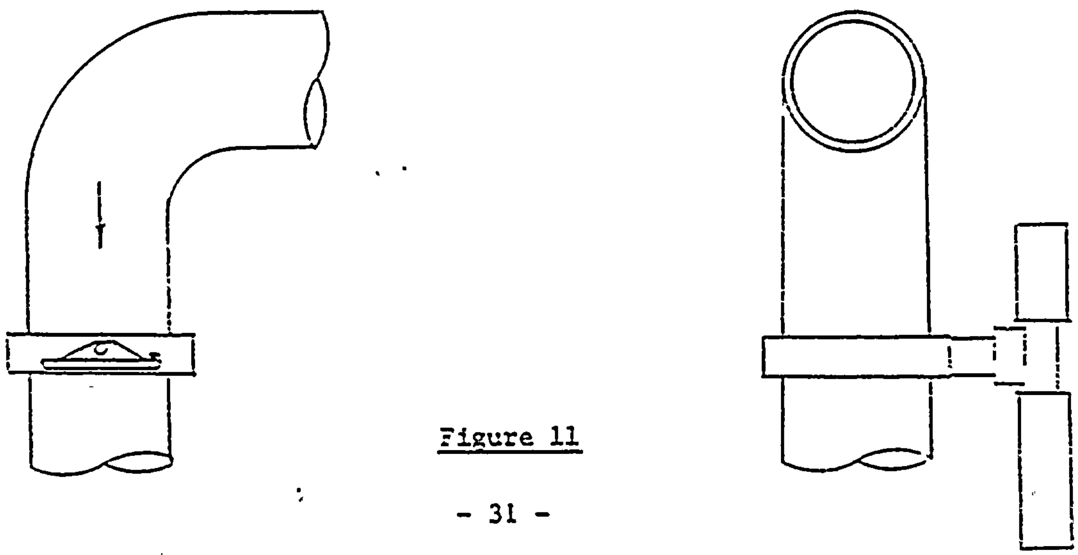


Figure 11

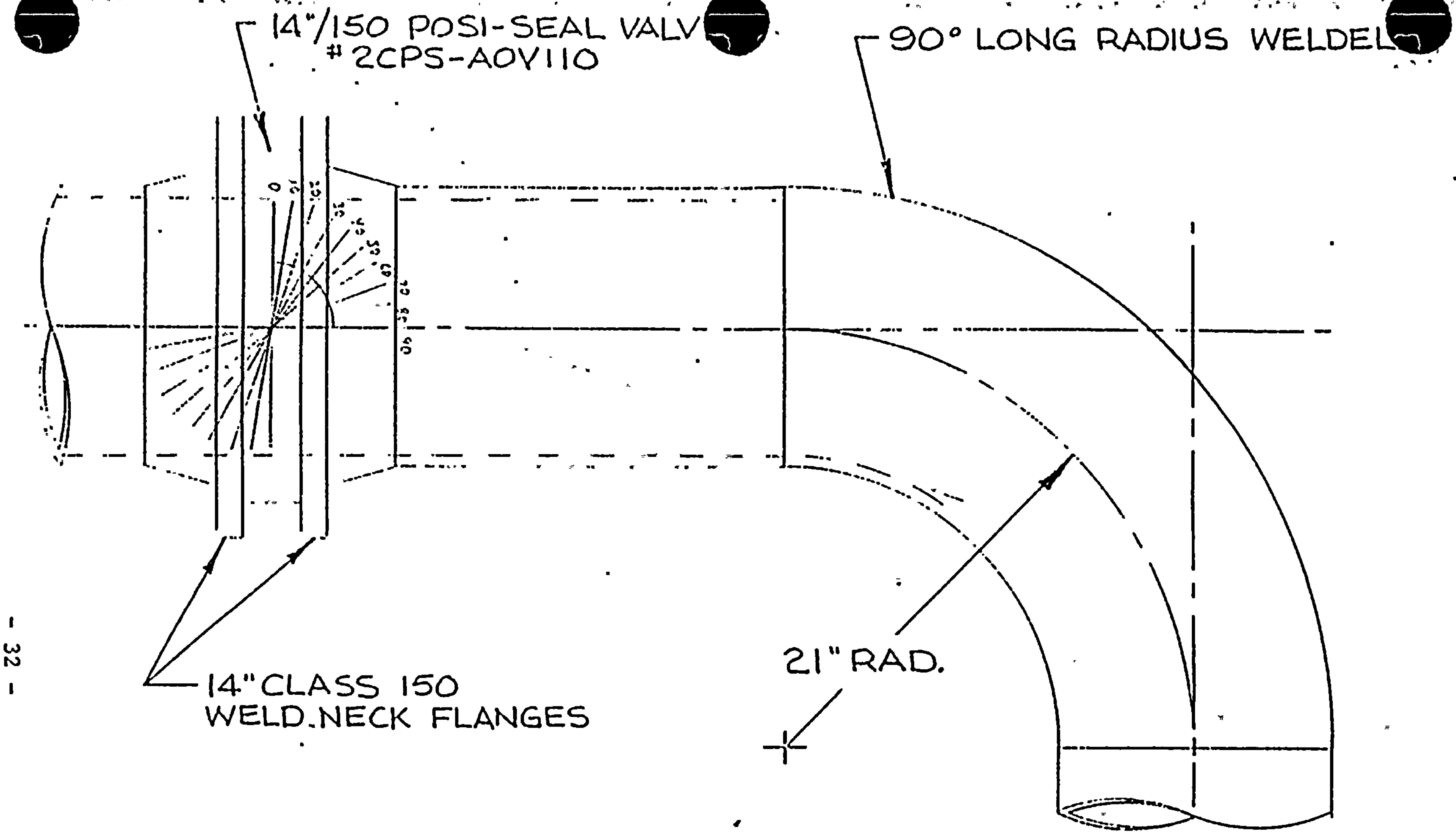


Figure 12

NINE MILE PT. NUCLEAR STA.-UNIT

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE 1/8" = 1'

This resultant direction is chosen since it results in the largest torques when added to the torques with the valve in the preferred direction. This represents the worst case, stress wise, in terms of the torque the valve assembly will be subject to. These torques are

$$R = D/4 \cos (20-\theta)$$

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	1.11	-2153	-5433	-7586
80	1.62	-3068	-6516	-9584
70	2.08	-3542	-3954	-7496
60	2.48	-3113	- 730	-3113
50	2.81	-2233	741	-1492
40	3.05	-1210	1217	7
30	3.19	- 504	1393	888
20	3.24	- 133	1436	1303
10	3.19	- 32	1445	1413

AOV111 (Case 4B)

It is recommended with this valve in the preferred direction it be orientated as shown below

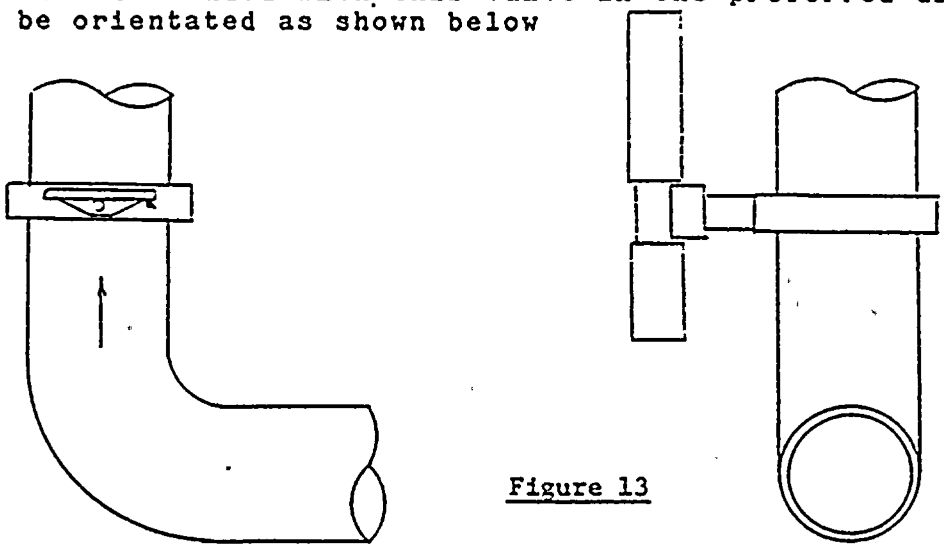


Figure 13

The direction of the flow resultant that results in the largest torque for this valve is the same as it is for valve AOV110. See Figure 14 on Page 35. Therefore, the torques are:

$$R = \frac{D}{4} \cos (20.\theta)$$

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	1.00	-1592	-2813	-4404
80	1.46	-2649	-4127	-6776
70	1.88	-2685	-2044	-4729
60	2.24	-2455	- 156	-2611
50	2.53	-1812	751	-1061
40	2.74	- 997	1058	61
30	2.88	- 418	1174	756
20	2.93	- 110	1203	1093
10	2.88	- 29	1209	1180

The determination of the closing times for valves AOV104, 105, 107, 110 and 111 with flow in the preferred direction is given in Appendix D.

If these valves cannot be installed in the preferred direction, then it is recommended that the amount of valve opening be restricted to 70 degrees. Shown in Appendix E are the closing times for these valves with this restriction.

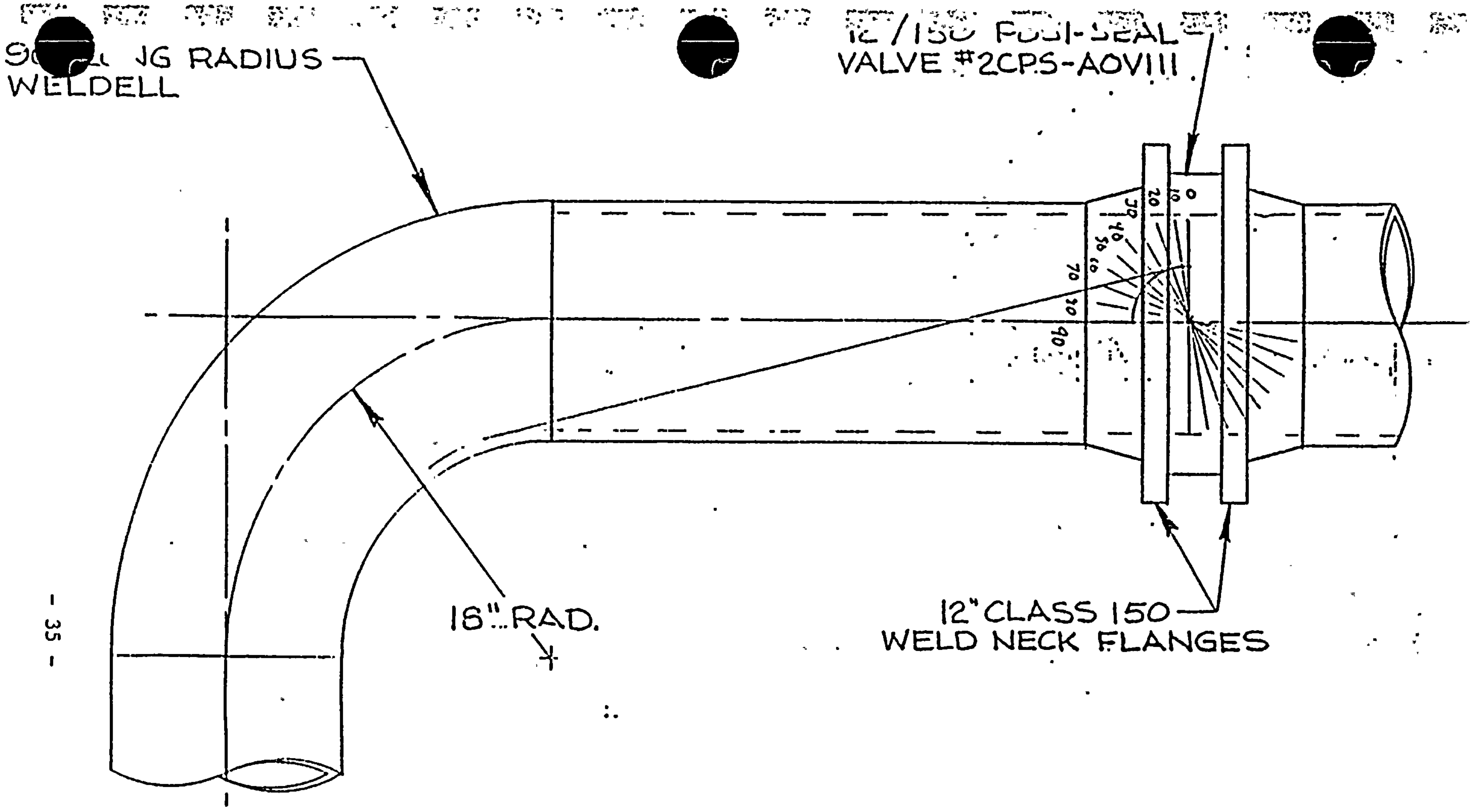


Figure 13

NINE MILE PT. NUCLEAR STA.-UNI

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE 1/8" = 1'

Seismic Analysis

For the seismic analysis of each individual valve, the conditions and orientations which resulted in the largest torques were used. They are as follows:

Case	Valve	Valve Opening	Flow Direction
1A	AOV106	80	Preferred
1B	AOV104	90	Nonpreferred
2A	AOV108	80	Preferred
2B	AOV110	80	Preferred
3A	AOV107	90	Nonpreferred
3B	AOV105	90	Nonpreferred
4A	AOV109	80	Preferred
4B	AOV111	80	Preferred

The seismic analyses are given in Appendix G. As can be seen on Page G-24 the disc pin stress for valve AOV111 exceeds the allowable; therefore, it is recommended the amount of valve opening for this valve be restricted to 70 degrees. The seismic analysis for this condition is given on Pages G-25 and G-26.

<u>APPENDIX A</u>

<u>SCHEMATIC OF THE PIPING SYSTEM</u>

<u>NOTE:</u> The orientation of the valves is based on the normal flow directions given on Posi-Seal assembly drawings, Enclosure (1).

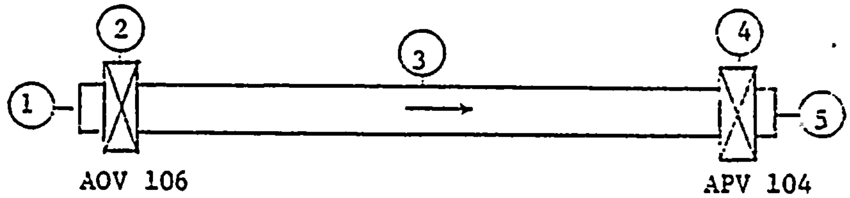
CASE 1

14" - 150 Class Valves 2CPS*AOV 104 & 106

Worse Condition

Piping outboard of valve 2CPS*AOV104 breaks off.

The resulting system is as shown below.



Per References (e) & (f)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{in} = 14"
2	Valve (7) Flow in the Preferred Direction	C_V = 6317
3	Straight Pipe (4)	L = 11'
4	Valve (7) Flow in the Nonpreferred Direction	C_V = 6317
5	Exit (8)	K = 1.0 D_{out} = 14"

Case 1A - Valve AOV106 Cycles
1B - Valve AOV104 Cycles

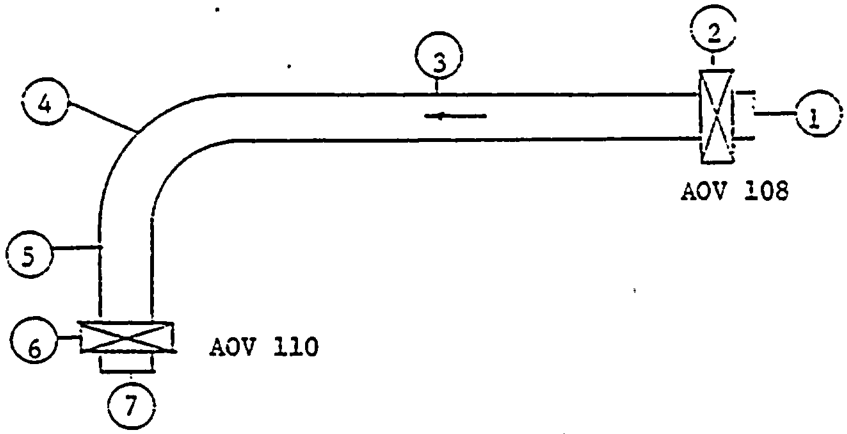
CASE 2

14" - 150 Class Valves 2CPS*AOV 108 & 110

Worse Condition

Piping outboard of valve 2CPS*AOV110 breaks off.

The resulting system is as shown below.



Per References (e) & (g)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{in} = 14"
2	Valve (7) Flow in the Preferred Direction	C_V = 6317
3	Straight Pipe (4)	L = 9'
4	Bend 90 Degrees (5)	K = 12 f_t = .16
5	Straight Pipe (4)	L = 3'
6	Valve (7) Flow in the Nonpreferred Direction	C_V = 6317
7	Exit (8)	K = 1 D_{out} = 14"

Case 2A - Valve AOV108 Cycles
2B - Valve AOV110 Cycles

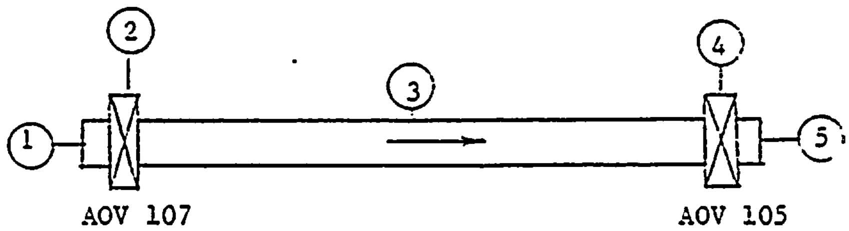
CASE 3

12" - 150 Class Valves 2CPS*AOV 105 & 107

Worse Condition

Piping outboard of valve 2CPS*AOV105 breaks off.

The resulting system is as shown below.



Per References (e) & (h).

Station No.	Type of Resistance (No.)	
1	Entrance (1)	$K = .5 \quad D_{in} = 12"$
2	Valve (7) Flow in the Nonpreferred Direction	$C_V = 4942$
3	Straight Pipe (4)	$L = 11'$
4	Valve (7) Flow in the Nonpreferred Direction	$C_V = 4942$
5	Exit (8)	$K = 1 \quad D_{out} = 12"$

Case 3A - Valve AOV107 Cycles
3B - Valve AOV105 Cycles

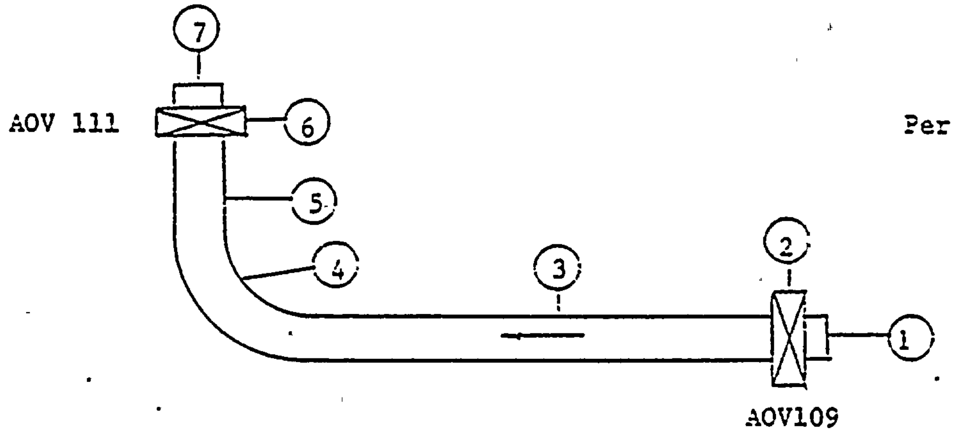
CASE 4

12". - 150 Class Valves 2CPS*AOV 109 & 111

Worse Condition

Piping outboard of valve 2CPS*AOV111 breaks off.

The resulting system is as shown below.



Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{in} = 12"
2	Valve (7) Flow in the Preferred Direction	C_V = 4942
3	Straight Pipe (4)	L = 9'
4	Bend 90 Degrees (5)	K = 12 f_t = .16
5	Straight Pipe (4)	L = 4'
6	Valve (7) Flow in the Nonpreferred Direction	C_V = 4942
7	Exit (8)	K = 1 D_{out} = 12"

Case 4A - Valve AOV109 Cycles
4B - Valve AOV111 Cycles

APPENDIX B

Determination of Flow Conditions

CASE 1A

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR30-M3HW

UPSTREAM PRESSURE	59.7 PSIA	INITIAL DENSITY	.271 LBS/FT^3
INITIAL TEMPERATURE	135 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	59.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1.0
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR @ 90 DEG	1182 IN.LBS/PSI

STEM DIA.	1.375 IN.	GAGE DIA.	12.974 IN
PACKING TORQUE	832 IN.LBS.	SEAL TORQUE	1454 IN.LBS
DIRECTION	Preferred		

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

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

UPSTREAM PRESSURE	INITIAL DENSITY [illegible]	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	27.1	135	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	1182

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
[illegible]	12.7?4	832	[illegible]

STATION NO.	TYPE OF RESISTANCE	DIAMETER (D)	LENGHT (L)	RESISTANCE (K)	CORRECTED RESISTANCE (K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.360	0.36066
3	STRAIGHT PIPE	14.0	[illegible]	[illegible]	[illegible]
4	VALVE	14.0	0.0	0.360	0.36066
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 5,447,632 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	398.9
2	53.5	0.2506	130.8	430.7
3	[illegible]	[illegible]	[illegible]	[illegible]
4	46.0	0.2252	125.3	479.5
5	39.1	0.2003	119.6	539.6
[illegible]	14.7	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

1779

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~90~~	~~[illegible]~~	~~5.45~~	~~[illegible]~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2710~~	~~135.0~~	~~[illegible]~~
2	53.5	0.2506	130.9	430.7
3	48.0	0.2320	126.8	465.1
~~4~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~
5	39.1	0.2003	119.6	539.6
6	14.7	0.0995	90.4	1085.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	5,447,632	9.68	- 6,115

^	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	399.9
~~2~~	~~53.5~~	~~0.2506~~	~~130.9~~	~~430.7~~
3	43.8	0.2173	123.6	496.6
4	41.6	0.2095	121.7	514.4
~~5~~	~~32.8~~	~~0.1767~~	~~113.7~~	~~[illegible]~~
6	14.7	0.0995	90.4	1085.6

~~NOTE: THERE IS CHOKED FLOW AT STATION 5~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~	~~Tclosing~~
70	4,828,829	14.98	- 3,415

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.2710	135.0	353.6
2	55.1	0.2561	131.9	373.6
~~3~~	~~[illegible]~~	~~[illegible]~~	~~120.5~~	~~[illegible]~~
4	39.5	0.1983	119.1	481.5
5	31.6	0.1722	112.6	554.4
~~6~~	~~14.7~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~	~~Tclosing~~
60	3,708,674	29.57	- 613

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.2710	135.0	271.6
2.	57.2	0.2631	133.4	279.3
~~3~~	~~27.7~~	~~[illegible]~~	~~108.4~~	~~[illegible]~~
4	26.6	0.1523	107.2	483.0
5	22.6	0.1357	102.3	542.1
~~6~~	~~14.7~~	~~0.0995~~	~~90.4~~	~~[illegible]~~

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~50~~	~~2,711,930~~	~~37.75~~	~~752~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2710~~	~~135.0~~	~~[illegible]~~
2	58.5	0.2671	134.2	201.2
3	20.7	0.1274	99.8	422.3
~~4~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~

[illegible]	15.3	[illegible]	[illegible]	[illegible]
[illegible]	14.7	0.0995	90.4	340.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,812,259	42.07	1,215

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	132.7
2	59.2	0.2596	134.7	133.2
3	17.2	0.1114	94.6	322.3
4	16.9	0.1104	94.2	325.6
5	16.1	0.1087	92.9	336.?
6	14.7	0.0995	90.4	361.2

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,109,994	43.97	1,391

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	81.2
2	59.6	0.2706	134.9	81.2
3	15.6	0.1040	92.0	211.7
4	15.5	0.1037	91.9	212.4
5	15.2	0.1021	91.3	215.6
6	14.7	0.0995	90.4	221.2

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	561,987	44.88	1,435

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	41.1
2	59.6	0.2709	134.9	41.1
3	15.0	0.1010	90.9	110.3
4	14.7	0.1007	90.9	110.4
5	14.8	0.1002	90.6	111.2
6	14.7	0.0995	90.4	112.0

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	284,134	44.91	1,444

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	20.8
2	59.6	0.2709	134.9	20.8
3	14.7	0.0999	90.5	56.4
4	14.7	0.0999	90.5	56.4
5	14.7	0.0997	90.5	56.5
6	14.7	0.0995	90.4	56.6

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

CASE 1A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Preferred

GAGE DIA. 12.474 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 90 DEG
AIR	1.4	1	1	1182

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.350	0.35053
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 4,727,178 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	57.7	0.2010	340.0	455.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	46.1	0.1572	313.9	556.4
5	39.2	0.1489	301.5	628.1
6	14.7	0.0738	227.8	1256.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	425.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	46.1	[illegible]	315.9	555.4
5	39.2	0.1489	301.5	628.1
6	14.7	0.0738	227.8	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	4,727,176	9.74	- 6,170

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	465.4
2	53.5	0.1860	[illegible]	[illegible]
3	43.8	0.1611	311.2	579.0
4	41.7	0.1557	306.9	597.5
5	33.1	0.1321	297.3	708.0
6	14.7	0.0738	227.8	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	4,185,884	15.15	- 3,450

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	412.1
2	55.2	0.1900	332.4	434.9
3	40.0	0.1511	303.3	546.9
4	38.4	0.1467	299.8	561.8
5	31.6	0.1277	283.6	645.4
6	14.7	0.0742	228.3	[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	3,202,679	29.86	- 622

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	315.3
2	57.3	0.1951	336.0	324.2
3	27.4	[illegible]	[illegible]	549.5
4	26.4	0.1123	269.4	563.9
5	22.6	0.1006	257.8	629.7
6	14.7	0.0738	227.8	858.1

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,339,992	37.94	752

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	230.4
2	58.5	0.1982	338.1	233.3
3	20.5	0.0939	250.8	492.8
4	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.8	627.0

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1.565.243	42.12	1,217

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	154.1
2	59.3	0.2001	339.3	154.5
3	17.2	0.0826	238.2	374.3
4	16.9	0.0819	237.4	373.1
5	15.1	0.0791	234.2	391.3
6	14.7	0.0738	227.8	419.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	957,243	44.00	1,392

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	94.2
2	59.6	0.2007	339.8	94.2
3	15.8	0.0770	231.7	245.3
4	15.5	0.0768	231.4	246.6
5	15.2	0.0757	230.1	250.0
6	14.7	0.0738	227.8	258.5

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	483,747	44.57	1,435

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.6
2	59.6	0.2009	339.9	47.6
3	14.9	0.0749	229.1	127.7
4	14.7	0.0748	229.0	127.9
5	14.8	0.0743	228.4	128.7
6	14.7	0.0738	227.8	129.6

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	244,569	44.91	1,444

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.0
2	59.6	0.2009	339.9	24.0
3	14.7	0.0741	228.1	65.2
4	14.7	0.0741	228.1	65.3
5	14.7	0.0739	227.9	65.4
6	14.7	0.0738	227.8	65.5

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

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CASE 1A

CONDITION 3

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 292 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.312

COMPRESSIBILITY 1

INITIAL DENSITY .138 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Sat. Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING.TORQUE 832 IN.LBS.

DIRECTION Preferred

GAGE DIA. 12.974 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10+2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	12.8	292	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
SAT. STEAM	1.312	.62	1	1182

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.36066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.860	0.36066
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 5,375,146 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.5
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	633.9
4	46.3	0.1141	275.1	555.5
5	40.3	0.1024	266.0	735.2
6	14.7	0.0474	209.2	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
~~90~~	~~5,895,146~~	~~[illegible]~~	-	~~4,335~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.1380~~	~~292.0~~	~~545.3~~
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	638.9
~~4~~	~~46.5~~	~~[illegible]~~	~~[illegible]~~	~~655.3~~
5	40.3	0.1024	266.0	735.2
6	14.7	0.0474	209.2	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
80	5,895,146	8.77	-	5,789

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.6
~~2~~	~~53.3~~	~~0.1266~~	~~284.2~~	~~592.9~~
3	44.5	0.1104	272.3	679.9
4	42.5	0.1065	269.3	702.2
~~5~~	~~35.2~~	~~0.0922~~	~~257.3~~	~~[illegible]~~
6	14.7	0.0474	209.2	1597.9

~~NOTE: THERE IS CHOKED FLOW AT STATION 5~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~		~~Tclosing~~
70	5,279,451	14.10	-	3,317

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.1380	292.0	488.6
2	54.9	0.1296	286.3	518.7
~~3~~	~~40.3~~	~~0.1034~~	~~[illegible]~~	~~650.2~~
4	39.3	0.1004	264.4	666.3
5	33.3	0.0884	254.1	757.0
~~6~~	~~14.7~~	~~0.0429~~	~~211.3~~	~~[illegible]~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~		~~Tclosing~~
60	4,057,308	29.47	-	630

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.1380	292.0	375.5
2	57.2	0.1336	289.1	386.7
~~3~~	~~27.7~~	~~0.0770~~	~~243.4~~	~~[illegible]~~
4	26.7	0.0747	241.1	693.2
5	23.3	0.0674	233.5	768.8
~~6~~	~~14.7~~	~~0.0474~~	~~209.2~~	~~1092.?~~

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~50~~	~~2,966,301~~	~~37.94~~	~~739~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.1380~~	~~292.0~~	~~274.3~~
2	58.6	0.1361	290.7	277.5
3	20.6	0.0615	226.9	615.7
~~4~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~

5	15.[illegible]	[illegible]	[illegible]	[illegible]
6	14.[illegible]	[illegible]	209.2	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,994,824	42.23	1,210

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	184.6
2	59.4	0.1375	291.[illegible]	184.3
3	17.2	0.0534	217.2	476.5
4	17.0	0.0530	216.6	480.5
5	15.2	0.0512	214.3	497.0
6	14.7	0.0474	209.2	537.3

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,217,400	43.98	1,390

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	112.6
2	59.6	0.1378	291.8	112.6
3	15.6	0.0496	212.2	313.1
4	15.5	0.0494	212.0	314.2
5	15.2	0.0487	211.1	318.6
6	14.7	0.0474	209.2	327.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	615,184	44.67	1,435

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	56.9
2	59.6	0.1379	291.9	56.9
3	14.9	0.0481	210.2	163.1
4	14.9	0.0481	210.1	163.3
5	14.8	0.0477	209.7	164.5
6	14.7	0.0474	209.2	165.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	311,010	44.91	1,444

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	28.7
2	59.6	0.1379	291.9	28.7
3	14.7	0.0476	209.5	83.4
4	14.7	0.0475	209.4	83.4
5	14.7	0.0475	209.3	83.5
6	14.7	0.0474	209.2	83.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

CASE 1B

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 135 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .271 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1.0

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Nonpreferred

GAGE DIA. 12.974 IN

SEAL TORQUE 14554 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	27.1	135	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	1182

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.230	0.23033
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 5,447,532 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	398.9
2	53.5	0.2506	130.8	430.7
3	48.0	0.2320	126.8	465.1
4	46.0	0.2252	125.3	473.3
5	39.1	0.2003	119.6	539.6
6	14.7	0.0995	90.4	1085.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

1002

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~90~~	~~5,4[illegible]7,532~~	~~3.95~~	~~[illegible],294~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2710~~	~~135.0~~	~~39[illegible].9~~
2	53.5	0.2506	130.3	430.7
3	48.0	0.2320	126.8	465.1
~~4~~	~~46.0~~	~~0.2252~~	~~125.3~~	~~479.5~~
5	39.1	0.2003	119.6	539.6
6	14.7	0.0995	90.4	1085.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	5,226,233	11.22	1,108

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	382.7
~~2~~	~~54.1~~	~~0.2526~~	~~131.2~~	~~409.9~~
3	49.2	0.2363	127.8	438.3
4	47.5	0.2304	126.5	448.7
~~5~~	~~36.3~~	~~0.1901~~	~~117.1~~	~~545.5~~
6	14.7	0.0995	90.4	1041.5

~~NOTE: THERE IS CHOKED FLOW AT STATION 5~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~	~~Tclosing~~
70	4,652,050	20.89	- 788

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.2710	135.0	340.7
2	55.5	0.2575	132.2	357.3
~~3~~	~~52.0~~	~~0.2458~~	~~129.3~~	~~374.3~~
4	50.9	0.2419	129.0	380.2
5	30.0	0.1659	110.9	556.3
~~6~~	~~14.7~~	~~0.0995~~	~~90.4~~	~~927.1~~

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~60~~	~~3,337,092~~	~~33.10~~	~~333~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2710~~	~~135.0~~	~~261.2~~
2	57.4	0.2637	133.5	268.1
3	55.5	0.2574	132.2	274.6
~~4~~	~~55.0~~	~~0.2555~~	~~131.9~~	~~276.3~~
5	21.8	0.1323	101.3	534.7
6	14.7	0.0995	90.4	710.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,661,389	39.16	1,130

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	194.9
~~2~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
3	[illegible]	[illegible]	[illegible]	[illegible]
4	57.3	0.2634	133.4	199.9
5	19.2	[illegible]	[illegible]	455.2
6	14.7	0.0995	90.4	530.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,802,844	42.57	1,347

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	132.0
2	59.2	0.2696	134.7	132.5
3	58.8	0.2681	134.4	133.2
4	58.7	0.2679	134.3	133.2
5	16.1	0.1066	92.9	335.4
6	14.7	0.0995	90.4	359.2

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,113,245	44.15	1,414

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	81.5
2	59.6	0.2706	134.9	81.5
3	59.4	0.2701	134.8	81.6
4	59.4	0.2700	134.8	81.5
5	15.2	0.1021	91.3	216.2
6	14.7	0.0995	90.4	221.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	560,464	44.79	1,440

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	41.0
2	59.6	0.2707	134.9	41.0
3	59.6	0.2707	134.9	41.0
4	59.6	0.2707	134.9	41.0
5	14.8	0.1002	90.5	110.9
6	14.7	0.0995	90.4	111.6

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	283,334	44.94	1,445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	20.7
2	59.6	0.2709	134.9	20.7
3	59.6	0.2709	134.9	20.7
4	59.6	0.2709	134.9	20.7
5	14.7	0.0997	90.5	56.3
6	14.7	0.0995	90.4	56.4

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 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1.0

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Non preferred

GAGE DIA. 12.974 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 290 DEG
AIR	1.4	1	1	1192

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.360	0.36066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.360	[illegible]
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 4,727,178 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	453.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	[illegible]	[illegible]	315.7	[illegible]
5	39.2	0.1489	301.5	628.1
6	14.7	0.0733	227.8	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

1917

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	[illegible]	5.92	7,337

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	485.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	45.1	0.1592	315.7	[illegible]
5	39.2	0.1489	301.5	623.1
6	14.7	0.0738	227.8	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	4,530,955	11.10	1,107

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.1
2	54.1	0.1875	330.7	477.?
3	49.3	0.1754	321.9	510.1
4	47.6	0.1710	318.7	522.0
5	36.5	0.1415	295.4	533.5
6	14.7	0.0738	227.8	1214.1

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	4,030,437	20.69	795

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	396.8
2	55.6	0.1910	333.1	416.5
3	52.0	0.1822	325.7	436.7
4	50.9	0.1793	324.8	442.8
5	30.2	0.1235	279.8	645.5
6	14.7	0.0738	227.8	1079.7

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	3,086,312	33.14	331

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	303.7
2	57.5	0.1956	336.3	311.6
3	55.5	0.1910	333.1	319.3
4	55.0	0.1897	332.2	320.?
5	21.9	0.0982	255.3	621.7
6	14.7	0.0733	227.8	827.0

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,302,002	39.28	1,131

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	226.6
2	[illegible]	[illegible]	[illegible]	[illegible]

4	[illegible]	[illegible]	375.3	331.8
5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.8	515.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,551,983	42.64	1,349

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	152.9
2	59.3	0.2001	339.4	153.2
3	59.0	0.1990	338.5	154.0
4	58.8	0.1988	338.5	154.0
5	16.1	0.0790	234.1	388.4
6	14.7	0.0738	227.8	415.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	960,302	44.13	1,424

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	94.5
2	59.6	0.2007	339.8	94.5
3	59.4	0.2003	339.5	94.7
4	59.4	0.2002	339.5	94.7
5	15.2	0.0757	230.1	250.7
6	14.7	0.0738	227.8	257.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	483,477	44.79	1,440

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.6
2	59.5	0.2007	339.9	47.5
3	59.6	0.2008	339.8	47.6
4	59.6	0.2008	339.8	47.6
5	14.8	0.0743	228.4	128.7
6	14.7	0.0738	227.8	129.5

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	244,414	44.94	1,445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.0
2	59.6	0.2009	339.9	24.0
3	59.6	0.2009	339.9	24.0
4	59.6	0.2009	339.9	24.0
5	14.7	0.0739	227.9	65.3
6	14.7	0.0738	227.8	65.4

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 3

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 292 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.312

COMPRESSIBILITY 1

INITIAL DENSITY .138 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Sat Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Nonpreferred

GAGE DIA. 12.974 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW GAS

UPSTREAM PRESSURE	INITIAL DENSITY (X10+2)	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	13.8	292	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
SAT. STEAM	1.312	.62	1	1182

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER (D)	LENGHT (L)	RESISTANCE (K)	CORRECTED RESISTANCE (K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.1142
4	VALVE	14.0	0.0	0.860	0.86066
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 5,895,146 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.6
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	638.9
4	46.5	0.1141	275.1	655.6
5	40.3	0.1024	266.0	735.2
6	14.7	0.0474	209.2	1587.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

1521

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
90	5,895,146	3.24	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.6
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	638.9
4	46.5	0.1141	275.1	655.6
5	40.3	0.1024	266.0	735.2
6	14.7	0.0474	209.2	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	5,895,146	13.62	1,159

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.6
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	638.9
4	46.5	0.1141	275.1	655.6
5	32.3	0.0876	253.2	857.4
6	14.7	0.0474	209.2	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	5,118,788	18.69	- 743

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	473.8
2	55.4	0.1305	286.9	499.1
3	52.1	0.1245	282.7	523.1
4	51.1	0.1225	281.4	529.5
5	32.4	0.0866	252.5	754.6
6	14.7	0.0474	209.2	1378.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	3,921,598	32.66	320

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	362.9
2	57.5	0.1341	289.4	372.4
3	55.7	0.1309	287.2	381.5
4	55.2	0.1309	286.6	383.0
5	22.5	0.0657	231.7	761.3
6	14.7	0.0474	209.2	1056.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,910,489	39.14	1,125

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	269.4
2	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	57.5	0.1342	239.4	275.7
5	[illegible]	[illegible]	[illegible]	330.5
6	14.7	0.0474	209.2	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,974,411	42.70	1,347

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	182.7
2	59.4	0.1375	291.7	182.7
3	59.0	0.1368	291.2	183.7
4	58.9	0.1366	291.1	183.7
5	16.2	0.0511	214.2	492.6
6	14.7	0.0474	209.2	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,217,279	44.15	1,413

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	112.7
2	59.6	0.1378	291.8	112.7
3	59.4	0.1375	291.7	112.9
4	59.4	0.1375	[illegible]	112.7
5	15.2	0.0487	211.1	313.3
6	14.7	0.0474	209.2	328.0

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	613,001	44.78	1,440

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	56.7
2	[illegible]	0.1379	291.9	56.7
3	59.6	0.1378	291.9	56.7
4	59.6	0.1378	291.9	56.7
5	14.8	0.0477	209.7	163.9
6	14.7	0.0474	209.2	165.1

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	309,891	44.94	1,445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	28.6
2	59.6	0.1379	291.9	28.6
3	59.6	0.1379	291.9	28.6
4	59.6	0.1379	291.9	28.6
5	14.7	0.0475	209.3	83.3
6	14.7	0.0474	209.2	83.4

NOTE: THERE IS CHOKED FLOW AT STATION 4

1223 NOTE: A POSITIVE CLOSING TORQUE INDICATES THAT THE VALVE WILL TEND TO REMAIN OPEN

CASE 2 A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis 1172IC - SR80 - M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Preferred

GAGE DIA. 12.574 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR
				[illegible]
AIR	1.4	1	1	1182

STEM DIA.	BASE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	9.0	0.115	0.11571
4	PIPE BEND	14.0	0.0	0.150	0.15000
5	STRAIGHT PIPE	14.0	3.0	0.038	0.03857
6	VALVE	14.0	0.0	0.360	0.36066
7	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 4,645,997 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1883	330.0	491.7
3	48.5	0.1734	320.5	528.9
4	47.2	0.1699	317.9	538.2
5	45.1	0.1643	315.3	554.3
6	44.7	0.1636	313.1	556.2
7	37.8	0.1450	298.4	633.8
8	14.7	0.0733	227.3	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1966	330.0	491.7
3	48.5	0.1734	320.5	528.9
4	47.2	[illegible]	317.9	539.2
5	45.1	0.1645	313.8	554.5
6	44.7	0.1636	313.1	556.2
7	37.3	0.1450	298.4	333.3
8	14.7	0.0738	227.8	1244.9

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
80	4,645,997	9.13	-	5,848

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1866	330.0	491.7
3	44.3	0.1633	312.7	561.3
4	43.1	0.1593	309.8	573.9
5	40.8	0.1534	305.1	594.4
6	40.3	0.1524	304.4	598.4
7	31.8	0.1281	284.0	717.3
8	14.7	0.0738	227.9	1244.9

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
70	4,142,038	14.35	-	3,307

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	407.8
2	55.2	0.1901	332.5	430.3
3	40.9	0.1534	305.1	533.4
4	39.6	0.1501	302.5	544.1
5	37.8	0.1452	298.6	560.9
6	37.5	0.1444	297.8	562.3
7	30.7	0.1251	281.1	655.0
8	14.7	0.0738	227.8	1109.3

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
50	3,204,783	23.71	-	537

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	315.6
2	57.2	0.1951	336.0	324.4
3	29.5	0.1187	290.3	534.0
4	27.3	[illegible]	273.4	543.7
5	26.7	0.1132	270.2	560.0
6	26.5	0.1128	269.8	562.2
7	[illegible]	0.1006	257.3	[illegible]
8	14.7	0.0738	227.8	858.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	OP ACROSS VALVE	Tclosing
50	2,339,509	37.40	756

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	230.2
2	58.5	0.1982	333.1	233.1
3	21.1	0.0957	252.7	483.3
4	20.7	0.0944	251.3	490.0
5	20.1	0.0925	249.3	499.9
6	20.0	0.0922	249.0	501.5
7	18.3	0.0865	242.7	534.6
8	14.7	0.0738	227.8	626.6

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	OP ACROSS VALVE	Tclosing
40	1,568,965	41.92	1,215

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	154.4
2	59.3	0.2001	339.3	154.9
3	17.4	0.0833	239.0	372.6
4	17.2	0.0828	238.4	374.9
5	17.0	0.0820	237.5	378.5
6	16.9	0.0818	237.3	379.4
7	16.2	0.0791	234.2	392.1
8	14.7	0.0739	227.8	420.3

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	OP ACROSS VALVE	Tclosing
30	959,472	43.83	1,390

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	94.3
2	59.6	0.2007	339.8	94.3
3	15.7	0.0774	232.1	244.8
4	15.5	0.0772	231.9	245.5
5	15.5	0.0769	231.6	246.4
6	15.5	0.0769	231.5	246.6
7	15.2	0.0757	230.1	250.3
8	14.7	0.0738	227.8	256.8

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	OP ACROSS VALVE	Tclosing
20	485,258	44.65	1,435

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.7
2	59.6	0.2009	339.9	47.7
3	15.0	0.0750	229.2	128.0
4	15.0	0.0749	229.1	128.1
5	14.9	0.0748	229.0	128.2
6	14.9	0.0748	229.0	128.2
7	14.8	0.0743	228.4	129.1
8	14.7	0.0738	227.8	130.0

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	[illegible]	[illegible]
10	245.337	44.91	1.444

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.1
2	59.5	[illegible]	339.[illegible]	24.1
3	14.7	0.0741	228.1	65.4
4	14.7	0.0741	228.1	65.4
5	14.7	0.0741	[illegible]	65.5
6	14.7	0.0741	229.1	65.5
7	14.7	0.0739	227.9	65.6
8	14.7	0.0738	227.8	65.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

CASE 2B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING TORQUE 832 IN.LBS.

DIRECTION Non preferred

GAGE DIA. 12.974 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=14 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 290 DEG
AIR	1.4	1	1	1182

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	9.0	0.115	0.11571
4	PIPE BEND	14.0	0.0	0.140	0.14000
5	STRAIGHT PIPE	14.0	3.0	0.038	0.03857
6	VALVE	14.0	0.0	0.860	0.86066
7	EXIT	14.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 4,645,997 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1833	330.0	491.7
3	48.5	0.1734	320.5	529.9
4	47.2	0.1699	317.9	538.2
5	45.1	0.1645	313.8	554.5
6	44.7	0.1636	313.1	556.2
7	37.8	0.1450	298.4	633.8
8	14.7	0.0733	227.3	1244.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES·

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~90~~	~~4,345,997~~	~~3.95~~	~~7,287~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2010~~	~~340.0~~	~~457.5~~
2	53.7	0.1966	330.0	491.7
3	48.5	0.1734	320.5	528.9
~~4~~	~~47.2~~	~~0.1699~~	~~317.7~~	~~538.2~~
5	45.1	0.1645	313.8	554.5
6	44.7	0.1636	313.1	556.2
~~7~~	~~37.8~~	~~0.1450~~	~~295.4~~	~~633.3~~
8	14.7	0.0738	227.8	1244.9

~~NOTE: THERE IS CHOKED FLOW AT STATION 7~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~	~~Tclosing~~
80	4,469,862	11.29	1,110

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.2010	340.0	440.1
2	54.3	0.1980	331.0	469.3
~~3~~	~~49.7~~	~~0.1763~~	~~322.6~~	~~500.4~~
4	48.5	0.1733	320.4	507.6
5	46.6	0.1685	316.8	521.2
~~6~~	~~46.4~~	~~0.1680~~	~~316.5~~	~~521.2~~
7	35.1	0.1377	292.1	642.2
8	14.7	0.0739	227.8	1197.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,982,860	20.51	780

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	392.1
~~2~~	~~55.3~~	~~0.1911~~	~~333.2~~	~~411.5~~
3	52.2	0.1827	327.2	430.7
4	51.4	0.1807	325.8	434.2
~~5~~	~~50.2~~	~~0.1777~~	~~323.6~~	~~440.3~~
6	50.1	0.1774	323.4	440.3
7	29.6	0.1217	278.2	647.2
~~8~~	~~14.7~~	~~0.0738~~	~~227.8~~	~~1067.2~~

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~60~~	~~3,060,321~~	~~38.93~~	~~337~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2010~~	~~340.0~~	~~302.1~~
2	57.6	0.1960	336.5	309.0
3	55.7	0.1914	333.4	316.3
~~4~~	~~55.4~~	~~0.1905~~	~~332.8~~	~~317.2~~
5	54.8	0.1892	331.8	318.9
6	54.7	0.1890	331.7	318.9
~~7~~	~~21.8~~	~~0.0979~~	~~255.0~~	~~619.7~~
8	14.7	0.0738	227.8	822.1

~~NOTE: THERE IS CHOKED FLOW AT STATION 4~~

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,298.648	39.15	1,132

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	225.3
2	58.6	0.1995	338.3	227.6
3	57.5	0.1961	336.5	230.4
4	57.5	0.1958	336.4	230.4
5	57.3	0.1953	336.1	230.4
6	57.3	0.1952	336.0	230.4
7	18.1	0.0859	242.0	526.8
8	14.7	0.0738	227.8	613.2

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,551.568	42.55	1,348

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	152.7
2	59.3	0.2001	339.4	153.1
3	58.8	0.1990	338.6	153.9
4	58.8	0.1989	338.5	153.9
5	58.7	0.1987	338.4	153.9
6	58.7	0.1986	338.4	153.9
7	16.1	0.0790	234.1	388.3
8	14.7	0.0738	227.8	415.7

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	753,471	44.13	1,414

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	94.3
2	59.6	0.2007	339.8	94.3
3	59.4	0.2003	339.5	94.5
4	59.4	0.2003	339.5	94.5
5	59.3	0.2002	339.4	94.5
6	59.3	0.2002	339.4	94.5
7	15.2	0.0757	230.1	230.3
8	14.7	0.0738	227.8	256.8

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	482,546	44.78	1,440

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.5
2	59.6	0.2009	339.9	47.5
3	59.6	0.2008	339.8	47.5
4	59.6	0.2008	339.8	47.5
5	59.6	0.2008	339.8	47.5
6	59.6	0.2008	339.8	47.5
7	14.8	0.0743	228.3	128.4
8	14.7	0.0738	227.8	129.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	$T_{closing}$
10	243,940	44.94	1,445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.0
2	59.6	0.2009	339.9	24.0
3	59.6	0.2009	339.9	24.0
4	59.6	0.2009	339.9	24.0
5	59.6	0.2009	339.9	24.0
6	59.6	0.2009	339.9	24.0
7	14.7	0.0739	227.9	65.2
8	14.7	0.0733	227.3	65.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

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

CASE · 3A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 761 IN.LBS/PSI

STEM DIA. 1.25 IN.

PACKING TORQUE 756 IN.LBS.

DIRECTION Nonpreferred

GAGE DIA. 11.703 IN

SEAL TORQUE 1183 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 DENSIYY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 290 DEG
AIR	1.4	1	1	761

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
4	VALVE	12.0	0.0	0.759	0.75903
5	EXIT	12.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 3,517,149 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	53.3	0.1855	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	316.9	563.2
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.8	1292.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 2,542 IN. LBS

DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~90~~	~~3,517,149~~	~~4.23~~	~~3,909~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2010~~	~~340.0~~	~~471.4~~
2	53.3	0.1855	329.2	509.4
3	48.5	0.1732	320.4	545.4
~~4~~	~~46.1~~	~~0.1673~~	~~316.9~~	~~563.2~~
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,517,149	8.39	908

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
~~2~~	~~53.3~~	~~0.1855~~	~~329.2~~	~~509.4~~
3	44.9	0.1641	313.5	575.6
4	42.3	0.1573	308.2	599.3
~~5~~	~~35.4~~	~~0.1384~~	~~292.7~~	~~684.2~~
6	14.7	0.0738	227.8	1282.7

~~NOTE: THERE IS CHOKED FLOW AT STATION 5~~

~~ANGLE~~	~~FLOW~~	~~DP ACROSS VALVE~~	~~Tclosing~~
70	3,173,985	13.52	- 103

	~~PRESSURE~~	~~DENSITY~~	~~TEMPERATURE~~	~~VELOCITY~~
1	59.7	0.2010	340.0	426.0
2	54.8	0.1890	331.7	451.9
~~3~~	~~41.2~~	~~0.1544~~	~~305.9~~	~~533.3~~
4	39.2	0.1490	301.6	571.8
5	33.3	0.1326	287.8	645.4
~~6~~	~~14.7~~	~~0.0738~~	~~227.8~~	~~1159.4~~

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
~~60~~	~~2,494,818~~	~~27.74~~	~~303~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2010~~	~~340.0~~	~~334.3~~
2	57.0	0.1945	335.5	344.6
3	29.0	0.1202	276.8	558.7
~~4~~	~~27.7~~	~~0.1133~~	~~273.2~~	~~577.3~~
5	24.0	0.1050	262.2	639.9
6	14.7	0.0738	227.8	909.3

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,823,803	37.17	991

1272

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	244.4

3	[illegible]	[illegible]	[illegible]	[illegible]
4	20.5	0.1939	250.9	522.7
5	13.3	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.3	665.1

NOTE: THERE IS CHOKED FLOW AT STATION 2.

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,226,814	41.80	1,137

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	164.4
2	59.2	0.2000	339.3	164.8
3	17.4	0.0833	237.4	395.2
4	17.2	0.0826	238.3	399.7
5	16.4	0.0799	235.1	413.3
6	14.7	0.0738	227.8	447.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	748,810	43.28	1,186

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.3
2	59.5	0.2007	339.8	100.3
3	15.7	0.0774	232.1	260.5
4	15.6	0.0770	231.7	261.5
5	15.3	0.0760	230.4	265.2
6	14.7	0.0738	227.8	273.1

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	378,407	44.65	1,205

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.7
2	59.6	0.2007	339.7	50.7
3	15.0	0.0750	229.2	135.9
4	14.9	0.0749	229.1	136.0
5	14.8	0.0744	228.4	136.7
6	14.7	0.0738	227.8	138.0

NOTE: THERE IS CHOKED FLOW AT STATION 2.

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191,313	44.91	1,209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.6
2	59.6	0.2009	339.9	25.6
3	14.7	0.0741	228.1	69.4
4	14.7	0.0741	228.1	69.5
5	14.7	0.0740	227.9	69.6
6	14.7	0.0738	227.8	69.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

CASE 3 B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE	59.7 PSIA	INITIAL DENSITY	.201 LBS/FT^3
INITIAL TEMPERATURE	340 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	59.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR @ 90 DEG	761 IN.LBS / PSI

STEM DIA.	1.25 IN.	GAGE DIA.	11.703 IN
PACKING TORQUE	756 IN.LBS.	SEAL TORQUE	1183 IN.LBS
DIRECTION	Unprotected		

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=12 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSIYY-X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	761

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
4	VALVE	12.0	0.0	0.759	0.75903
5	EXIT	12.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,517,147 SCFM

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	53.3	0.1855	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	315.7	583.2
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 2,542 IN. LBS
DELTA P=45.00 PSI

1225

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]0	3,517,149	5.75	4,455

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	53.3	0.1955	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	315.9	563.2
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	3,517,149	11.89	958

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	53.3	0.1955	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	315.9	563.2
5	34.2	0.1332	290.0	700.5
6	14.7	0.0733	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,099,067	18.46	- 207

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	415.3
2	55.0	0.1896	332.2	439.4
3	51.5	0.1811	328.1	460.0
4	50.0	0.1773	323.3	469.0
5	31.6	0.1276	293.4	653.9
6	14.7	0.0738	227.8	1130.2

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]0	2,396,102	31.58	491

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	321.1
2	57.2	0.1950	335.9	330.1
3	55.3	0.1904	332.7	338.1
4	54.6	0.1886	331.4	340.3
5	23.0	0.1019	259.0	633.9
6	14.7	0.0738	227.8	873.9

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,788,061	38.46	997

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
3	57.4	0.1955	335.3	245.8
4	57.1	0.1948	335.3	246.3
5	18.7	0.0377	244.0	549.0
6	14.7	0.0738	227.8	652.1

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,214,165	42.37	1,142

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.7
2	59.2	0.2000	339.3	163.1
3	58.8	0.1989	338.6	164.0
4	58.7	0.1987	338.4	164.0
5	16.3	0.0797	234.9	409.9
6	14.7	0.0738	227.8	442.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	750,738	44.07	1,187

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.6
2	59.5	0.2007	339.8	100.6
3	59.4	0.2003	339.5	100.8
4	59.3	0.2002	339.4	100.8
5	15.3	0.0760	230.4	265.9
6	14.7	0.0738	227.8	273.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	377,992	44.76	1,206

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.6
2	59.6	0.2009	339.9	50.6
3	59.6	0.2008	339.8	50.6
4	59.6	0.2008	339.8	50.6
5	14.8	0.0744	228.4	136.8
6	14.7	0.0738	227.8	137.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191,090	44.94	1,209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.6
2	59.6	0.2009	339.9	25.6
3	59.6	0.2009	339.9	25.6
4	59.6	0.2009	339.9	25.6
5	14.7	0.0740	227.9	69.5
6	14.7	0.0738	227.8	69.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

CASE 4 A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3 HW

UPSTREAM PRESSURE	59.7 PSIA	INITIAL DENSITY	.201 LBS/FT^3
INITIAL TEMPERATURE	340 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	59.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR @ 90 DEG	761 IN.LBS/PSI

STEM DIA.	1.25 IN.	GAGE DIA.	11.703 IN
PACKING TORQUE	756 IN.LBS.	SEAL TORQUE	1183 IN.LBS
DIRECTION	Preferred		

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
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	761

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.750	453	1130

STATION NO.	TYPE OF RESISTANCE	DIAMETER (D)	LENGHT (L)	RESISTANCE (K)	CORRECTED RESISTANCE (K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	9.?	0.135	0.13500
4	PIPE BEND	12.0	0.0	0.160	0.16000
5	STRAIGHT PIPE	12.0	4.0	0.060	0.06000
6	VALVE	12.0	0.0	0.759	0.75903
7	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 3,443,784 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	57.7	0.2010	340.0	481.5
2	53.6	0.1861	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	316.1	542.7
5	45.1	0.1647	313.9	559.1
6	44.4	0.1629	312.5	564.2
7	33.4	0.1437	279.3	551.3
8	14.7	0.0738	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 2,242 IN. LBS

DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	2,540

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1861	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	[illegible]	[illegible]
5	45.1	0.1647	313.9	559.1
6	44.4	0.1629	312.5	564.2
7	38.4	0.1467	299.8	[illegible]
8	14.7	0.0733	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,443,764	7.82	- 3,330

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1861	329.7	497.4
3	45.7	[illegible]	[illegible]	556.7
4	43.9	0.1614	311.4	572.2
5	41.5	0.1550	306.4	594.3
6	40.7	[illegible]	304.9	[illegible]
7	33.7	0.1336	288.3	694.0
8	14.7	0.0733	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,138,455	12.70	- 1,968

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	420.6
2	54.7	[illegible]	332.1	445.0
3	42.2	0.1571	308.1	536.8
4	40.8	0.1531	304.9	549.0
5	39.7	0.1492	300.9	555.3
6	38.4	0.1467	299.8	569.5
7	32.5	0.1301	285.7	642.0
8	14.7	0.0733	[illegible]	[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,494,027	22.72	- 321

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	334.2
2	57.0	0.1945	335.5	344.5
3	34.3	0.1363	290.2	494.7
4	33.4	0.1329	288.1	502.4
5	23.2	0.1178	285.2	570.0
6	29.0	0.1171	273.9	[illegible]
7	24.0	0.1050	262.2	639.8
8	14.7	0.0733	227.8	909.6

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	[illegible]	36.39	460

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	244.4
2	[illegible]	[illegible]	[illegible]	[illegible]
3	22.0	0.0997	255.8	497.4
4	21.5	0.0970	254.0	506.5
5	[illegible]	[illegible]	[illegible]	[illegible]
6	20.6	0.0940	250.9	522.3
7	18.8	0.0883	244.7	556.0
8	14.7	0.0733	227.3	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,225,352	41.49	755

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	164.4
2	59.2	0.2000	339.3	164.8
3	17.7	0.0846	240.5	390.3
4	17.5	0.0837	237.7	[illegible]
5	17.3	0.0829	238.6	398.2
6	17.2	0.0826	238.3	399.6
7	15.4	0.0779	233.1	413.3
8	14.7	0.0738	227.3	447.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	748,829	43.78	872

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.3
2	59.5	0.2007	339.9	100.3
3	15.8	0.0778	232.5	257.2
4	15.7	0.0775	232.2	260.1
5	15.6	0.0772	231.8	261.2
6	15.5	0.0770	231.7	[illegible]
7	15.3	0.0760	230.4	265.2
8	14.7	0.0738	227.8	273.1

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	378,417	44.62	902

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.7
2	59.5	0.2009	339.9	50.7
3	15.0	0.0751	229.3	135.7
4	15.0	0.0750	229.2	135.8
5	15.0	0.0749	229.1	136.0
6	14.9	0.0749	229.1	136.0
7	14.8	0.0744	228.4	137.0
8	14.7	0.0738	227.8	138.9

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	59.6	0.2009	339.9	25.6
3	14.7	0.0741	229.2	69.4
4	[illegible]	[illegible]	[illegible]	[illegible]
5	14.7	0.0741	229.1	69.5
6	14.7	0.0741	229.1	69.5
7	[illegible]	[illegible]	[illegible]	[illegible]
8	14.7	0.0738	227.9	69.7

NOTE: THERE IS CHOKED FLOW AT STATION 2

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

CASE 4B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721 C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 761 IN.LBS/PSI

STEM DIA. 1.25 IN.

PACKING TORQUE 756 IN.LBS.

DIRECTION Nonpreferred

GAGE DIA. 11.703 IN

SEAL TORQUE 1183 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 DENSIYY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	761

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
4	PIPE BEND	12.0	0.0	0.150	0.15000
5	STRAIGHT PIPE	12.0	4.0	0.060	0.06000
6	VALVE	12.0	0.0	0.759	0.75903
7	EXIT	12.0	0.0	1.000	1.00000

FLOW IN NONPREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,443,764 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1851	327.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	318.1	542.7
5	45.1	0.1647	313.7	559.1
6	44.4	0.1628	312.5	564.2
7	38.4	0.1469	297.8	631.5
8	14.7	0.0738	227.3	1258.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 2,542 IN. LBS
DELTA P=45.00 PSI

1025

B-48

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,443,[illegible]54	5.9[illegible]	[illegible],445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1861	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	318.1	542.7
5	45.1	0.1647	313.9	559.1
6	44.4	0.1628	312.5	564.2
7	38.4	0.1439	299.3	[illegible]
8	14.7	0.0738	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,443,764	12.44	964

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1861	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	318.1	542.7
5	45.1	0.1647	313.9	559.1
6	44.4	0.1628	312.5	564.2
7	32.0	0.1288	234.5	720.1
8	14.7	0.0738	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,049,241	17.33	- 130

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	408.6
2	55.2	0.1901	332.5	431.2
3	51.9	0.1819	326.6	450.7
4	50.7	0.1790	324.6	457.0
5	49.3	0.1755	[illegible]	[illegible]
6	49.0	0.1746	321.3	466.1
7	31.6	0.1278	283.7	642.5
8	14.7	0.0738	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,37[illegible],062	31.29	495

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	318.4
2	57.2	0.1951	335.9	327.4
3	55.4	0.1906	332.8	335.1
4	54.8	0.1893	331.9	[illegible]
5	54.2	0.1878	330.8	338.6
6	54.1	0.1874	330.6	338.6
7	22.8	0.1012	258.4	332.0
8	14.7	0.0738	227.8	866.6

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,794,842	38.36	996

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.2
2	58.4	0.1980	338.0	242.2
3	57.5	0.1958	333.3	245.2
4	57.3	0.1952	336.0	245.2
5	57.1	0.1947	335.7	246.2
6	57.0	0.1946	335.5	245.2
7	18.6	0.0876	243.9	548.3
8	14.7	0.0733	227.8	650.9

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,211,947	42.27	1,141

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.4
2	59.2	0.2000	337.3	162.3
3	58.3	0.1989	338.6	163.7
4	58.7	0.1987	338.4	163.7
5	58.5	0.1985	338.3	163.7
6	58.6	0.1984	338.2	163.7
7	16.3	0.0797	234.9	409.2
8	14.7	0.0733	227.8	442.0

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	749,436	44.03	1,187

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.4
2	59.5	0.2007	339.3	100.4
3	59.4	0.2003	339.5	100.6
4	59.3	0.2002	339.3	100.5
5	59.3	0.2001	339.4	100.6
6	59.3	0.2001	339.4	100.6
7	15.3	0.0750	230.4	265.4
8	14.7	0.0738	227.8	273.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	377,317	44.75	1,206

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.5
2	59.6	0.2009	339.9	50.5
3	59.6	0.2008	339.8	50.5
4	59.6	0.2008	339.8	50.5
5	59.6	0.2007	339.8	50.5
6	59.5	0.2007	339.8	50.5
7	14.8	0.0744	228.4	136.6
8	14.7	0.0738	227.8	137.6

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	CLOSING
10	190.753	44.93	1,2[illegible]9

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.5
2	[illegible]	[illegible]	[illegible]	25.5
3	59.6	0.2009	339.9	25.5
4	59.6	0.2009	339.9	25.5
5	59.3	0.2009	339.9	25.5
6	59.6	0.2009	339.9	25.5
7	14.7	0.0740	227.9	69.4
8	14.7	0.0739	227.8	69.5

NOTE: THERE IS CHOKED FLOW AT STATION 6

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

CASE 1B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA	INITIAL DENSITY .201 LBS/FT^3
INITIAL TEMPERATURE 340 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 59.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1.0
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.	GAGE DIA. 12.974 IN
PACKING TORQUE 832 IN.LBS.	SEAL TORQUE 1454 IN.LBS
DIRECTION Preferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE-14 VALVE CLASS-150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-[illegible]	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
[illegible]	[illegible]	340	14.7	[illegible]

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR [illegible]
AIR	1.4	1	1	1182

STEM DIA.	DISC DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	[illegible]	[illegible]	[illegible]	[illegible]
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= [illegible] SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	[illegible]	[illegible]	[illegible]	[illegible]
5	39.2	0.1489	301.5	629.1
6	14.7	0.0738	227.3	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	45.1	[illegible]	[illegible]	[illegible]
5	39.2	0.1489	301.5	628.1
6	14.7	0.0738	227.8	1266.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	4,530,955	11.10	- 6,519

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.1
2	54.1	[illegible]	[illegible]	[illegible]
3	49.3	0.1754	321.9	510.1
4	47.6	0.1710	318.7	522.0
5	36.5	[illegible]	295.4	[illegible]
6	14.7	0.0738	227.8	1214.1

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	4,030,437	20.69	- 3,998

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	396.8
2	55.6	0.1910	333.1	416.5
3	[illegible]	[illegible]	[illegible]	[illegible]
4	50.9	0.1793	324.8	442.8
5	30.2	0.1235	279.8	645.5
6	14.7	0.0733	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	[illegible]	[illegible]	746

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	57.5	0.1956	336.3	311.6
3	55.5	0.1910	333.1	319.3
4	[illegible]	[illegible]	[illegible]	[illegible]
5	21.9	0.0982	255.3	621.7
6	14.7	0.0738	227.8	827.0

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,302,002	39.28	737

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	226.6
2	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	33[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.8	[illegible]

NOTE: [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,551,983	42.64	1,218

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	152.8
2	59.3	0.2001	339.4	153.2
3	[illegible]	[illegible]	[illegible]	[illegible]
4	58.8	0.1988	338.5	154.0
5	16.1	0.0790	234.1	388.4
6	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	[illegible]	340.0	[illegible]
2	59.6	0.2007	339.8	94.5
3	59.4	0.2003	339.5	94.7
4	59.4	[illegible]	339.5	[illegible]
5	15.2	0.0757	230.1	250.7
6	14.7	0.0738	227.8	257.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	483,477	44.79	1,436

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.6
2	[illegible]	[illegible]	[illegible]	[illegible]
3	59.6	0.2008	339.3	47.6
4	59.6	0.2008	339.3	47.6
5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.8	129.5

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	244,414	44.94	1,445

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.0
2	59.6	0.2009	339.9	24.0
3	59.6	0.2009	339.9	24.0
4	59.6	0.2009	339.9	24.0
5	14.7	0.0739	227.9	65.3
6	14.7	0.0738	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

CASE 2B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE	59.7 PSIA	INITIAL DENSITY	.201 LBS/FT^3
INITIAL TEMPERATURE	340 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	59.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR @ 90 DEG	1182 IN.LBS/PSI

STEM DIA.	1.375 IN.	GAGE DIA.	12.974 IN
PACKING TORQUE	832 IN.LBS.	SEAL TORQUE	1754 IN.LBS
DIRECTION	Preferred		

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE-14 VALVE CLASS-150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X1000	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 270 DEG
AIR	1.4	1	1	1182

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.974	832	1454

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	14.0	0.0	0.500	0.50000
2	VALVE	14.0	0.0	0.860	0.86065
3	STRAIGHT PIPE	14.0	9.0	0.115	0.11571
4	PIPE BEND	14.0	0.0	0.150	[illegible]
5	STRAIGHT PIPE	14.0	3.0	0.038	0.03857
6	VALVE	14.0	0.0	0.860	0.86066
7	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 4,645,997 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1888	330.0	471.7
3	48.5	0.1734	320.5	528.9
4	47.2	0.1699	317.9	538.2
5	45.1	0.1645	313.3	554.5
6	44.7	0.1636	313.1	556.2
7	37.8	0.1450	298.4	633.8
8	14.7	0.0733	227.0	1244.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 3,101 IN. LBS
DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	53.7	0.1366	330.0	491.7
3	48.5	0.1734	320.5	528.9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	45.1	0.1645	313.8	554.5
6	44.7	0.1636	313.1	556.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	14.7	0.0738	227.8	1244.9

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	4,469,262	11.29	- 6,516

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	440.1
2	54.3	0.1880	331.0	469.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	48.5	0.1733	320.4	507.6
5	46.6	0.1685	316.8	521.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	35.1	0.1377	292.1	642.2
8	14.7	0.0738	227.3	1197.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3.982,860	20.51	- 3,754

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	392.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	52.2	0.1827	327.2	430.7
4	51.4	0.1807	325.8	434.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	50.1	0.1774	323.4	440.3
7	29.6	0.1217	273.2	647.2
[illegible]	14.7	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	[illegible]	730

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
[illegible]	59.7	[illegible]	340.0	[illegible]
2	57.6	0.1960	336.5	309.0
3	55.7	0.1914	333.4	316.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	54.3	0.1892	331.8	318.9
6	54.7	0.1890	331.7	319.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	14.7	0.0738	227.8	322.1

[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]0	2,238,648	39.15	[illegible]41

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	225.3
2	58.5	0.1985	338.3	227.6
3	57.5	[illegible]	[illegible]	[illegible]
4	57.5	0.1958	336.4	230.4
5	57.3	0.1953	336.1	230.4
6	57.3	0.1952	336.0	[illegible]
7	18.1	0.0859	242.0	526.8
8	14.7	0.0738	227.8	613.2

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,551,568	42.35	1,217

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	152.7
2	59.3	0.2001	339.4	153.1
3	58.8	0.1990	338.6	153.9
4	58.8	0.1989	338.5	153.9
5	58.7	0.1987	338.4	153.9
6	58.7	0.1986	338.4	153.9
7	16.1	0.0790	234.1	388.3
8	14.7	0.0738	227.3	413.7

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	753,471	44.13	1,373

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	94.3
2	59.6	0.2007	339.8	94.3
3	59.4	0.2003	339.5	94.5
4	59.4	0.2003	339.2	94.5
5	59.3	0.2002	339.4	94.5
6	59.3	0.2002	339.4	94.5
7	15.2	0.0757	230.1	250.3
8	14.7	0.0738	227.8	256.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	482.546	44.78	1,436

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	47.5
2	59.6	0.2009	339.7	47.5
3	59.5	0.2009	339.3	47.5
4	59.6	0.2008	339.3	47.5
5	59.6	0.2008	339.8	47.5
6	59.6	0.2008	339.9	47.5
7	14.8	0.0743	228.3	128.4
8	14.7	0.0738	227.8	129.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.0
2	[illegible]	[illegible]	[illegible]	[illegible]
3	59.6	0.2009	339.9	24.0
4	59.5	0.2009	339.9	24.0
5	[illegible]	[illegible]	[illegible]	[illegible]
6	59.6	0.2009	339.9	24.0
7	14.7	0.0739	227.9	65.2
8	14.7	[illegible]	[illegible]	65.2

NOTE: THERE IS CHOKED FLOW AT STATION 6

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

CASE 3A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE	59.7 PSIA	INITIAL DENSITY	.201 LBS/FT^3
INITIAL TEMPERATURE	340 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	59.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR. @ 90 DEG	761 IN.LBS/PSI

STEM DIA.	1.25 IN.	GAGE DIA.	11.703 IN
PACKING TORQUE	756 IN.LBS.	SEAL TORQUE	1183 IN.LBS
DIRECTION	Preferred		

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

[illegible] SYSTEM ANALYSIS

VALVE SIZE=12 VALVE CLASS=150 FLOW=GAS

UPSTREAM PRESSURE	INITIAL DENSITY--X10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR [illegible]
AIR	1.4	1	1	761

STEM DIA.	SEAT DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	[illegible]	[illegible]
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
4	VALVE	12.0	0.0	0.759	[illegible]
5	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= [illegible] SCFM

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	57.7	[illegible]	340.0	471.4
2	53.3	0.1855	329.2	509.4
3	49.5	0.1732	320.4	545.4
4	[illegible]	[illegible]	[illegible]	[illegible]
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.3	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 2,542 IN. LBS
DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	[illegible]	[illegible]
2	53.3	0.1955	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	[illegible]	[illegible]	[illegible]	[illegible]
5	40.2	0.1516	303.6	624.9
6	14.7	0.0739	227.3	1232.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
49	3,517,149	8.39	- 3,237

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	[illegible]	[illegible]	[illegible]	[illegible]
3	44.9	0.1641	313.5	575.6
4	42.3	0.1573	308.2	599.3
5	[illegible]	0.1384	292.7	[illegible]
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,178,985	13.52	- 1,773

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	426.0
2	54.8	0.1890	331.7	451.9
3	41.2	0.1544	303.7	[illegible]
4	39.2	0.1490	301.6	571.8
5	33.3	0.1326	287.8	645.4
6	14.7	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	2,474,313	27.74	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	57.0	0.1945	335.5	344.6
3	29.0	0.1202	276.3	558.7
4	[illegible]	[illegible]	[illegible]	[illegible]
5	24.0	0.1050	262.2	639.9
6	14.7	0.0738	227.3	909.8

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,823,803	37.17	758

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	244.4

6	14.[illegible]	[illegible].0738	22[illegible].3	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,226,314	41.80	1,056

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	164.4
2	59.2	0.2000	339.3	164.3
3	17.[illegible]	[illegible]	2[illegible]	395.2
4	17.2	0.0826	238.3	399.7
5	16.4	0.0799	235.1	413.3
6	14.7	[illegible].0738	22[illegible]	[illegible]47.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	7[illegible]	[illegible]	1,[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.3
2	59.5	0.2007	339.3	100.3
3	15.7	0.0774	232.1	260.5
4	15.[illegible]	0.0770	231.7	2[illegible]
5	15.3	0.0760	230.4	265.2
6	14.7	0.0738	227.3	273.1

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	373,407	44.65	1,202

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.7
2	59.[illegible]	0.2009	33[illegible]	[illegible]
3	15.0	0.0750	229.2	135.9
4	14.9	0.0749	229.1	136.0
5	14.3	0.0744	228.4	13[illegible].7
6	14.7	0.0738	227.8	138.0

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191,313	44.91	1,209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.6
2	59.6	0.2009	339.9	25.6
3	14.7	0.0741	229.1	[illegible]
4	14.7	0.0741	229.1	69.5
5	14.7	0.0740	227.9	69.6
6	14.7	[illegible].0738	227.3	69.7

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 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 57.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 761 IN.LBS/PSI

STEM DIA. 1.25 IN.

PACKING TORQUE 756 IN.LBS.

DIRECTION Preferred

GAGE DIA. 11.703 IN

SEAL TORQUE 1183 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

B65

~~CONTROL SYSTEM ANALYSIS~~

VALVE SIZE-12 VALVE CLASS=150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10**2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
~~59.7~~	~~20.1~~	~~340~~	~~14.7~~	~~59.7~~

MEDIA	RATIO OF ~~SP. HEAT~~	SPECIFIC ~~GRAVITY~~	COMPRESSIBILITY	HYDRODYNAMIC FACTOR ~~90 DEG~~
AIR	1.4	1	1	761

~~STEM~~ DIA.	~~CAGE~~ DIA.	~~PACKING~~ TORQUE	~~SEAL~~ TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
~~1~~	~~ENTRANCE~~	~~12.0~~	~~0.0~~	~~0.500~~	~~0.50000~~
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
~~4~~	~~VALVE~~	~~12.0~~	~~0.0~~	~~0.759~~	~~0.75903~~
5	EXIT	12.0	0.0	1.000	1.00000

~~FLOW IN PREFERRED DIRECTION~~

CONDITIONS WITH VALVE OPEN

~~FLOW= 3,317,147 SCFH~~

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
~~1~~	~~59.7~~	~~0.2010~~	~~340.0~~	~~471.4~~
2	53.3	0.1855	329.2	509.4
3	48.5	0.1732	320.4	545.4
~~4~~	~~45.1~~	~~0.1673~~	~~313.7~~	~~583.2~~
5	40.2	0.1516	303.6	624.9
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

~~CONDITIONS WITH VALVE SHUT~~

VALVE TORQUE= 2,542 IN. LBS

DELTA P=45.00 PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	53.3	0.1955	329.2	509.4
3	48.5	0.1732	320.4	545.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	40.2	0.1516	303.6	624.9
6	14.7	0.0733	227.3	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,517,149	11.89	- 4,100

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	315.9	563.2
5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0733	227.8	1282.7

~~NOTE: THERE IS CHOKED FLOW AT STATION 5~~

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,099,067	18.46	- 2,135

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	415.3
2	55.0	0.1896	332.2	439.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	50.0	0.1773	323.3	469.0
5	31.6	0.1276	283.4	653.9
[illegible]	[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
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	57.2	0.1950	335.9	330.1
3	55.3	0.1904	332.7	338.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	23.0	0.1018	259.0	633.8
6	14.7	0.0738	227.3	373.9

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,788,061	38.46	751

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.6

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14.7	0.0739	227.8	552.1

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,214.155	42.37	1,059

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.7
2	59.2	0.2000	339.3	163.1
3	[illegible]	[illegible]	[illegible]	[illegible]
4	58.7	0.1987	338.4	164.0
5	16.3	0.0797	234.9	409.9
6	14.7	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	0.2010	[illegible]	[illegible]
2	59.5	0.2007	339.3	100.6
3	59.4	0.2003	339.5	100.8
4	59.3	0.2002	[illegible]	[illegible]
5	15.3	0.0760	230.4	265.9
6	14.7	0.0733	227.8	273.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	377,992	44.76	1,203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.6
2	[illegible]	[illegible]	[illegible]	[illegible]
3	59.6	0.2008	339.8	50.6
4	59.6	0.2008	339.3	50.6
5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0739	227.8	137.3

NOTE: THERE IS CHOKED FLOW AT STATION 4.

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191,090	44.94	1,209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.6
2	59.6	0.2009	339.9	25.6
3	59.6	[illegible]	[illegible]	[illegible]
4	59.6	0.2009	339.9	25.6
5	14.7	0.0740	227.9	69.5
6	14.7	[illegible]	227.9	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

CASE 4B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE 59.7 PSIA

INITIAL TEMPERATURE 340 °F

SHUT OFF PRESSURE 59.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .201 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 761 IN.LBS/PSI

STEM DIA. 1.25 IN.

PACKING TORQUE 756 IN.LBS.

DIRECTION Preferred

GAGE DIA. 11.703 IN

SEAL TORQUE 1183 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
59.7	[illegible]	340	14.7	59.[illegible]

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR [illegible] DEG
AIR	1.4	1	1	761

STEM DIA.	BASE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGHT-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	VALVE	12.0	0.0	0.759	0.75903
3	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
4	PIPE BEND	12.0	0.0	[illegible]	[illegible]
5	STRAIGHT PIPE	12.0	4.0	0.060	0.06000
6	VALVE	12.0	0.0	0.759	0.75903
7	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,443,764 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.3	[illegible]	[illegible]	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	318.1	542:7
5	45.1	[illegible]	[illegible]	[illegible]
6	44.4	0.1628	312.5	564.2
7	38.4	0.1469	299.3	631.5
8	14.7	0.0753	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 2,542 IN. LBS
DELTA P=[illegible] PSI

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	340.0	[illegible]
2	53.6	0.1961	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	[illegible]	[illegible]	[illegible]
5	45.1	0.1647	313.9	559.1
6	44.4	0.1628	312.5	564.2
7	38.4	[illegible]	[illegible]	[illegible]
8	14.7	0.0738	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
80	3,443,764	12.44	-	4,127

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	461.5
2	53.6	0.1961	329.7	497.4
3	49.0	0.1746	321.3	530.2
4	47.2	0.1702	318.1	542.7
5	45.1	0.1647	313.9	559.1
6	44.4	0.1628	312.5	564.2
7	32.0	0.1288	284.5	720.1
8	14.7	0.0738	227.8	1256.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
70	3,049,241	17.33	-	2,044

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	408.6
2	[illegible]	[illegible]	[illegible]	[illegible]
3	51.9	0.1819	326.6	450.7
4	50.7	0.1790	324.6	457.0
5	49.3	[illegible]	[illegible]	[illegible]
6	49.0	0.1746	321.3	466.1
7	31.6	0.1278	283.7	642.5
8	14.7	0.0739	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	57.2	0.1951	335.9	327.4
3	55.4	0.1906	332.8	335.1
4	[illegible]	[illegible]	[illegible]	[illegible]
5	54.2	0.1878	330.8	338.6
6	54.1	0.1874	330.6	338.6
7	[illegible]	[illegible]	258.4	[illegible]
8	14.7	0.0739	227.8	866.6

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
[illegible]	[illegible]	30.35	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.2
2	[illegible]	0.1990	339.0	242.2
3	[illegible]	[illegible]	[illegible]	245.2
4	57.3	0.1952	336.0	245.2
5	57.1	0.1947	335.7	245.2
6	57.0	[illegible]	[illegible]	245.2
7	18.6	0.0876	243.9	548.3
8	14.7	0.0738	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,211,947	42.27	1,058

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.4
2	59.2	[illegible]	[illegible]	[illegible]
3	58.3	0.1989	339.6	163.7
4	58.7	0.1987	338.4	163.7
5	[illegible]	[illegible]	[illegible]	[illegible]
6	58.6	0.1784	338.2	163.7
7	16.3	0.0797	234.9	409.2
8	14.7	[illegible]	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	747,433	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	59.5	0.2007	339.8	100.4
3	59.4	0.2003	339.5	100.6
4	59.3	0.2002	[illegible]	[illegible]
5	59.3	0.2001	339.4	100.6
6	59.3	0.2001	339.4	100.6
7	15.3	0.0760	230.4	235.4
8	14.7	0.0738	227.8	273.3

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	377,317	44.75	1,203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.5
2	59.6	0.2009	339.9	50.5
3	[illegible]	0.2008	[illegible]	[illegible]
4	59.6	0.2008	339.8	50.5
5	59.6	0.2007	339.8	50.5
6	[illegible]	0.2007	[illegible]	[illegible]
7	14.8	0.0744	228.4	136.6
8	14.7	0.0738	227.8	137.6

NOTE: THERE IS CHOKED FLOW AT STATION 6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.5
[illegible]	[illegible]	[illegible]	339.[illegible]	[illegible]
3	59.6	0.2009	339.9	25.5
4	59.6	0.2009	339.9	25.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	59.6	0.2009	339.9	25.5
7	14.7	0.0740	227.9	69.4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 6

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.

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HV

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 7770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 1182

PACKING TORQUE 832 IN.LBS.

STEM DIA. 1.375 IN.

BUILDING PRESSURE 45 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 6317

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1454 IN.LBS.

GAGE DIA. 12.974 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	65.2	44.9
20	.0749	127.7	44.7
30	.0770	245.3	44.0
40	.0826	374.8	42.1
50	.0939	492.8	37.9
60	.115	549.5	29.9
70	.151	546.9	15.2
80	.161	579.0	9.74
90	.172	541.9	5.48

DETERMINATION OF CLOSING TIME

[illegible] CLASS VALVE WITH A [illegible] ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 90	SOL. VALVE Cv= 2.2a
MEDIA=AIR	VALVE CV= [illegible]	HYDRO. TORQUE [illegible]	[illegible]
PACKING TORQUE= 832	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= 12.974
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0749	.0773	.0806	.0939	.1150	.1510	.1610	.1720
VELOCITY	65.2	127.7	245.8	374.8	492.8	549.5	546.9	579.0	541.9
PRES DROP	44.90	44.70	44.00	42.10	37.70	29.90	15.20	9.74	5.48

LOCA CLOSES THE VALVE TO 63 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS 5032 IN.LBS. @ 30 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	4634	-3137	-2562	499	614	63.00	25.49
0.05	0	2558	-2843	-928	499	614	52.35	36.01
0.10	0	2048	-2773	-389	499	614	45.34	39.64
0.15	0	1800	-2708	-208	499	614	40.39	41.34
0.20	0	1677	-2673	-112	499	614	36.03	42.35
0.25	0	1623	-2678	-58	499	614	31.71	43.63
0.30	0	1620	-2702	-31	499	614	[illegible]	[illegible]
0.35	0	1649	-2745	-17	499	614	24.56	44.38
0.40	0	1701	-2805	-8	499	614	21.21	44.61
0.45	0	1772	-2881	-4	499	614	[illegible]	[illegible]
0.50	0	1859	-2970	-2	499	614	15.06	44.79
0.55	0	1959	-3071	-1	499	614	12.24	44.85
0.60	0	2071	-3184	-0	499	614	[illegible]	[illegible]
0.65	0	2194	-3308	-0	499	614	7.09	44.92
0.70	0	2327	-3440	-0	499	614	4.75	44.95
0.75	0	1720	-3580	-0	[illegible]	614	[illegible]	[illegible]
0.80	0	1382	-3693	-0	1696	614	0.96	44.99

2992

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 40 PSIG SOLENOID VALVE C_v 2.36

MEDIA Air VALVE C_v 6317

HYDRODYNAMIC TORQUE @ 90 1182 SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 832 IN.LBS. SEAL TORQUE 1454 IN.LBS.

STEM DIA. 1.375 IN. GAGE DIA. 12.974 IN.

BUILDING PRESSURE 3.1 PSIG dt .25 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0739	65.3	44.9
20	.0743	128.7	44.8
30	.0757	250.7	44.2
40	.0790	388.4	42.6
50	.0861	529.0	39.3
60	.0982	661.7	33.1
70	.124	645.5	20.7
80	.142	633.6	11.1
90	.149	628.1	6.92

DETERMINATION OF CLOSING TIME

[illegible] CLASS VALVE WITH A [illegible] ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE CV= 3317	HYDRO. TORQUE @ 90= [illegible]	SHUT-OFF PRES. [illegible]
PACKING TORQUE= 832	SEAL TORQUE= 1454	Ostem= 1.375	Ogage= 12.974
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0759	.0743	.0757	.0790	.0851	.0982	.1240	.1420	.1490
VELOCITY	65.3	123.7	250.7	338.4	529.0	621.7	645.5	633.6	629.1
PRES DROP	44.90	44.30	44.20	42.60	39.30	33.10	20.70	11.10	6.92

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	14946	12993	-5924	6431	832	614	90.00	6.92
0.25	7324	5870	-5924	6431	832	614	90.00	6.92
0.50	6229	4276	-5924	6431	832	614	90.00	6.92
0.75	5436	3483	-5924	6431	832	614	90.00	6.92
1.00	4720	2738	-5924	6431	832	614	90.00	6.92
1.25	4530	2577	-5924	6431	832	614	90.00	6.92
1.50	4242	2289	-5924	6431	832	614	90.00	6.92
1.75	4025	2082	-5924	6431	832	614	90.00	6.92
2.00	3830	1877	-5924	6431	832	614	90.00	6.92
2.25	3678	1724	-5924	6431	832	614	90.00	6.92
2.50	3549	1575	-5924	6431	832	614	90.00	6.92
2.75	3438	1485	-5924	6431	832	614	90.00	6.92
3.00	3342	1389	-5924	6431	832	614	90.00	6.92
3.25	3259	1305	-5924	6431	832	614	90.00	6.92
3.50	3185	1231	-5924	6431	832	614	90.00	6.92
3.75	3119	1166	-5924	6431	832	614	90.00	6.92
4.00	3060	1107	-5924	6431	832	614	90.00	6.92
4.25	3007	1053	-5924	6431	832	614	90.00	6.92
4.50	2959	1005	-5924	6431	832	614	90.00	6.92
4.75	2915	[illegible]	-5924	6431	832	614	90.00	6.92
5.00	2875	921	-5924	6431	832	614	90.00	6.92
5.25	2838	884	-5924	6431	832	614	90.00	6.92
5.50	2804	850	-5924	6431	832	614	90.00	6.92
5.75	2772	819	-5924	6431	832	614	90.00	6.92
6.00	2743	790	-5924	6431	832	614	90.00	6.92
6.25	2715	762	-5924	6431	832	614	90.00	6.92
6.50	2691	738	-5924	6431	832	614	90.00	6.92
6.75	2667	714	-5924	6431	832	614	90.00	6.92

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR B.H. N721C-SR80

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Pro Lever

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 1182

PACKING TORQUE 832 IN.LBS.

STEM DIA. 1.375 IN.

BUILDING PRESSURE 45 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 6317

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1454 IN.LBS.

GAGE DIA. 12.974 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	65.4	44.9
20	.0750	128.0	44.7
30	.0774	247.8	43.9
40	.0833	372.8	41.9
50	.0957	483.3	37.4
60	.119	534.0	28.7
70	.153	533.4	14.4
80	.163	561.6	9.13
90	.173	528.9	5.22

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begins= 5970	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.2-
MEDIA=AIR	VALVE C. [illegible]	HYDRO. TORQUE [illegible]	SHUT-OFF PRES. [illegible]
PACKING TORQUE= 932	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= 12.97-
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VELOCITY	65.4	128.0	244.8	372.8	483.3	534.0	533.4	561.6	523.9
PRES DROP	44.90	44.70	43.90	41.90	37.40	28.70	14.40	9.13	5.22

LOCA CLOSES THE VALVE TO 63 DEGREES WITH THE ACTUATOR STILL ACTUATED

~~MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -3373 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	4334	-3137	-2481	499	614	63.00	[illegible]
0.05	0	2541	-2843	-811	499	614	52.35	35.35
0.10	0	2045	-2773	-385	499	614	45.88	39.25
0.15	0	1802	-2708	-207	499	614	40.84	[illegible]
0.20	0	1677	-2678	-113	499	614	36.08	42.63
0.25	0	1623	-2678	-58	499	614	31.75	43.50
0.30	0	1617	-2702	-31	499	614	[illegible]	44.04
0.35	0	1649	-2745	-17	499	614	24.60	44.33
0.40	0	1700	-2805	-9	499	614	21.25	44.59
0.45	0	1771	[illegible]	[illegible]	499	614	[illegible]	[illegible]
0.50	0	1858	-2969	-2	499	614	15.10	44.77
0.55	0	1953	-3070	-1	499	614	12.28	44.85
0.60	0	2070	-3183	-0	499	614	[illegible]	[illegible]
0.65	0	2193	-3306	-0	499	614	7.12	44.92
0.70	0	2325	-3439	-0	499	614	4.78	44.95
0.75	0	1723	-3577	-0	[illegible]	614	[illegible]	[illegible]
0.80	0	1385	-3693	-0	1593	614	0.97	44.99

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME	.72	SCF	ACTUATOR YOKE RADIUS	2.5	IN.
ACTUATOR PRESSURE	80	PSIG	SOLENOID VALVE C_v	2.26	
MEDIA	Air		VALVE C_v	6317	
HYDRODYNAMIC TORQUE @ 90	1182		SHUT OFF PRESSURE DROP	45	PSI
PACKING TORQUE	832	IN.LBS.	SEAL TORQUE	1454	IN.LBS.
STEM DIA.	1.375	IN.	GAGE DIA.	12.974	IN.
BUILDING PRESSURE	3.1	PSIG	dt	.25	SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1477
20	1565
30	1858
40	2333
50	2786
60	2367
70	1106
80	2170
90	7287

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.06
MEDIA=AIR	VALVE Cv= [illegible]	[illegible]	[illegible]
PACKING TORQUE= 832	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= 12.974
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
LOCA TORQUE	1477	[illegible]	[illegible]	2333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	14355	12993	-5924	5840	832	614	90.00
0.25	7035	[illegible]	-5924	5840	832	614	90.00
0.50	5633	4276	-5924	5840	832	614	90.00
0.75	4845	3483	-5924	5840	832	614	90.00
1.00	[illegible]	[illegible]	-5924	5840	832	614	90.00
1.25	3939	2577	-5924	5840	832	614	90.00
1.50	3651	2289	-5924	5840	632	614	90.00
1.75	3424	[illegible]	-5924	5840	832	614	90.00
2.00	3239	1877	-5924	5840	832	614	90.00
2.25	3086	1724	-5924	5840	832	614	90.00
2.50	[illegible]	[illegible]	-5924	5840	832	614	90.00
2.75	2847	1485	-5924	5840	832	614	90.00
3.00	2751	1389	-5924	5840	332	614	90.00
3.25	[illegible]	1305	-5924	5840	832	614	90.00
3.50	2594	1231	-5924	5840	832	614	90.00
3.75	2528	1166	-5924	5840	832	614	90.00
4.00	[illegible]	[illegible]	-5924	5840	832	614	90.00
4.25	2416	1053	-5924	5840	832	614	90.00
4.50	2367	1005	-5924	5840	832	614	90.00
4.75	[illegible]	[illegible]	-5924	5840	832	614	90.00
5.00	2283	921	-5924	5840	832	614	90.00
5.25	2247	884	-5924	5840	832	614	90.00
5.50	[illegible]	[illegible]	-5924	5840	832	614	90.00
5.75	2181	819	-5924	5840	832	614	90.00
6.00	2152	790	-5924	5840	832	614	90.00

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 7770

ACTUATOR VOLUME .72 SCF		ACTUATOR YOKE RADIUS 2.5 IN.	
ACTUATOR PRESSURE 80 PSIG		SOLENOID VALVE C_v 2.26	
MEDIA Air		VALVE C_v 4942	
HYDRODYNAMIC TORQUE @ 90 761		SHUT OFF PRESSURE DROP 45 PSI	
PACKING TORQUE 756 IN.LBS.		SEAL TORQUE 1183 IN.LBS.	
STEM DIA. 1.25 IN.		GAGE DIA. 11.703 IN.	
BUILDING PRESSURE 45 PSIG		dt 0.1 SEC.	

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	69.4	44.9
20	.0750	135.9	44.7
30	.0774	260.5	43.9
40	.0836	395.2	41.8
50	.0952	510.4	37.2
60	.120	558.7	27.9
70	.154	553.3	13.5
80	.164	575.6	8.39
90	.173	545.4	4.86

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 30	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4742	HYDRO. TORQUE [illegible]	SHUT-OFF PRESS. [illegible] 45
PACKING TORQUE= 756	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0750	.0774	.0838	.0962	.1200	.1540	.1540	.1730
VELOCITY	69.4	135.9	260.5	395.2	510.4	558.7	553.3	575.6	545.4
PRES DROP	44.90	44.70	43.90	41.80	37.20	27.90	13.50	8.39	4.86

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	4396	5913	-5924	3197	756	454	90.00	4.86
0.10	3737	5307	-5924	3197	756	454	90.00	4.86
0.20	3301	4818	-5924	3197	756	454	90.00	4.86
0.30	2898	4415	-5924	3197	756	454	90.00	4.86
0.40	2560	4077	-5924	3197	756	454	90.00	4.86
0.50	2271	3788	-5924	3197	756	454	90.00	4.86
0.60	2022	3539	-5924	3197	756	454	90.00	4.86
0.70	1805	3322	-5924	3197	756	454	90.00	4.86
0.80	1613	3130	-5924	3197	756	454	90.00	4.86
0.90	1443	2960	-5924	3197	756	454	90.00	4.86
1.00	1271	2803	-5924	3197	756	454	90.00	4.86
1.10	1154	2671	-5924	3197	756	454	90.00	4.86
1.20	1030	2548	-5924	3197	756	454	90.00	4.86
1.30	918	2435	-5924	3197	756	454	90.00	4.86
1.40	815	2332	-5924	3197	756	454	90.00	4.86
1.50	720	2238	-5924	3197	756	454	90.00	4.86
1.60	633	2151	-5924	3197	756	454	90.00	4.86
1.70	553	2070	-5924	3197	756	454	90.00	4.86
1.80	479	1996	-5924	3197	756	454	90.00	4.86
1.90	410	1927	-5924	3197	756	454	90.00	4.86
2.00	345	1862	-5924	3197	756	454	90.00	4.86
2.10	285	1802	-5924	3197	756	454	90.00	4.86
2.20	229	1743	-5924	3197	756	454	90.00	4.86
2.30	176	1693	-5924	3197	756	454	90.00	4.86
2.40	126	1643	-5924	3197	756	454	90.00	4.86
2.50	79	1596	-5924	3197	756	454	90.00	4.86
2.60	35	1552	-5924	3197	756	454	90.00	4.86
2.70	0	1510	-5924	3197	756	454	90.00	4.86
2.80	0	2042	-5451	2510	453	454	87.70	5.67
2.90	0	2570	-4858	1380	453	454	84.05	6.75
3.00	0	3381	-4154	-135	453	454	78.30	9.25
3.10	0	3347	-3377	-393	453	454	68.00	16.25
3.20	0	2229	-2871	-264	453	454	53.88	33.58
3.30	0	1882	-2731	-58	453	454	42.58	40.61
3.40	0	1787	-2675	-19	453	454	33.00	43.26
3.50	0	1839	-2742	-5	453	454	24.77	44.31
3.60	0	1989	-2896	-1	453	454	17.49	44.75
3.70	0	2208	-3116	-0	453	454	11.14	44.37
3.80	0	2480	-3388	-0	453	454	5.65	44.94
3.90	0	1806	-3695	-0	1434	454	0.73	44.99

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 2770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 3.1 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1153 IN.LBS.

GAGE DIA. 11.703 IN.

dt .25 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0740	69.5	44.9
20	.0744	136.8	44.8
30	.0760	265.9	44.1
40	.0797	409.9	42.4
50	.0877	549.0	38.5
60	.102	633.8	31.6
70	.128	653.9	18.5
80	.135	700.5	11.9
90	.152	624.9	5.95

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= [illegible]	[illegible]
PACKING TORQUE= 756	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0740	.0744	.0750	.0797	[illegible]	.1020	[illegible]	[illegible]	[illegible]
VELOCITY	69.5	136.3	265.9	409.9	549.0	633.8	653.9	700.5	624.9
PRES DROP	44.90	44.80	44.10	42.40	38.50	31.60	18.50	11.90	5.95

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	11966	12993	-5924	3687	756	454	90.00	5.95
0.25	4644	[illegible]	-5924	3687	756	454	90.00	5.95
0.50	3249	4276	-5924	3687	756	454	90.00	5.95
0.75	2456	3483	-5924	3687	756	454	90.00	5.95
1.00	[illegible]	[illegible]	-5924	3687	756	454	90.00	5.95
1.25	1550	2577	-5924	3687	756	454	90.00	5.95
1.50	1262	2289	-5924	3687	756	454	90.00	5.95
1.75	1035	[illegible]	-5924	3687	756	454	90.00	5.95
2.00	850	1877	-5924	3687	756	454	90.00	5.95
2.25	698	1724	-5924	3687	756	454	90.00	5.95
2.50	568	1595	-5924	3687	756	454	90.00	5.95
2.75	458	1485	-5924	3687	756	454	90.00	5.95
3.00	362	1389	-5924	3687	756	454	90.00	5.95
3.25	277	1305	-5924	3687	756	454	90.00	5.95
3.50	205	1231	-5924	3687	756	454	90.00	5.95
3.75	139	1166	-5924	3687	756	454	90.00	5.95
4.00	80	1107	-5924	3687	756	454	90.00	5.95
4.25	27	1053	-5924	3687	756	454	90.00	5.95
4.50	0	1005	-5924	3687	756	454	90.00	5.75
4.75	0	[illegible]	-5174	[illegible]	453	454	[illegible]	[illegible]
5.00	0	3497	-3942	-462	453	454	76.08	14.48
5.25	0	1915	-2751	-72	453	454	43.90	40.87
5.50	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
5.75	0	2490	-3398	-0	453	454	5.47	44.94

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 45 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.703 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	69.4	44.9
20	.0751	135.7	47.6
30	.0778	259.2	43.8
40	.0846	390.3	41.4
50	.0987	497.4	36.4
60	.135	494.9	22.7
70	.157	536.8	12.7
80	.166	556.7	7.82
90	.175	530.2	4.59

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5[illegible]	Tspring ending 3770		
ACT. VOL.= .7[illegible]	ACT. YOKE RADIUS= [illegible]	ACT. PRESS= 80	SOL. VALVE Cv= 2.0[illegible]
MEDIA=AIR	[illegible]	[illegible]	[illegible]
PACKING TORQUE= 756	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0751	.0778	.084[illegible]	.0907	.1050	.1570	.1640	.17[illegible]
VELOCITY	69.4	135.7	259.2	390.3	497.4	494.9	536.9	556.7	530.2
PRES DROP	44.90	44.60	43.80	41.40	36.40	22.70	12.70	7.82	4.59

LOCA CLOSES THE VALVE TO 68 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS 2900 IN.LBS. @ 30 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	4675	-3372	2186	453	454	60.00	14.79
0.05	0	2950	-2978	-880	453	454	58.32	24.99
0.10	0	2342	-2825	-425	453	454	51.16	34.81
0.15	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.20	0	1910	-2701	-117	453	454	39.85	41.43
0.25	0	1829	-2675	-61	453	454	35.02	42.59
0.30	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.35	0	1827	-2720	-15	453	454	26.45	44.08
0.40	0	1878	-2778	-7	453	454	22.59	44.39
0.45	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.50	0	2046	-2952	-1	453	454	15.59	44.73
0.55	0	2156	-3064	-0	453	454	12.44	44.82
0.60	0	[illegible]	[illegible]	-0	453	454	[illegible]	[illegible]
0.65	0	2417	-3325	-0	453	454	6.78	44.93
0.70	0	2563	-3471	-0	453	454	4.25	44.95
0.75	0	[illegible]	[illegible]	[illegible]	[illegible]	454	[illegible]	[illegible]
0.80	0	1713	-3743	-0	1575	454	0.30	44.99

CASE ~~6~~

DETERMINATION OF CLOSING TIME

VALVE SIZE 12 VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME	.72 SCF	ACTUATOR YOKE RADIUS	2.5 IN.
ACTUATOR PRESSURE	80 PSIG	SOLENOID VALVE C_v	2.26
MEDIA	Air	VALVE C_v	4942
HYDRODYNAMIC TORQUE @ 90	761	SHUT OFF PRESSURE DROP	45 PSI
PACKING TORQUE	756 IN.LBS.	SEAL TORQUE	1183 IN.LBS.
STEM DIA.	1.25 IN.	GAGE DIA.	11.703 IN.
BUILDING PRESSURE	3.1 PSIG	dt	.25 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1234
20	1113
30	855
40	1873
50	2209
60	1940
70	1111
80	1798
90	5174

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 5930 Tspring ending 3770
ACT. VOL.= .72 ACT. YOKE RADIUS= 2.5 ACT. PRESS= 90 SOL. VALVE Cv= 2.25
MEDIA=AIR VALVE CV= 4942 HYDRO. TORQUE @ 70= 751 SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 756 SEAL TORQUE= 1133 Dstem= 1.25 Dgage= 11.703
BUILDING PRESSURE= 3.1

DEG.	10	20	30	40	50	60	70	80	90
LOAD TORQUE	1234	1113	355	1873	2207	1740	1111	1773	2174

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	12242	12993	-5924	3963	756	454	90.00
0.25	4920	5570	-5924	3963	756	454	90.00
0.50	3525	4276	-5924	3963	756	454	90.00
0.75	2732	3483	-5924	3963	756	454	90.00
1.00	[illegible]	[illegible]	-5924	3963	756	454	90.00
1.25	1826	2577	-5924	3963	756	454	90.00
1.50	1538	2289	-5924	3963	756	454	90.00
1.75	1311	2062	-5924	3963	756	454	90.00
2.00	1126	1877	-5924	3963	756	454	90.00
2.25	973	1724	-5924	3963	756	454	90.00
2.50	844	1595	-5924	3963	756	454	90.00
2.75	734	1485	-5924	3963	756	454	90.00
3.00	638	1389	-5924	3963	756	454	90.00
3.25	555	1309	-5924	3963	756	454	90.00
3.50	481	1231	-5924	3963	756	454	90.00
3.75	415	1166	-5924	3963	756	454	90.00
4.00	356	1107	-5924	3963	756	454	90.00
4.25	303	1053	-5924	3963	756	454	90.00
4.50	254	1005	-5924	3963	756	454	90.00
4.75	211	961	-5924	3963	756	454	90.00
5.00	170	921	-5924	3963	756	454	90.00
5.25	134	884	-5924	3963	756	454	90.00
5.50	100	850	-5924	3963	756	454	90.00
5.75	68	819	-5924	3963	756	454	90.00
6.00	39	790	-5924	3963	756	454	90.00

APPENDIX D

Determination of the Closing Times of Valves AOV104, 105, 107, 110 & 111 in the Preferred Direction.

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 40 PSIG SOLENOID VALVE C_v 2.26

MEDIA Air VALVE C_v 6317

HYDRODYNAMIC TORQUE @ 90 1182 SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 832 IN.LBS. SEAL TORQUE 1454 IN.LBS.

STEM DIA. 1.375 IN. GAGE DIA. 12.974 IN.

BUILDING PRESSURE 3.1 PSIG dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0739	65.3	44.9
20	.0743	128.7	44.8
30	.0757	250.7	44.2
40	.0790	388.4	42.6
50	.0861	529.0	39.3
60	.0982	661.7	33.1
70	.124	645.5	20.7
80	.142	633.6	11.1
90	.149	628.1	6.92

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tporing begin= 3730	Tporing ending 3770		
ACT. VOL.= .7?	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 30	SOL. VALVE Cv= ?.??
MEDIA=AIR	VALVE Cv= 3317	HYDRO. TORQUE [illegible]	[illegible]
PACKING TORQUE= 832	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= 12.974
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0739	.074?	.0757	.079?	.08??	.0982	.1240	.1420	.14?0
VELOCITY	65.3	129.7	250.7	388.4	529.0	621.7	645.5	633.6	628.1
PRES DROP	44.90	44.80	44.20	42.60	39.30	33.10	20.70	11.10	6.92

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	2083	12993	-5924	-6431	832	614	90.00	6.92
0.05	329	[illegible]	-5924	-6431	832	614	90.00	6.92
0.10	0	10375	-5924	-6431	832	614	90.00	6.92
0.15	0	10783	-4492	-7404	499	614	81.32	10.54
0.20	0	8002	-3204	-3931	499	614	[illegible]	[illegible]
0.25	0	2730	-2858	-985	499	614	53.21	37.30
0.30	0	2091	-2775	-429	499	614	46.29	40.62
0.35	0	[illegible]	[illegible]	[illegible]	499	614	[illegible]	[illegible]
0.40	0	1685	-2679	-120	499	614	36.31	43.13
0.45	0	1626	-2678	-62	499	614	32.16	43.35
0.50	0	1617	-2700	-32	499	614	[illegible]	[illegible]
0.55	0	1647	-2742	-18	499	614	24.77	44.51
0.60	0	1697	-2801	-9	499	614	21.41	44.71
0.65	0	1767	-2873	-5	499	614	[illegible]	[illegible]
0.70	0	1853	-2964	-2	499	614	15.24	44.84
0.75	0	1953	-3065	-1	499	614	12.41	44.87
0.80	0	2064	-3177	-0	499	614	[illegible]	[illegible]
0.85	0	2187	-3300	-0	499	614	7.24	44.92
0.90	0	2318	-3432	-0	499	614	4.89	44.95
0.95	0	[illegible]	[illegible]	-0	981	614	[illegible]	[illegible]
1.00	0	1394	-3690	-0	1681	614	1.01	44.98

CASE 2/3

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR B.H., N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 1182

PACKING TORQUE 832 IN.LBS.

STEM DIA. 1.375 IN.

BUILDING PRESSURE 3.1 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 6317

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1454 IN.LBS.

GAGE DIA. 12.974 IN.

dt .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1413
20	1303
30	858
40	7
50	-1492
60	-3113
70	-7496
80	-9584
90	-7586

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930 Tspring ending 3770
ACT. VOL.= .72 ACT. YOKE RADIUS= 2.5 ACT. PRESS= 80 SOL. VALVE Cv= 2.2[illegible]
~~MEDIA= AIR~~ ~~VALVE CV= [illegible]~~ ~~HYDRO. TORQUE [illegible]~~ ~~SHUT-OFF PRESS. [illegible]~~
PACKING TORQUE= 832 SEAL TORQUE= 1454 Dstem= 1.375 Dgage= 12.974
BUILDING PRESSURE= 3.1

DEG.	10	20	30	40	50	60	70	80	90
~~LOCA TORQUE~~	~~1413~~	~~1303~~	~~383~~	~~7~~	~~-1472~~	~~-3113~~	~~-7493~~	~~-9524~~	~~-7583~~

LOCA CLOSES THE VALVE TO 69 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -9917 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	0	[illegible]	-3372	[illegible]	499	614	[illegible]
0.05	0	3953	-2772	-2294	499	614	45.70
0.10	0	2620	-2677	-1057	499	614	35.66
0.15	0	2108	-2692	-529	499	614	29.35
0.20	0	1966	-2745	-334	499	614	24.60
0.25	0	1874	-2818	-169	499	614	20.62
0.30	0	1903	-2904	-112	499	614	17.21
0.35	0	1967	-3002	-78	499	614	14.10
0.40	0	2046	-3113	-47	499	614	11.23
0.45	0	2353	-3233	-234	499	614	8.27
0.50	0	2875	-3374	-614	499	614	5.88
0.55	0	3453	-3549	-1017	499	614	3.03
0.60	0	2648	-3756	-1428	1921	614	[illegible]

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_v 2.26

MEDIA Air

VALVE C_v 4942

HYDRODYNAMIC TORQUE @ 90 761

SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 756 IN.LBS.

SEAL TORQUE 1183 IN.LBS.

STEM DIA. 1.25 IN.

GAGE DIA. 11.703 IN.

BUILDING PRESSURE 45 PSIG

dt .65 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	69.4	44.9
20	.0750	135.9	44.7
30	.0774	260.5	43.9
40	.0836	395.2	41.8
50	.0962	510.4	37.2
60	.120	558.7	27.9
70	.154	553.3	13.5
80	.164	575.6	8.39
90	.173	545.4	4.86

DETERMINATION OF CLOSING TIME

~~12 - 150 CLASS VALVE WITH A [illegible]~~

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
~~MEDIA=AIR~~	~~VALVE CV= [illegible]~~	~~HYDRO. TORQUE [illegible]~~	~~SHUT-OFF PRES. DROP= [illegible]~~
PACKING TORQUE= 756	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
~~DENSITY~~	~~.0741~~	~~.0750~~	~~.0774~~	~~.0836~~	~~.0962~~	~~.1200~~	~~[illegible]~~	~~[illegible]~~	~~.1730~~
VELOCITY	69.4	135.9	260.5	395.2	510.4	558.7	553.3	575.6	545.4
PRES DROP	44.90	44.70	43.90	41.80	37.20	27.90	13.50	8.39	4.86

LOCA CLOSES THE VALVE TO 57 DEGREES WITH THE ACTUATOR STILL ACTUATED

~~MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS 3177 IN.LBS. @ 30 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~~	~~4661~~	~~-3319~~	~~-2156~~	~~453~~	~~454~~	~~57.00~~	~~[illegible]~~
0.05	0	2909	-2945	-872	453	454	57.12	30.57
0.10	0	2273	-2809	-372	453	454	49.96	37.21
~~0.15~~	~~0~~	~~2049~~	~~-2734~~	~~-202~~	~~453~~	~~454~~	~~[illegible]~~	~~[illegible]~~
0.20	0	1391	-2693	-106	453	454	38.90	42.03
0.25	0	1821	-2675	-54	453	454	34.15	43.02
~~0.30~~	~~0~~	~~1803~~	~~[illegible]~~	~~-25~~	~~453~~	~~454~~	~~29.77~~	~~[illegible]~~
0.35	0	1835	-2729	-13	453	454	25.70	44.24
0.40	0	1890	-2792	-6	453	454	21.83	44.54
~~0.45~~	~~0~~	~~1737~~	~~-2874~~	~~-3~~	~~453~~	~~454~~	~~[illegible]~~	~~[illegible]~~
0.50	0	2066	-2972	-1	453	454	14.98	44.80
0.55	0	2179	-3086	-0	453	454	11.86	44.86
~~0.60~~	~~0~~	~~2303~~	~~-3214~~	~~-0~~	~~453~~	~~454~~	~~[illegible]~~	~~[illegible]~~
0.65	0	2444	-3352	-0	453	454	6.28	44.93
0.70	0	2592	-3500	-0	453	454	3.79	44.96
~~0.75~~	~~0~~	~~1707~~	~~[illegible]~~	~~-0~~	~~1293~~	~~454~~	~~[illegible]~~	~~[illegible]~~

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR B.LL.s N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW P.L.....

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 7770

ACTUATOR VOLUME .72 SCF

ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_v 2.26

MEDIA Air

VALVE C_v 4942

HYDRODYNAMIC TORQUE @ 90 761

SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 756 IN.LBS.

SEAL TORQUE 1183 IN.LBS.

STEM DIA. 1.75 IN.

GAGE DIA. 11.703 IN.

BUILDING PRESSURE 3.1 PSIG

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0740	69.5	44.9
20	.0744	136.8	44.8
30	.0760	265.9	44.1
40	.0797	409.9	42.4
50	.0877	549.0	38.5
60	.102	633.8	31.6
70	.128	653.9	18.5
80	.135	700.5	11.9
90	.152	624.9	5.95

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 90	SOL. VALVE Cv= 0.26
MEDIA=AIR	VALVE [illegible]	HYDRO. TORQUE [illegible] 761	SHUT OFF PRES. DROP= [illegible]
PACKING TORQUE= 756	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0740	.0744	.0760	.0797	.0877	.1020	.1200	.1350	.1520
VELOCITY	69.5	136.8	265.9	409.9	549.0	633.8	653.9	700.5	624.9
PRES DROP	44.90	44.80	44.10	42.40	38.50	31.60	18.50	11.90	5.95

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	4591	12993	-5924	-3687	756	454	90.00	5.95
0.05	[illegible]	[illegible]	-5924	-3687	756	454	90.00	5.95
0.10	1974	10375	-5924	-3687	756	454	90.00	5.95
0.15	1040	9442	-5924	-3687	756	454	90.00	5.95
0.20	[illegible]	[illegible]	-5924	-3687	756	454	90.00	5.95
0.25	0	8016	-5924	-3687	756	454	90.00	5.95
0.30	0	8392	-4779	-4521	453	454	83.50	9.81
0.35	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.40	0	3671	-3085	-1494	453	454	61.62	29.47
0.45	0	2546	-2856	-598	453	454	53.06	36.38
0.50	0	2147	-2777	[illegible]	453	454	[illegible]	[illegible]
0.55	0	1949	-2713	-144	453	454	41.09	41.97
0.60	0	1845	-2678	-75	453	454	36.14	43.05
0.65	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.70	0	1819	-2709	-18	453	454	27.41	44.28
0.75	0	1864	-2763	-9	453	454	23.48	44.55
0.80	0	[illegible]	[illegible]	-4	453	454	[illegible]	[illegible]
0.85	0	2022	-2928	-2	453	454	16.38	44.83
0.90	0	2129	-3036	-1	453	454	13.17	44.86
0.95	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
1.00	0	2384	-3292	-0	453	454	7.40	44.92
1.05	0	2528	-3436	-0	453	454	4.83	44.95
1.10	0	[illegible]	[illegible]	-0	[illegible]	454	[illegible]	[illegible]
1.15	0	1762	-3717	-0	1500	454	0.65	44.99

CASE 4B

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 3.1 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.703 IN.

dt .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1180
20	1093
30	756
40	61
50	-1061
60	-2611
70	-4729
80	-6776
90	-4404

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begins= 5930 Tspring ending 3770
ACT. VOL.= .72 ACT. YOKE RADIUS= 2.5 ACT. PRESS= 90 SOL. VALVE Cv= 2.26
MEDIA=AIR VALVE CV= 4742 HYDRO. TORQUE @ 70= 73. SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 756 SEAL TORQUE= 1183 Dstem= 1.25 Dgage= 11.703
BUILDING PRESSURE= 3.1

DEG.	10	20	30	40	50	60	70	80	90
LOCA TORQUE	1130	1073	756	31	-1061	-2311	-4729	-6776	-4404

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	2664	12993	-5924	-5614	756	454	90.00
0.05	1200	11023	-5924	-5614	756	454	90.00
0.10	47	10375	-5924	-5614	756	454	90.00
0.15	0	9442	-5924	-5614	756	454	90.00
0.20	0	11137	-4802	-7454	453	454	[illegible]
0.25	0	7776	-3331	-5353	453	454	67.23
0.30	0	4234	-2814	-2327	453	454	50.36
0.35	0	2905	-2598	-1116	453	454	39.51
0.40	0	2330	-2677	-610	453	454	32.24
0.45	0	2152	-2717	-343	453	454	26.70
0.50	0	2069	-2787	-189	453	454	22.14
0.55	0	2070	-2376	-102	453	454	18.22
0.60	0	2144	-2981	-71	453	454	14.73
0.65	0	2283	-3100	-93	453	454	11.53
0.70	0	2517	-3231	-194	453	454	8.61
0.75	0	3009	-3383	-533	453	454	5.73
0.80	0	3219	-3552	-882	779	454	2.77
0.85	0	2386	-3758	-1198	1616	454	0.10

CASE 4B

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME	.72 SCF	ACTUATOR YOKE RADIUS	2.5 IN.
ACTUATOR PRESSURE	80 PSIG	SOLENOID VALVE C_v	2.26
MEDIA	Air	VALVE C_v	4942
HYDRODYNAMIC TORQUE @ 90	761	SHUT OFF PRESSURE DROP	45 PSI
PACKING TORQUE	756 IN.LBS.	SEAL TORQUE	1183 IN.LBS.
STEM DIA.	1.75 IN.	GAGE DIA.	11.703 IN.
BUILDING PRESSURE	3.1 PSIG	dt	.05 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1180
20	1093
30	756
40	61
50	-1061
60	-2611
70	-4729
80	-6776
90	-4404

DETERMINATION OF CLOSING TIME

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 90	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 45

BUILDING PRESSURE= 3.1

DEG.	10	20	30	40	50	60	70	80	90
LOCA TORQUE	1190	1093	756	61	-1061	-2611	-4729	-6776	-4404

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	257	8475	-3488	-5939	756	454	70.00
0.05	0	7520	-3488	-5939	756	454	70.00
[illegible]	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]
0.15	0	3209	-2726	-1391	453	454	42.15
0.20	0	2502	-2675	-735	453	454	34.04
0.25	0	[illegible]	-2703	[illegible]	453	454	[illegible]
0.30	0	2087	-2765	-229	453	454	23.32
0.35	0	2053	-2850	-110	453	454	19.24
0.40	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]
0.45	0	2209	-3066	-51	453	454	12.39
0.50	0	2333	-3194	-102	453	454	9.39
[illegible]	0	[illegible]	-3337	[illegible]	453	454	[illegible]
0.60	0	3339	-3511	-784	453	454	3.61
0.65	0	2996	-3716	-1132	1497	454	0.66

APPENDIX E

Determination of the Closing Time of Valves AOV104, 105, 107, 110 & 111 in the Nonpreferred Direction with the Valve Opening Restricted to 70 Degrees

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Nonpreferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_v 2.26

MEDIA Air

VALVE C_v 6317

HYDRODYNAMIC TORQUE @ 90 1182

SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 832 IN.LBS.

SEAL TORQUE 1454 IN.LBS.

STEM DIA. 1.375 IN.

GAGE DIA. 12.974 IN.

BUILDING PRESSURE 3.1 PSIG

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0739	65.3	44.9
20	.0743	128.7	44.8
30	.0759	250.7	44.2
40	.0790	388.4	42.6
50	.0861	529.0	39.3
60	.0982	621.7	33.1
70	.124	645.5	20.7
80	.142	633.6	11.1
90	.149	628.1	6.92

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 3730	Tspring ending= [illegible]		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 6317	HYDRO. TORQUE @ 90= 1132	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 832	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= [illegible]
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0739	.0743	.0757	.0790	.0861	.0982	.1240	.1420	.1490
VELOCITY	65.3	128.7	250.7	388.4	[illegible]	621.7	[illegible]	633.6	629.1
PRES DROP	44.90	44.80	44.20	42.60	39.30	33.10	20.70	11.10	6.92

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	4510	8475	-3488	-1922	832	614	70.00	20.70
0.05	3555	7520	-3488	-1922	832	614	70.00	20.70
0.10	2303	[illegible]	-3488	-1922	832	614	70.00	20.70
0.15	2194	6158	-3488	-1922	832	614	70.00	20.70
0.20	1689	5654	-3488	-1922	832	614	70.00	20.70
0.25	[illegible]	5229	-3488	-1922	832	614	70.00	[illegible]
0.30	900	4865	-3488	-1922	832	614	70.00	20.70
0.35	586	4550	-3488	-1922	832	614	70.00	20.70
0.40	310	4275	-3488	-1922	832	614	70.00	20.70
0.45	67	4032	-3488	-1922	832	614	70.00	20.70
0.50	0	3815	-3488	-1922	832	614	70.00	20.70
0.55	0	[illegible]	[illegible]	[illegible]	499	614	[illegible]	[illegible]
0.60	0	2346	-2901	-557	499	614	55.33	35.99
0.65	0	1914	-2803	-224	499	614	49.47	39.47
0.70	0	1773	-2781	-123	499	614	[illegible]	[illegible]
0.75	0	1654	-2702	-65	499	614	40.03	42.58
0.80	0	1606	-2677	-42	499	614	35.84	43.26
0.85	0	[illegible]	[illegible]	[illegible]	499	614	[illegible]	[illegible]
0.90	0	1604	-2702	-15	499	614	28.18	44.30
0.95	0	1639	-2744	-8	499	614	24.55	44.52
1.00	0	[illegible]	[illegible]	[illegible]	499	614	[illegible]	[illegible]
1.05	0	1766	-2878	-2	499	614	18.16	44.91
1.10	0	1853	-2966	-1	499	614	15.17	44.84
1.15	0	1934	[illegible]	-0	499	614	[illegible]	[illegible]
1.20	0	2066	-3180	-0	499	614	9.69	44.90
1.25	0	2189	-3303	-0	499	614	7.19	44.92
1.30	0	2321	-3433	-0	499	614	[illegible]	[illegible]
1.35	0	1966	-3575	-0	994	614	2.65	44.97
1.40	0	1390	-3691	-0	1686	614	1.00	44.98

0392

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5430 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_v 2.26

MEDIA Air VALVE C_v 6317

HYDRODYNAMIC TORQUE @ 90 1182 SHUT OFF PRESSURE DROP 45 PSI

PACKING TORQUE 832 IN.LBS. SEAL TORQUE 1454 IN.LBS.

STEM DIA. 1.375 IN. GAGE DIA. 12.924 IN.

BUILDING PRESSURE 3.1 PSIG dt .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1413
20	1315
30	970
40	363
50	-522
60	-1693
70	-1106
80	50
90	7287

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible]

ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 6317	HYDRO. TORQUE @ 90= 1132	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= [illegible]	SEAL TORQUE= [illegible]	Dstem= [illegible]	[illegible]
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
LOCA TORQUE	1477	1565	1858	2333	2786	2367	1106	2170	7297

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	6092	8475	-3488	-340	832	614	70.00
0.10	4181	6564	-3488	-340	832	614	70.00
0.20	3035	[illegible]	[illegible]	-340	832	614	[illegible]
0.30	2254	4637	-3488	-340	832	614	70.00
0.40	1682	4065	-3488	-340	832	614	70.00
0.50	1242	[illegible]	-3488	-340	832	614	70.00
0.60	893	3276	-3488	-340	832	614	70.00
0.70	607	2990	-3488	-340	832	614	70.00
0.80	[illegible]	[illegible]	-3488	-340	832	614	[illegible]
0.90	168	2551	-3488	-340	832	614	70.00
1.00	0	2378	-3488	-340	832	614	70.00
1.10	0	1099	-3051	[illegible]	499	614	[illegible]
1.20	0	683	-2906	1108	499	614	55.51
1.30	0	475	-2840	1250	499	614	52.12
1.40	0	[illegible]	[illegible]	[illegible]	499	614	[illegible]
1.50	0	431	-2787	1241	499	614	47.53
1.60	0	517	-2772	1141	499	614	45.62
1.70	0	[illegible]	-2737	[illegible]	499	614	[illegible]
1.80	0	706	-2701	881	499	614	39.89
1.90	0	853	-2679	711	499	614	36.31
2.00	0	[illegible]	-2679	[illegible]	499	614	[illegible]
2.10	0	1268	-2711	329	499	614	27.19
2.20	0	1508	-2793	171	499	614	21.80
2.30	0	1734	-2933	[illegible]	499	614	[illegible]
2.40	0	1976	-3128	38	499	614	10.87
2.50	0	2819	-3369	-563	499	614	5.98
2.60	0	[illegible]	-3722	[illegible]	1804	614	[illegible]

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 45 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.783 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.10741	69.4	44.9
20	.10750	135.9	44.7
30	.10774	260.5	43.9
40	.10836	395.2	41.8
50	.10962	510.4	37.2
60	.120	558.7	27.9
70	.154	553.3	13.5
80	.164	575.6	8.39
90	.173	545.4	4.86

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= [illegible] Tspring ending [illegible]
ACT. VOL.= .72 ACT. YOKE RADIUS= 2.5 ACT. PRESS= 80 SOL. VALVE Cv= 2.26
MEDIA=AIR VALVE Cv= 4942 HYDRO. TORQUE @ 90= 761 SHUT-OFF PRES. DROP= 45
PACKING TORQUE= [illegible] SEAL TORQUE= [illegible] [illegible] [illegible]
BUILDING PRESSURE= 45

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0750	.0774	.0836	.0962	.1200	.1540	.1640	.1730
VELOCITY	[illegible]	135.7	250.5	375.2	510.4	[illegible]	[illegible]	[illegible]	[illegible]
PRES DROP	44.90	44.70	43.90	41.80	37.20	27.70	13.50	9.39	4.86

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	583	3857	-3488	-995	756	454	70.00	13.50
0.05	385	3659	-3488	-995	756	454	70.00	13.50
0.10	207	3481	-3488	-995	756	454	70.00	13.50
0.15	45	3320	-3488	-995	756	454	70.00	13.50
0.20	0	3173	-3488	-995	756	454	70.00	13.50
0.25	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.30	0	2444	-2949	-403	453	454	57.29	30.41
0.35	0	2097	-2827	-179	453	454	51.30	35.98
0.40	0	[illegible]	[illegible]	-87	453	454	[illegible]	[illegible]
0.45	0	1850	-2711	-46	453	454	40.93	41.36
0.50	0	1798	-2678	-27	453	454	36.24	42.58
0.55	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.60	0	1808	-2707	-9	453	454	27.65	44.02
0.65	0	1855	-2758	-4	453	454	23.73	44.40
0.70	0	1924	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.75	0	2014	-2921	-0	453	454	16.60	44.76
0.80	0	2120	-3028	-0	453	454	13.33	44.83
0.85	0	[illegible]	[illegible]	-0	453	454	[illegible]	[illegible]
0.90	0	2374	-3282	-0	453	454	7.57	44.92
0.95	0	2517	-3425	-0	453	454	5.00	44.94
1.00	0	[illegible]	[illegible]	-0	[illegible]	454	[illegible]	[illegible]
1.05	0	1775	-3710	-0	1480	454	0.73	44.99

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 3.1 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.703 IN.

dt .05 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0740	69.5	44.9
20	.0744	136.8	44.8
30	.0760	265.9	44.1
40	.0797	409.9	42.4
50	.0877	549.0	38.5
60	.102	633.8	31.6
70	.128	653.9	18.5
80	.135	700.5	11.9
90	.152	627.9	5.95

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= [illegible]	Tspring ending [illegible]		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= [illegible]	SEAL TORQUE= [illegible]	Dstem= [illegible]	Dgage= [illegible]
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0740	.0744	.0760	.0797	.0877	.1020	.1280	.1350	.1520
VELOCITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PRES DROP	44.90	44.80	44.10	42.40	33.50	31.60	13.50	11.70	5.95

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	5040	8475	-3488	-1156	756	454	70.00	18.50
0.05	4085	7520	-3488	-1156	756	454	70.00	18.50
0.10	[illegible]	[illegible]	-3488	-1156	756	454	70.00	18.50
0.15	2724	6158	-3488	-1156	756	454	70.00	18.50
0.20	2219	5654	-3488	-1156	756	454	70.00	18.50
0.25	1794	[illegible]	-3488	-1156	756	454	70.00	18.50
0.30	1431	4865	-3488	-1156	756	454	70.00	18.50
0.35	1116	4550	-3488	-1156	756	454	70.00	18.50
0.40	[illegible]	[illegible]	-3488	-1156	756	454	70.00	18.50
0.45	597	4032	-3488	-1156	756	454	70.00	18.50
0.50	381	3815	-3488	-1156	756	454	70.00	18.50
0.55	187	[illegible]	-3488	-1156	756	454	70.00	18.50
0.60	13	3447	-3488	-1156	756	454	70.00	18.50
0.65	0	3289	-3488	-1156	756	454	70.00	18.50
0.70	0	3025	-3134	[illegible]	453	454	[illegible]	[illegible]
0.75	0	2447	-2939	-416	453	454	56.88	33.74
0.80	0	2087	-2821	-174	453	454	50.86	37.90
0.85	0	[illegible]	[illegible]	[illegible]	453	454	[illegible]	[illegible]
0.90	0	1844	-2707	-45	453	454	40.53	42.19
0.95	0	1796	-2677	-27	453	454	35.36	43.10
1.00	0	1788	[illegible]	[illegible]	453	454	[illegible]	[illegible]
1.05	0	1811	-2710	-8	453	454	27.31	44.28
1.10	0	1860	-2764	-4	453	454	23.41	44.56
1.15	0	[illegible]	[illegible]	-1	453	454	[illegible]	[illegible]
1.20	0	2023	-2930	-0	453	454	16.32	44.83
1.25	0	2130	-3033	-0	453	454	13.12	44.86
1.30	0	[illegible]	[illegible]	-0	453	454	[illegible]	[illegible]
1.35	0	2386	-3294	-0	453	454	7.36	44.92
1.40	0	2530	-3438	-0	453	454	4.79	44.95
1.45	0	[illegible]	[illegible]	-0	[illegible]	454	[illegible]	[illegible]
1.50	0	1759	-3718	-0	1504	454	0.63	44.99

CASE YD

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW Non-preferred

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA Air

HYDRODYNAMIC TORQUE @ 90 761

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 3.1 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v 4942

SHUT OFF PRESSURE DROP 45 PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.703 IN.

dt .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)
10	1234
20	1113
30	855
40	1873
50	2209
60	1940
70	1111
80	1798
90	5174

DETERMINATION OF CLOSING TIME

[illegible]

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Tspring begin= 3930	Tspring ending= 2770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 90	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 756	SEAL TORQUE= 1103	Dstem= 1.25	Dyoke= [illegible]
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
LOCA TORQUE	1234	1113	855	1873	2209	1940	1111	1778	5174

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees
0.00	6097	8475	-3488	-99	756	454	70.00
0.10	4196	6564	-3488	-99	756	454	70.00
0.20	3040	5413	-3488	-99	756	454	70.00
0.30	2259	4637	-3488	-99	756	454	70.00
0.40	1687	4065	-3488	-99	756	454	70.00
0.50	1247	3625	-3488	-99	756	454	70.00
0.60	898	3276	-3488	-99	756	454	70.00
0.70	612	2990	-3488	-99	756	454	70.00
0.80	374	2752	-3488	-99	756	454	70.00
0.90	173	2551	-3483	-99	756	454	70.00
1.00	0	2373	-3488	-99	756	454	70.00
1.10	0	2227	-3488	-99	756	454	70.00
1.20	0	1541	-3072	623	453	454	61.27
1.30	0	1078	-2375	888	453	454	54.08
1.40	0	933	-2774	933	453	454	48.35
1.50	0	1050	-2750	792	453	454	43.36
1.60	0	1271	-2690	510	453	454	33.50
1.70	0	1704	-2873	-124	453	454	[illegible]
1.80	0	2042	-2763	-186	453	454	23.45
1.90	0	2087	-2750	-45	453	454	15.69
2.00	0	2327	-3171	-43	453	454	[illegible]
2.10	0	3276	-3430	-704	453	454	4.10

2975

APPENDIX F

Comparison of Actual to Calculated Closing Times

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721 C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW —

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 7770

ACTUATOR VOLUME .72 SCF

ACTUATOR PRESSURE 80 PSIG

MEDIA ____

HYDRODYNAMIC TORQUE @ 90 ____

PACKING TORQUE 832 IN.LBS.

STEM DIA. 1.375 IN.

BUILDING PRESSURE 0 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.26

VALVE C_v ____

SHUT OFF PRESSURE DROP ____ PSI

SEAL TORQUE 1454 IN.LBS.

GAGE DIA. 12.974 IN.

dt 0.1 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

[illegible]

THERE IS NO FLOW

Tspring begin= 5930 Tspring ending 3770
ACT. VOL.= .[illegible] ACT. YOKE RADIUS= 2.5 ACT. PRESS= 80 SOL. VALVE Cv= 2.26
PACKING TORQUE= 832 SEAL TORQUE= 1454 Dstem= 1.375 Dgage= 12.77
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	8424	13517	-5924	0	832	0	90.00	0.00
0.10	5254	10347	-5924	0	832	0	90.00	0.00
0.20	[illegible]	[illegible]	-5924	0	832	0	90.00	0.00
0.30	2146	7239	-5924	0	832	0	90.00	0.00
0.40	1237	6330	-5924	0	832	0	90.00	0.00
0.50	342	5334	-5924	0	832	0	90.00	0.00
0.60	0	5084	-5924	0	832	0	90.00	0.00
0.70	0	4017	-4517	0	499	0	81.52	0.00
0.80	0	3043	-3542	0	499	0	70.94	0.00
0.90	0	2498	-2997	0	499	0	58.78	0.00
1.00	0	2279	-2779	0	499	0	46.80	0.00
1.10	0	2173	-2676	0	499	0	35.17	0.00
1.20	0	2241	-2741	0	499	0	24.89	0.00
1.30	0	2437	-2937	0	499	0	16.10	0.00
1.40	0	2723	-3222	0	499	0	2.79	0.00
1.50	0	2689	-3565	0	876	0	2.79	0.00

POSI-SEAL INTERNATIONAL, INC.

VALVE ASSEMBLY CYCLE TEST REPORT

PSI VALVE SERIAL NO.		TRAVELER NO.	
19157-03A		83-19157-03-0100	
CUSTOMER	PURCHASE ORDER NO.	ITEM	TAG NO.
Stone+Webster	NMP2-P304D		2CPS*AOV104
OPERATOR TYPE	MANUFACTURER	SERIAL NO.	
N721C-SR80-M3HW	BETTIS	83-9021-3	

ACCESSORIES: as listed per spec. Sheet.

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 19157 T-5, REV.B

TEST CONDITIONS

1. Each valve shall be cycle tested with the specific actuator which will be shipped with that particular valve.
2. This test shall be performed after hydrostatic testing is completed and without further adjustment to packing.
3. Each valve shall be cycled, open and closed two (2) times with its actuator. The valve shall also be cycled once with the maximum working ~~differential~~ static pressure applied (= 150 PSIG). The time to open and close the valve shall not exceed three (3) minutes for valves with manual gear actuators.
4. During the cycle test, there shall be no binding or malfunctions.

S.W.E.C. PQA INSPECTED 207

TEST RESULTS

1. Failure Mode: F/C

2. Closed to Open: / Open to Closed:

Closed to Open		Open to Closed	
First time:	1.9 sec. (w/actuator)	First time:	1.7 sec. (w/actuator)
Second time:	1.8 sec. (w/actuator)	Second time:	1.7 sec. (w/actuator)
Third time:	1.7 sec. (w/ 150 PSIG)	Third time:	1.7 sec. (w/ N/A PSIG)
Fourth time:	60 sec. (Man. override)	Fourth time:	60 sec. (Man. override

3. During the cycle test, there shall be no binding or malfunctions.
4. The cycle test was performed and completed satisfactorily in accordance with all requirements per PSI Specification No. 19157-T5, Rev. B

NIAGARA MOHAWK POWER CORP
NINE MILE POINT NUC STA UNIT 2
P.O. NO. NMP2-P3040 JO NC 12177
BUTTERFLY VALVES - CATEGORY I
PAGE 51 TAG 2CPS*AOV104.......

GAGE #I-1091

TESTED BY	DATE	INSPECTED BY	DATE
E. ROSE	7/8/83	Stephen [signature]	7/8/83
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE
J.E. Donovan SWEC PQA	7-8-83		

F-3

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW —

ACTUATOR TORQUES (IN.LBS)

SPRING BEGINNING 5930 SPRING ENDING 3770

ACTUATOR VOLUME .72 SCF

ACTUATOR YOKE RADIUS 2.5 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_v 2.26

MEDIA ______

VALVE C_v ______

HYDRODYNAMIC TORQUE @ 90 ______

SHUT OFF PRESSURE DROP ______ PSI

PACKING TORQUE 756 IN.LBS.

SEAL TORQUE 1183 IN.LBS.

STEM DIA. 1.25 IN.

GAGE DIA. 11.703 IN.

BUILDING PRESSURE 0 PSIG

dt 0.1 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

[illegible]

THERE IS NO FLOW

Tspring begin= 5930   Tspring ending 3770
ACT. VOL.= .72   ACT. YOKE RADIUS= 2.5   ACT. PRESS= 30   SOL. VALVE C.= 2.26
PACKING TORQUE= 755   SEAL TORQUE= 1133   Dstem= 1.25   Dgage= [illegible]
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	8348	13517	-5924	0	756	0	90.00	0.00
0.10	5178	10347	-5924	0	756	0	90.00	0.00
0.20	3320	2487	-5924	0	756	0	90.00	0.00
0.30	2070	7239	-5924	0	756	0	90.00	0.00
0.40	1161	6330	-5924	0	756	0	90.00	0.00
0.50	466	5634	-5924	0	756	0	90.00	0.00
0.60	0	5034	-5924	0	756	0	90.00	0.00
0.70	0	4063	-4517	0	453	0	81.52	0.00
0.80	0	3080	-3333	0	453	0	70.79	0.00
0.90	0	2533	-2987	0	453	0	58.64	0.00
1.00	0	2321	-2775	0	453	0	46.24	0.00
1.10	0	2221	-2675	0	453	0	34.45	0.00
1.20	0	2300	-2753	0	453	0	24.04	0.00
1.30	0	2510	-2964	0	453	0	15.23	0.00
1.40	0	2810	-3263	0	453	0	[illegible]	0.00
1.50	0	2489	-3618	0	1128	0	2.02	0.00

F-5

POSI-SEAL INTERNATIONAL, INC.

VALVE ASSEMBLY CYCLE TEST REPORT

PSI VALVE SERIAL NO.		TRAVELER NO.	
19157- 4A		83-19157-04	
CUSTOMER	PURCHASE ORDER NO.	ITEM	TAG NO.
Stone + Webster	NMP2-P304D		2CPS AOV107
OPERATOR TYPE	MANUFACTURER	SERIAL NO.	
N721C-SR80-M3HW	BETTIS	83-9021-8	

ACCESSORIES: as listed per spec. sheet.

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 19157 T-5, REV. B

TEST CONDITIONS

1. Each valve shall be cycle tested with the specific actuator which will be shipped with that particular valve.
2. This test shall be performed after hydrostatic testing is completed and without further adjustment to packing.
3. Each valve shall be cycled, open and closed two (2) times with its actuator. The valve shall also be cycled once with the maximum working ~~differential~~ pressure applied (= 150 PSIG). The time to open and close the valve shall not exceed three (3) minutes for valves with manual gear actuators.
4. During the cycle test, there shall be no binding or malfunctions.

S.W.E.C. PQA INSPECTED-207

TEST RESULTS

1. Failure Mode: FAIL CLOSED

2. Closed to Open: / Open to Closed:

Closed to Open:		Open to Closed:	
First time:	2.1 sec. (w/actuator)	First time:	1.7 sec. (w/actuator)
Second time:	2.0 sec. (w/actuator)	Second time:	1.7 sec. (w/actuator)
Third time:	2.2 sec. (w/ 150 PSIG)	Third time:	2.0 sec. (w/ N/A PSIG)
Fourth time;	24 sec. (man. override)	Fourth time:	21 sec. (man. override)

3. During the cycle test, there shall be no binding or malfunctions.
4. The cycle test was performed and completed satisfactorily in accordance with all requirements per PSI Specification No. 19157-T5, Rev. B

NIAGARA MOHAWK POWER CORP
NINE MILE POINT NUC STA UNIT 2
P.O. NO. NMP2-P3040 JO NO 12177
BUTTERFLY VALVES - CATEGORY I
PAGE 21 TAG 2CPS*AOV107

Posi-Seal International, Inc.
Rts. 49 & U.S. 95
North Stonington, Conn. 06359

I-1091

TESTED BY	DATE	INSPECTED BY	DATE
John Robbins	7-11-83	Jude Burdiak	7-11-83
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE
J. C. Donovan S&W PQA	7-11-83		

F-6

APPENDIX G

Seismic and LOCA Stress Analysis

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE:	14"
VALVE CLASS:	150
ACTUATOR:	N721C - SR80 - M3HW
CUSTOMER:	Niagara Mohawk
P.O. NO.:	NMP2- P304N / 12177
SPEC. NO.:	NMP2- P304N and Add #1, #2 & #3
REFERENCE NO.:	19157
ITEM NO.:	3 AOV 106

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-3	REV.	B
B.	BODY DWG. NO.	1114-302	REV.	A
C.	DISC DWG. NO.	2114-301	REV.	B
D.	STEM DWG. NO.	2510-015	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-197	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE:	45	PSI
TEMPERATURE:	340	DEG. F.

VALVE TORQUES

LOCA TORQUE:	6170 Case 1A	IN-LBS
MEDIA:	Air	
FLOW DIRECTION:	Preferred	

G-LOADINGS

TRANSVERSE:	4
VERTICAL:	3
LONGITUDINAL:	3

SIZE 14" CLASS 150

DIMENSIONAL DATA

ACTUATOR N721C-CC80-

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	9.438	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	1.375	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	61	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.125	Di	B5
STEM DIA.	1.375	D1	D1
GAGE DIA. OF DISC	12.974	D	D
WIDTH SMALL DIA. BACK OF DISC	1.906	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
THRUST WASHER THICKNESS	.316	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.604	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	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.	.498	dp	D5
VALVE BODY O.D.	21	d1	D8
VALVE BODY WATERWAY DIA.	13.312	R7	R7
ADJACENT PIPING O.D.	14	R8	R8
ADJACENT PIPING I.D.	13.126	R9	R9
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	"	A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

14 CLASS 150 VALVE ASSEMBLY
[illegible]

CUSTOMER:NIAGARA MOHAWK
[illegible]
SPEC.NO.:NMP2-P;304D
REF.NO.:19157
ITEM NO.:3

REFERENCE DWGS.
A.ASSY DWG.NO.:19157-3 REV.B
B.BODY DWG.NO.:1114-302 REV.A
C.DISC DWG.NO.:2114-301 REV.B
D.STEM DWG.NO.:2510-015 REV.A
E.PIN DWG.NO. :2600-060 REV.A
F.BRACKET DWG.NO.8000-197 REV.-

ALLOWABLE STRESSES (PSI)
A.BODY: 23400
B.STEM: 52800
C.PIN: 52800
D.BRACKET: 18900
E.BOLTING: 37500

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(F)= 340

LOCA FORCE= 3170
MEDIA=AIR
FLOW DIRECTION=PREFERRED

G LOADINGS
TRANSVERSE= 4
VERTICAL= 3
LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 1.375	W1= 219	W2= 27
W4= 31	T1= .375	T2= 5	T3= 7	T4= 3	T9= .75	T0= .625
d3= 0	Di= 2.125	D1= 1.375	D= 12.974	E1= 1.906	E2= .313	
L2= .316	Y2= 1.604	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 5	X8= 2	T5= 9.72	R3= 0	R2= 0	
Z= 65	dp= .498	d1= 21	R7= 13.312	R8= 14	R9= 13.126	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 85 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 575 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.
LATERAL DISC/STEM= 604 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 9901 PSI
TENSILE= 3471 PSI
COMBINED= 15019 PSI VS.ALLOW.= 37500

SHEAR= 8315 PSI
TENSILE= 17010 PSI
COMBINED= 20400 PSI VS.ALLOW= 37500

SHEAR= 638 PSI
TENSILE= 3667 PSI
COMBINED= 3765 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 917 PSI
TENSILE= 1234 PSI
COMBINED= 1722 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 12087 PSI
TENSILE= 4460 PSI
COMBINED= 14922 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 14808 PSI VS.ALLOW= 31680

SECTION MODULUS
VALVE= 762.38 IN↑3
PIPING= 61.22 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 3.83100000E-03 INCHES
VERTICAL= 8.30000000E-05 INCHES
TRANSVERSE= 2.19000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED..John G. Langan.....DATED..6/12/87......

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C - SRKO - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2- P304N / 12177
SPEC. NO.: NMP2- P304N and Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 3 AOV 104

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-3	REV.	B
B.	BODY DWG. NO.	1114-302	REV.	A
C.	DISC DWG. NO.	2114-301	REV.	B
D.	STEM DWG. NO.	2510-015	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-197	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 7339 Case 1B IN-LBS
MEDIA: Air
FLOW DIRECTION: Non preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 14" CLASS 150

DIMENSIONAL DATA

ACTUATOR N721C-SR80-

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	9.438	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.188	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	1.375	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	61	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.575	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.125	Di	B5
STEM DIA.	1.375	D1	D1
GAGE DIA. OF DISC	12.974	D	D
WIDTH SMALL DIA. BACK OF DISC	1.906	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
THRUST WASHER THICKNESS	.316	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.604	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	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.	.499	dp	D5
VALVE BODY O.D.	21	d1	D8
VALVE BODY WATERWAY DIA.	13.312	R7	R7
ADJACENT PIPING O.D.	14	R8	R8
ADJACENT PIPING I.D.	13.126	R9	R9
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS	11	N3	N3
DBC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

14 CLASS 150 VALVE ASSEMBLY
[illegible]

CUSTOMER:NIAGARA MOHAWK
P.O.NO.:NMP2-[illegible]
SPEC.NO.:NMP2-P;3040
REF.NO.:19157
ITEM NO.:3

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASSY DWG.NO.:19157-3 REV.B	A.BODY: 23400
B.BODY DWG.NO.:1114-302 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2114-301 REV.B	C.PIN: 52800
D.STEM DWG.NO.:2510-[illegible] REV.A	D.BRACKET: 18900
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.3000-197 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(F)= 340

	G LOADINGS
LOCA TORQUE= 7339	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=NONPREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 1.375	W1= 219	W2= 27
W4= 31	T1= .375	T2= 5	T3= 7	T4= 3	T9= .75	T0= .525
d3= 0	Di= 2.125	D1= 1.375	O= 12.974	E1= 1.906	E2= .813	
L2= .316	Y2= 1.604	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 5	X8= 2	T5= 7.75	R5= 0	R3= 0	
%= 65	dp= .498	d1= 21	R7= 13.312	R8= 14	R9= 13.126	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 85 VS. 33HZ.	SHEAR= 10372 PSI
VERTICAL(Y) ACT./VALVE= 276 VS. 33HZ.	TENSILE= 14097 PSI
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 17018 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8362 PSI	SHEAR= 621 PSI
TENSILE= 18314 PSI	TENSILE= 3887 PSI
COMBINED= 21557 PSI VS.ALLOW= 37500	COMBINED= 3983 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 969 PSI	SHEAR= 14378 PSI
TENSILE= 1284 PSI	TENSILE= 4427 PSI
COMBINED= 1806 PSI VS.ALLOW= 23400	COMBINED= 14761 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 17314 PSI VS.ALLOW= 31680	VALVE= 762.38 IN↑3
	PIPING= 61.22 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 3.83100000E-03 INCHES	NOT APPLICABLE
VERTICAL= 1.11000000E-04 INCHES	
TRANSVERSE= 1.80000000E-03 INCHES	

SIGNED..[signature]........DATED..6/11/81......

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2 - P304 N / 12177
SPEC. NO.: NMP2 - P304 N and Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 3 AOV 108

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-3	REV.	B
B.	BODY DWG. NO.	1114-302	REV.	A
C.	DISC DWG. NO.	2114-301	REV.	B
D.	STEM DWG. NO.	2510-015	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-197	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA 351 GR CF8M	23400	PSI
B.	STEM	SA 564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA 564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 5848 Case 2A IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 4
VERTICAL: 3
LONGITUDINAL: 3

SIZE 14" CLASS 150

DIMENSIONAL DATA

ACTUATOR N721C-SR80-

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	8.438	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	1.375	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	61	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.125	Di	B5
STEM DIA.	1.375	D1	D1
GAGE DIA. OF DISC	13.924	D	D
WIDTH SMALL DIA. BACK OF DISC	1.906	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
THRUST WASHER THICKNESS	.316	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.604	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	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.	.498	dp	D5
VALVE BODY O.D.	21	d1	D8
VALVE BODY WATERWAY DIA.	13.312	R7	R7
ADJACENT PIPING O.D.	14	R8	R8
ADJACENT PIPING I.D.	13.126	R9	R9
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	↓	A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
~~NUCLEAR SEISMIC ANALYSIS~~

14 CLASS 150 VALVE ASSEMBLY
~~[illegible] ACTUATOR~~

CUSTOMER:NIAGARA MOHAWK
~~P.O.NO.:NMP2-P304O/12277~~
SPEC.NO.:NMP2-P:3040
REF.NO.:19157
~~ITEM NO.:[illegible]~~

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
~~A.ASS'Y DWG.NO.:17127-3 REV.B~~	~~A.BODY: 23400~~
B.BODY DWG.NO.:1114-302 REV.A	B.STEM: 52900
C.DISC DWG.NO.:2114-301 REV.B	C.PIN: 52900
~~D.STEM DWG.NO.:2510-015 REV.A~~	~~D.BRACKET: 18900~~
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.8000-197 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
~~TEMPERATURE(F)= 340~~

	G LOADINGS
~~LOCA TORQUE= 3848~~	~~TRANSVERSE= 4~~
MEDIA=AIR	VERTICAL= 3
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 1.375	W1= 219	W2= 27
~~W4= 21~~	~~T1= .375~~	~~T2= 3~~	~~T3= 7~~	~~T4= 3~~	~~T7= .75~~	~~T8= .625~~
d3= 0	Di= 2.125	D1= 1.375	D= 12.974	E1= 1.906	E2= .813	
L2= .316	Y2= 1.604	N1= 4	A1= .1416	X6= 4.5	N2= 4	
~~A2= .1416~~	~~X7= 5~~	~~X8= 2~~	~~T5= 9.75~~	~~R5= 0~~	~~R6= [illegible]~~	
Z= 65	dp= .498	d1= 21	R7= 13.312	R8= 14	R9= 13.126	
L= 0	T= 0	G= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 35 VS. 33HZ.	SHEAR= 9650 PSI
~~VERTICAL(Y) ACT./VALVE= 376 VS. 33HZ.~~	~~TENSILE= 8491 PSI~~
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 14733 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8107 PSI	SHEAR= 629 PSI
~~TENSILE= 17010 PSI~~	~~TENSILE= 3574 PSI~~
COMBINED= 20255 PSI VS.ALLOW= 37500	COMBINED= 3701 PSI VS.ALLOW= 18900

~~VALVE NECK STRESSES~~	~~STEM STRESSES~~
SHEAR= 396 PSI	SHEAR= 11456 PSI
TENSILE= 1234 PSI	TENSILE= 4460 PSI
~~COMBINED= 1705 PSI VS.ALLOW= 23400~~	~~COMBINED= 13902 PSI VS.ALLOW= 52900~~

DISC PIN STRESS	SECTION MODULUS
~~SHEAR= 14035 PSI VS.ALLOW= 31330~~	~~VALVE= 752.38 IN^3~~
	PIPING= 61.22 IN^3

~~ACTUATOR DEFLECTIONS~~	~~BODY BOLTING~~
LONGITUDINAL= 3.83100000E-03 INCHES	NOT APPLICABLE
VERTICAL= 8.30000000E-05 INCHES	
~~TRANSVERSE= 2.10000000E-03 INCHES~~	

SIGNED...[signature].......DATED..6/11/87.......

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2- P304N / 12177
SPEC. NO.: NMP2- P304N and Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 3 AOV 110

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-3	REV.	B
B.	BODY DWG. NO.	1114-302	REV.	A
C.	DISC DWG. NO.	2114-301	REV.	B
D.	STEM DWG. NO.	2510-015	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-197	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 9584 Case 2B IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 3
LONGITUDINAL: 4

SIZE 14" CLASS 150

DIMENSIONAL DATA

ACTUATOR N721C-SR80-A

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	9.438	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	1.375	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	61	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	7	T3	T3
THICKNESS OF VALVE NECK	3	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.125	Di	B5
STEM DIA.	1.375	D1	D1
GAGE DIA. OF DISC	12.974	D	D
WIDTH SMALL DIA. BACK OF DISC	1.906	E1	E1
WIDTH LARGE DIA. OF DISC	.813	E2	E2
THRUST WASHER THICKNESS	.316	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.604	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1415	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	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.	.498	dp	D5
VALVE BODY O.D.	21	d1	D8
VALVE BODY WATERWAY DIA.	13.312	R7	R7
ADJACENT PIPING O.D.	14	R8	R8
ADJACENT PIPING I.D.	13.126	R9	R9
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	↓	A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

14 CLASS 150 VALVE ASSEMBLY
WITH [illegible] ACTUATOR

CUSTOMER:NIAGARA MOHAWK
P.O.NO.:NMP2-P3040-12177
SPEC.NO.:NMP2-P;3040
REF,NO.:19157
ITEM NO.:3

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-3 REV.5	A.BODY: 23400
B.BODY DWG.NO.:1114-302 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2114-301 REV.B	C.PIN: 52800
D.STEM DWG.NO.:2510-015 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.8000-197 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(F)= 340

	G LOADINGS
LOCA TORQUE= 7534	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 3
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 4

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 1.375	W1= 219	W2= 27
d4= 61	T1= .375	T2= 5	T3= 7	fw= 3	T7= .75	T0= 7625
d3= 0	Di= 2.125	D1= 1.375	D= 12.974	E1= 1.906	E2= .813	
L2= .316	Y2= 1.604	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 4	X8= 2	T5= 9.75	K5= 0	K6= 0	
Z= 65	dp= .498	d1= 21	R7= 13.312	R8= 14	R9= 13.126	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 85 VS. 33HZ.	SHEAR= 13259 PSI
VERTICAL(Y) ACT./VALVE= 576 VS. 33HZ.	TENSILE= 3491 PSI
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 18168 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 10333 PSI	SHEAR= 782 PSI
TENSILE= 19933 PSI	TENSILE= 4736 PSI
COMBINED= 24240 PSI VS.ALLOW= 37500	COMBINED= 5105 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 1261 PSI	SHEAR= 18776 PSI
TENSILE= 1431 PSI	TENSILE= 4460 PSI
COMBINED= 2138 PSI VS.ALLOW= 23400	COMBINED= 21130 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 23002 PSI VS.ALLOW= 31580	VALVE= 752.38 IN↑3
	PIPING= 61.22 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 5.10800000E-03 INCHES	NOT APPLICABLE
VERTICAL= 8.30000000E-05 INCHES	
TRANSVERSE= 1.50000000E-03 INCHES	

SIGNED....[signature]......DATED....6/19/84.....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N761C - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D-12177
SPEC. NO.: NMP2-P304D & Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 4 AOV 107

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-4	REV.	A
B.	BODY DWG. NO.	1112-301	REV.	A
C.	DISC DWG. NO.	2112-301	REV.	A
D.	STEM DWG. NO.	2510-013	REV.	A
E.	PIN DWG. NO.	7600-060	REV.	A
F.	BRACKET DWG. NO.	8000-199	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18500	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 3998 Case 3A IN-LBS
MEDIA: Air
FLOW DIRECTION: Nonpreferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

ACTUATOR U721C-3R80-M3HL

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	8.438	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	2.665	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	26	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	3.182	T3	T3
THICKNESS OF VALVE NECK	0	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	2.875	d3	Do
PACKING BORE I.D.	1.255	Di	B5
STEM DIA.	1.247	D1	D1
GAGE DIA. OF DISC	11.703	D	D
WIDTH SMALL DIA. BACK OF DISC	1.625	E1	E1
WIDTH LARGE DIA. OF DISC	.938	E2	E2
THRUST WASHER THICKNESS	.305	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.557	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	3.182	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	3.182	X8	X8
LENGTH OF BRACKET	9.75	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.	.309	dp	D5
VALVE BODY O.D.	15.0	d1	D8
VALVE BODY WATERWAY DIA.	12.062	R7	R7
ADJACENT PIPING O.D.	12.75	R8	R8
ADJACENT PIPING I.D.	11.938	R9	R9
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	〃	A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	〃	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY
WITH [illegible] ACTUATOR

CUSTOMER:NIAGARA MOHAWK
P.O.NO.NMP2-P3040/12177
SPEC.NO.:NMP2-P;3040
REF.NO.:19157
ITEM NO.:4

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:[illegible] REV.A	A.BODY: 23400
B.BODY DWG.NO.:1112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 52800
D.STEM DWG.NO.:2510-013 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.8000-199 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(°F)= [illegible]

	G LOADINGS
LOCA TORQUE= 3978	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=NONPREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 23	T1= .875	T2= 3	T3= 3.182	T4= 0	T9= .75	T0= .025
d3= 2.875	Di= 1.755	D1= 1.247	D= 11.703	E1= 1.625	E2= .933	
L2= .305	Y2= 1.557	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 3.182	X8= 3.182	T5= 0.75	R5= 0	R6= 0	
%= 65	dp= .309	d1= 15	R7= 12.062	R8= 12.75	R9= 11.938	
L= 0	T= 0	B= 1	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 62 VS. 33HZ.	SHEAR= 7786 PSI
VERTICAL(Y) ACT./VALVE= 456 VS. 33HZ.	TENSILE= 10897 PSI
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.	COMBINED= 14795 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8368 PSI	SHEAR= 529 PSI
TENSILE= 17832 PSI	TENSILE= 3227 PSI
COMBINED= 21162 PSI VS.ALLOW= 37500	COMBINED= 3313 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 2976 PSI	SHEAR= 10500 PSI
TENSILE= 8782 PSI	TENSILE= 4526 PSI
COMBINED= 9340 PSI VS.ALLOW= 23400	COMBINED= 13008 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 22977 PSI VS.ALLOW= 31330	VALVE= 192.79 IN↑3
	PIPING= 47.09 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 7.08900000E-03 INCHES	NOT APPLICABLE
VERTICAL= 1.77000000E-04 INCHES	
TRANSVERSE= 5.60000000E-03 INCHES	

SIGNED....[signature]........DATED....4/27/87.....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7LLC - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D-12177
SPEC. NO.: NMP2-P304D & Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 4 AOV 109

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-4	REV.	A
B.	BODY DWG. NO.	1113-301	REV.	A
C.	DISC DWG. NO.	2113-301	REV.	A
D.	STEM DWG. NO.	2510-013	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-199	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1025	52800	PSI
C.	PIN	SA564 GR 630 cond H1025	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 3330 Case 4A IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

DIMENSIONAL DATA

ACTUATOR H721C-3A80-M3HL

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	8.439	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	2.665	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	26	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	3.182	T3	T3
THICKNESS OF VALVE NECK	0	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	2.875	d3	Do
PACKING BORE I.D.	1.755	Di	B5
STEM DIA.	1.247	D1	D1
GAGE DIA. OF DISC	11.703	D	D
WIDTH SMALL DIA. BACK OF DISC	1.625	E1	E1
WIDTH LARGE DIA. OF DISC	.938	E2	E2
THRUST WASHER THICKNESS	.305	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.557	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	3.182	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	3.182	X8	X8
LENGTH OF BRACKET	9.75	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.	.309	dp	D5
VALVE BODY O.D.	15.0	d1	D8
VALVE BODY WATERWAY DIA.	12.062	R7	R7
ADJACENT PIPING O.D.	12.75	R8	R8
ADJACENT PIPING I.D.	11.939	R9	R9
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	〃	A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	1	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY

[illegible]

CUSTOMER:NIAGARA MOHAWK
P.O.NO.:NMP2-304D/12177
SPEC.NO.:NMP2-P;304D
REF,NO,:19157
ITEM NO.: 1

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASSY DWG.NO.:19157-? REV.A	A.BODY: 23400
B.BODY DWG.NO.:1112-301 REV.A	B.STEM: 52900
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 52900
D.STEM DWG.NO.:2610-013 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.2000-199 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(°F)= 340

	G LOADINGS
LOAD TORQUE= 3330	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W3= 23	T1= .875	T2= 6	T3= 3.182	T4= 0	T7= .75	T9= .625
d3= 2.875	Di= 1.755	D1= 1.247	D= 11.703	E1= 1.625	E2= .938	
L2= .305	Y2= 1.557	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 3.182	X8= 3.182	T5= 7.75	R5= 0	R6= 0	
Z= 65	do= .309	di= 15	R7= 12.062	R8= 12.75	R9= 11.938	
L= 0	T= 0	B= 1	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 62 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 155 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.
LATERAL DISC/STEM= 906 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 7273 PSI
TENSILE= 10397 PSI
COMBINED= 14376 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 7855 PSI
TENSILE= 17852 PSI
COMBINED= 20817 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 511 PSI
TENSILE= 3097 PSI
COMBINED= 3179 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 2709 PSI
TENSILE= 8782 PSI
COMBINED= 9351 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 8746 PSI
TENSILE= 4526 PSI
COMBINED= 11297 PSI VS.ALLOW= 52900

DISC PIN STRESS
SHEAR= 19138 PSI VS.ALLOW= 31090

SECTION MODULUS
VALVE= 192.79 IN↑3
PIPING= 47.09 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 7.08900000E-03 INCHES
VERTICAL= 1.77000000E-04 INCHES
TRANSVERSE= 5.30000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED..*John L. Kortyan*....DATED..*1/13/84*......

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7LLC - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D-12177
SPEC. NO.: NMP2-P304D & Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 5 AOV 105

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-5	REV.	C
B.	BODY DWG. NO.	1112-301	REV.	A
C.	DISC DWG. NO.	2112-301	REV.	A
D.	STEM DWG. NO.	2510-013	REV.	A
E.	PIN DWG. NO.	2600-060	REV.	A
F.	BRACKET DWG. NO.	8000-199	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 cond H1075	52800	PSI
D.	BRACKET	CS	18500	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 75 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 4485 Case 3B IN-LBS
MEDIA: Air
FLOW DIRECTION: Non-preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

ACTUATOR N721C-SR80-A

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	8.438	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.688	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	2.665	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	26	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	6.5	T3	T3
THICKNESS OF VALVE NECK	2.939	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	1.755	Di	B5
STEM DIA.	1.247	D1	D1
GAGE DIA. OF DISC	11.703	D	D
WIDTH SMALL DIA. BACK OF DISC	1.625	E1	E1
WIDTH LARGE DIA. OF DISC	.938	E2	E2
THRUST WASHER THICKNESS	.305	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.557	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	3.4	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.309	dp	D5
VALVE BODY O.D.	16.0	d1	D8
VALVE BODY WATERWAY DIA.	13.062	R7	R7
ADJACENT PIPING O.D.	12.75	R8	R8
ADJACENT PIPING I.D.	11.938	R9	R9
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		A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY
WITH [illegible] ACTUATOR

CUSTOMER:NIAGARA MOHAWK
P.O.NO.:[illegible]
SPEC.NO.:NMP2-P;3040
REF.NO.:19157
ITEM NO.:[illegible]

REFERENCE DWGS.
A.ASS'Y DWG.NO.:[illegible] REV.[illegible]
B.BODY DWG.NO.:1112-302 REV.A
C.DISC DWG.NO.:2112-301 REV.A
D.STEM DWG.NO.:[illegible] REV.A
E.PIN DWG.NO. :2600-060 REV.A
F.BRACKET DWG.NO.8000-199 REV.-

ALLOWABLE STRESSES (PSI)
A.BODY: 23400
B.STEM: 52800
C.PIN: 52800
D.BRACKET: 18900
E.BOLTING: 37500

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(F)= [illegible]

LOCK TORQUE= [illegible]
MEDIA=AIR
FLOW DIRECTION=NONPREFERRED

G LOADINGS
TRANSVERSE= 3
VERTICAL= 4
LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.688	X2= 3.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 25	T1= .375	T2= 5	T3= 3.5	T4= [illegible]	T7= .75	T6= .225
d3= 0	Di= 1.755	D1= 1.247	D= 11.703	E1= 1.625	E2= .933	
L2= .305	Y2= 1.557	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= [illegible]	X7= 5	X8= 2	T5= 7.75	R5= [illegible]	R6= [illegible]	
Z= 65	dp= .309	d1= 16	R7= 12.062	R8= 12.75	R9= 11.938	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 78 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= [illegible] VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.
LATERAL DISC/STEM= 906 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 8162 PSI
TENSILE= [illegible] PSI
COMBINED= 15107 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 8337 PSI
TENSILE= [illegible] PSI
COMBINED= 25495 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 543 PSI
TENSILE= [illegible] PSI
COMBINED= 3443 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 1380 PSI
TENSILE= 2578 PSI
COMBINED= [illegible] PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 11779 PSI
TENSILE= 4526 PSI
COMBINED= [illegible] PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= [illegible] PSI VS.ALLOW= [illegible]

SECTION MODULUS
VALVE= [illegible] IN↑3
PIPING= 47.09 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 4.45400000E-03 INCHES
VERTICAL= 1.16000000E-04 INCHES
TRANSVERSE= [illegible] INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED..[signature]..........DATED...1/19/87.....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7U1C - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D-12177
SPEC. NO.: NMP2-P304D & Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 5 AOV111

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-5	REV.	C
B.	BODY DWG. NO.	1112-301	REV.	A
C.	DISC DWG. NO.	2112-301	REV.	A
D.	STEM DWG. NO.	2510-013	REV.	A
E.	PIN DWG. NO.	7600-060	REV.	A
F.	BRACKET DWG. NO.	8000-199	REV.	—

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 cond H1075	52800	PSI
D.	BRACKET	CS	18500	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 6776 Case 4B IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

ACTUATOR N721C-SR80-A

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	2.688	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	8.438	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.685	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	2.665	X5	X5
ACTUATOR WEIGHT	219	W1	W4
BRACKET WEIGHT	27	W2	W5
DISC WEIGHT	26	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	6.5	T3	T3
THICKNESS OF VALVE NECK	2.939	T4	T4
THICKNESS OF BRACKET SIDE PLATES	.75	T9	T9
THICKNESS OF BRACKET TOP PLATE	.625	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	1.755	Di	B5
STEM DIA.	1.247	D1	D1
GAGE DIA. OF DISC	11.703	D	D
WIDTH SMALL DIA. BACK OF DISC	1.625	E1	E1
WIDTH LARGE DIA. OF DISC	.938	E2	E2
THRUST WASHER THICKNESS	.305	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.557	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	.1416	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	9.75	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	3.4	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1	R6	R6
% TORQUE ON DISC PIN	65	%	T7
DISC PIN DIA.	.309	dp	D5
VALVE BODY O.D.	16.0	d1	D8
VALVE BODY WATERWAY DIA.	12.062	R7	R7
ADJACENT PIPING O.D.	12.75	R8	R8
ADJACENT PIPING I.D.	11.938	R9	R9
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		A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
~~NUCLEAR SEISMIC ANALYSIS~~

12 CLASS 150 VALVE ASSEMBLY

CUSTOMER:NIAGARA MOHAWK
~~P.O.NO.: [illegible]~~
SPEC.NO.:NMP2-P;304D
REF,NO.:19157
~~ITEM NO.:5~~

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
~~A:ASS'Y DWG.NO.:19157-5 REV.0~~	~~A.BODY: 23400~~
B.BODY DWG.NO.:1112-302 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 52900
~~D.STEM DWG.NO.: [illegible] REV.A~~	~~D.BRACKET: 19900~~
E.PIN DWG.NO. :2600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.8000-199 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
~~TEMPERATURE(F)= 340~~

	G LOADINGS
~~LOCA TORQUE= 3776~~	~~TRANSVERSE= 3~~
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.688	X2= 8.438	X3= 3.689	X4= 6	X5= 2.665	W1= 219	W2= 27
~~W4= 25~~	~~T1= .375~~	~~T2= 3~~	~~T3= 3.3~~	~~T4= 2.938~~	~~T9= .75~~	~~T0= [illegible]~~
d3= 0	Di= 1.755	D1= 1.247	D= 11.703	E1= 1.625	E2= .938	
L2= .305	Y2= 1.557	N1= 4	A1= .1416	X6= 4.5	N2= 4	
~~A2= .1413~~	~~X7= 5~~	~~X8= 2~~	~~T5= 9.75~~	~~R5= 3.4~~	~~R6= 2~~	
Z= 65	dp= .309	d1= 16	R7= 12.062	R8= 12.75	R9= 11.938	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 78 VS. 33HZ.	SHEAR= 9935 PSI
~~VERTICAL(Y) ACT./VALVE= 533 VS. 33HZ.~~	~~TENSILE= 10697 PSI~~
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.	COMBINED= 16632 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 9838 PSI	SHEAR= 605 PSI
~~TENSILE= 22749 PSI~~	~~TENSILE= 3809 PSI~~
COMBINED= 26431 PSI VS.ALLOW= 37500	COMBINED= 3903 PSI VS.ALLOW= 19900

~~VALVE NECK STRESSES~~	~~STEM STRESSES~~
SHEAR= 1640 PSI	SHEAR= 17796 PSI
TENSILE= 2578 PSI	TENSILE= 4526 PSI
~~COMBINED= 3376 PSI VS.ALLOW= 23400~~	~~COMBINED= 29203 PSI VS.ALLOW= 52800~~

DISC PIN STRESS	SECTION MODULUS
~~SHEAR= 38943 PSI VS.ALLOW= 31580~~	~~VALVE= 272.23 IN†3~~
	PIPING= 47.09 IN†3

~~ACTUATOR DEFLECTIONS~~	~~BODY BOLTING~~
LONGITUDINAL= 4.45400000E-03 INCHES	NOT APPLICABLE
VERTICAL= 1.16000000E-04 INCHES	
~~TRANSVERSE= 1.30000000E-03 INCHES~~	

SIGNED.....[signature]..DATED...6/19/87....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7216 - SR8D - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D-12177
SPEC. NO.: NMP2-P304D & Add #1, #2 & #3
REFERENCE NO.: 19157
ITEM NO.: 5 AOV111

REFERENCE DWGS.

A.	ASS'Y DWG. NO.	19157-5	REV.	C
B.	BODY DWG. NO.	1112-301	REV.	B
C.	DISC DWG. NO.	2112-301	REV.	A
D.	STEM DWG. NO.	2510-013	REV.	A
E.	PIN DWG. NO.	7600-060	REV.	A
F.	BRACKET DWG. NO.	8000-199	REV.	-

ALLOWABLE STRESSES

A.	BODY	SA351 GR CF8M	23400	PSI
B.	STEM	SA564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA564 GR 630 Cond H1075	52800	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 4729 @ 70 Case 4B IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 7
LONGITUDINAL: 3

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY
WITH [illegible] ACTUATOR

CUSTOMER:NIAGARA MOHAWK
P.O.NO.:NMP2-P3040/[illegible]
SPEC.NO.:NMP2-P;3040
REF.NO.:19157
ITEM NO.:[illegible]

REFERENCE DWGS.
A.ASS'Y DWG.NO.:19157-3 REV.C
B.BODY DWG.NO.:1112-302 REV.A
C.DISC DWG.NO.:2112-301 REV.A
D.STEM DWG.NO.:2510-013 REV.A
E.PIN DWG.NO. :2600-060 REV.A
F.BRACKET DWG.NO.8000-199 REV.-

ALLOWABLE STRESSES (PSI)
A.BODY: 23400
B.STEM: 52800
C.PIN: 52800
D.BRACKET: 18900
E.BOLTING: 37500

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE(F)= 340

LOCA TORQUE= 4729
MEDIA=AIR
FLOW DIRECTION=PREFERRED

G LOADINGS
TRANSVERSE= 3
VERTICAL= 4
LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.638	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 25	T1= .375	T2= 3	T3= 8.5	T4= 2.938	T9= .75	T0= .625
d3= 0	Di= 1.755	D1= 1.247	D= 11.703	E1= 1.625	E2= .938	
L2= .305	Y2= 1.557	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 5	X8= 2	T5= 9.75	[illegible]	R4= 1	
%= 65	dp= .309	d1= 16	R7= 12.062	R8= 12.75	R9= 11.938	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 78 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 585 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.
LATERAL DISC/STEM= 906 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 8350 PSI
TENSILE= 10597 PSI
COMBINED= 15265 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 3497 PSI
TENSILE= 22739 PSI
COMBINED= 25590 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 549 PSI
TENSILE= 3404 PSI
COMBINED= 3492 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 1408 PSI
TENSILE= 2578 PSI
COMBINED= 3199 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 12420 PSI
TENSILE= 4526 PSI
COMBINED= 14000 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 27179 PSI VS.ALLOW= 31680

SECTION MODULUS
VALVE= 272.23 IN↑3
PIPING= 47.09 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 4.45400000E-03 INCHES
VERTICAL= 1.16000000E-04 INCHES
TRANSVERSE= 1.30000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED....[signature]....DATED..6/14/84.....

APPENDIX H

Miscellaneous Calculations

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title Determination of Flow ΔP's with Valve Angle = 70° Page 4-1
Calc. By J. [signature] 7/16/84 Checked By

12" Valves @ 70°

$P_1 = 15.7$ psia

$Q = 1300$ SCFM = 78000 SCFH

$G = 1$ $Z = 1$ $T = 150°F$

$C_v @ 70° = 3113$ $X_T @ 70 = .42$ $F_K = 1$

VALVE SIZE= 12 IN. CLASS=150

~~Q= 78000~~ ~~Cv= 3113~~ ~~P1= 15.7~~ ~~Fp= 1~~
Fk= 1 Xt= .42 G= 1 'F= 150 Z= 1

~~DELTA P= 0.0132 PSI~~

@ 90°

$C_v @ 90° = 4942$ $X_T @ 90 = .33$

~~VALVE SIZE= 12 IN. CLASS=150~~

Q= 78000 Cv= 4942 P1= 15.7 Fp= 1
~~Fk= 1~~ ~~Xt= .33~~ ~~G= 1~~ ~~'F= 150~~ ~~Z= 1~~

DELTA P= 0.0052 PSI

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title ______ Page H-2
Calc. By [signature] 7/16/84 Checked By ______

14" Values @ 70°

P_1 = 15.7 psia
Q = 2200 SCFM = 132000 SCFH
G = 1 Z = 1 T = 150 °F
C_v @ 70° = 3979 X_T @ 70 = .42 F_K = 1

VALVE SIZE= 14 IN. CLASS=150

Q= 132000	Cv= 3979	P1= 15.7	Fp= 1	
Fk= 1	Xt= .42	G= 1	'F= 150	Z= 1

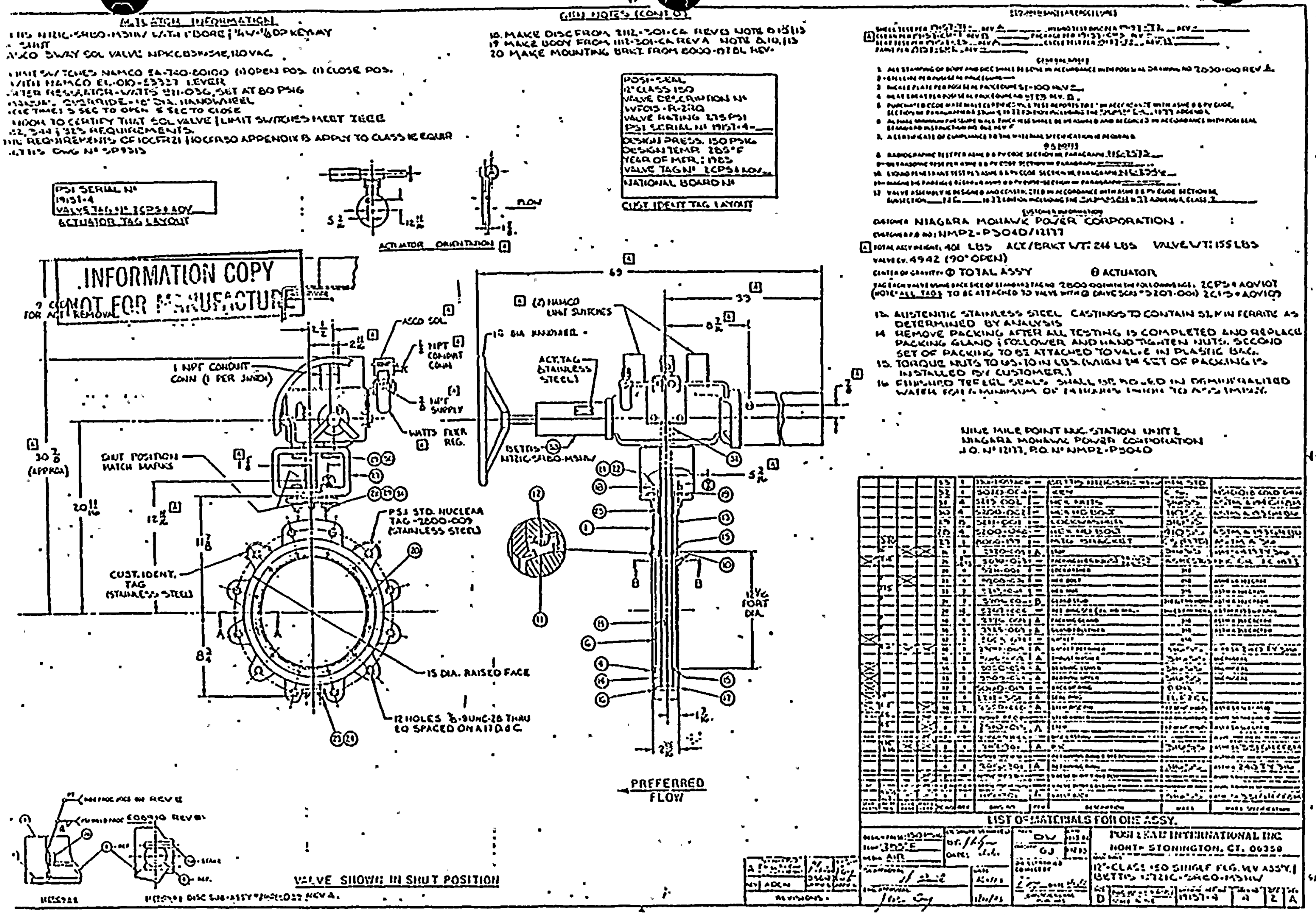
DELTA P= 0.0232 PSI

@ 90°
C_v @ 90° = 6317 X_T @ 90° = .33

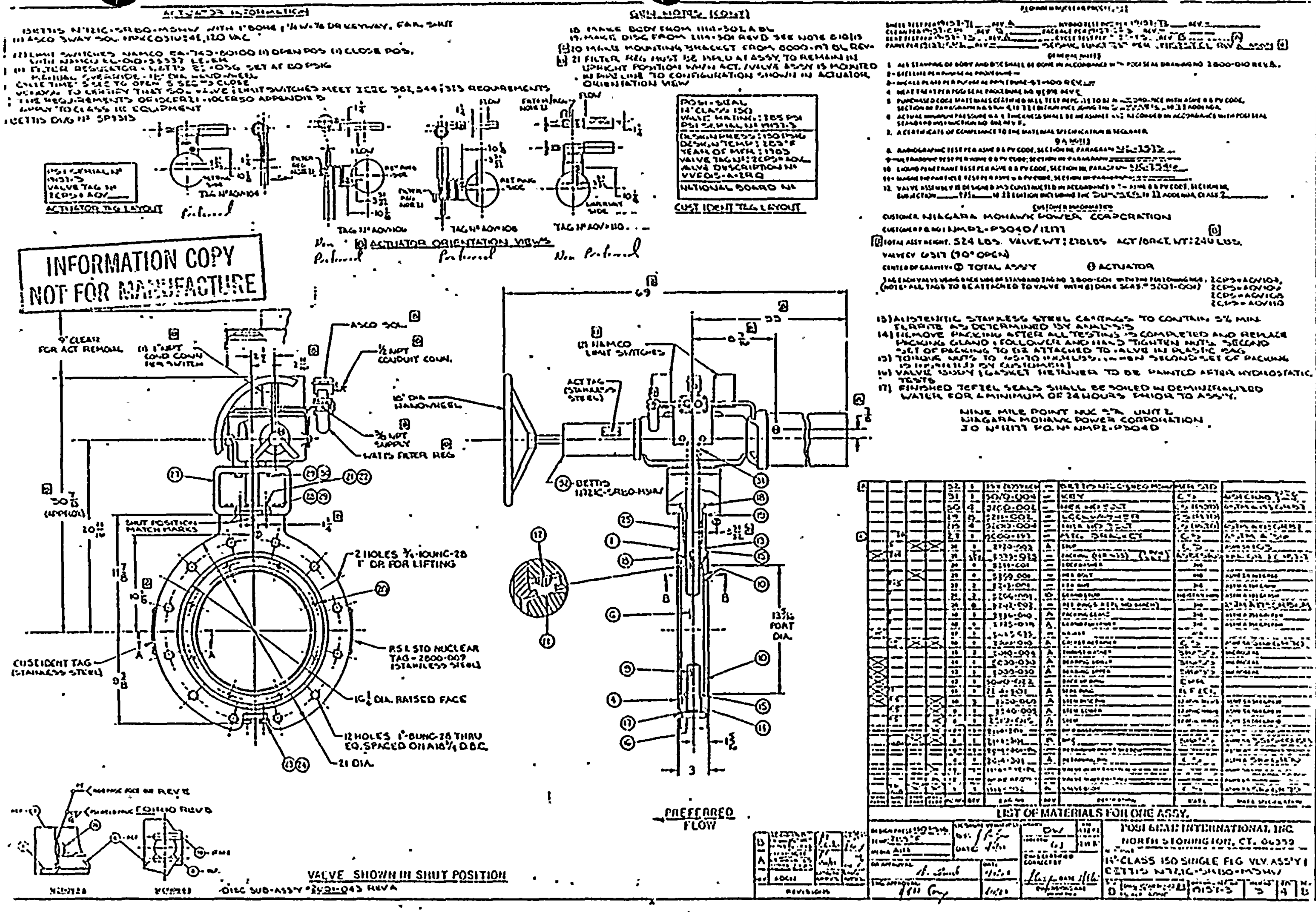
VALVE SIZE= 14 IN. CLASS=150

~~Q= 132000~~	~~Cv= 6317~~	~~P1= 15.7~~	~~Fp= 1~~	
Fk= 1	Xt= .33	G= 1	'F= 150	Z= 1

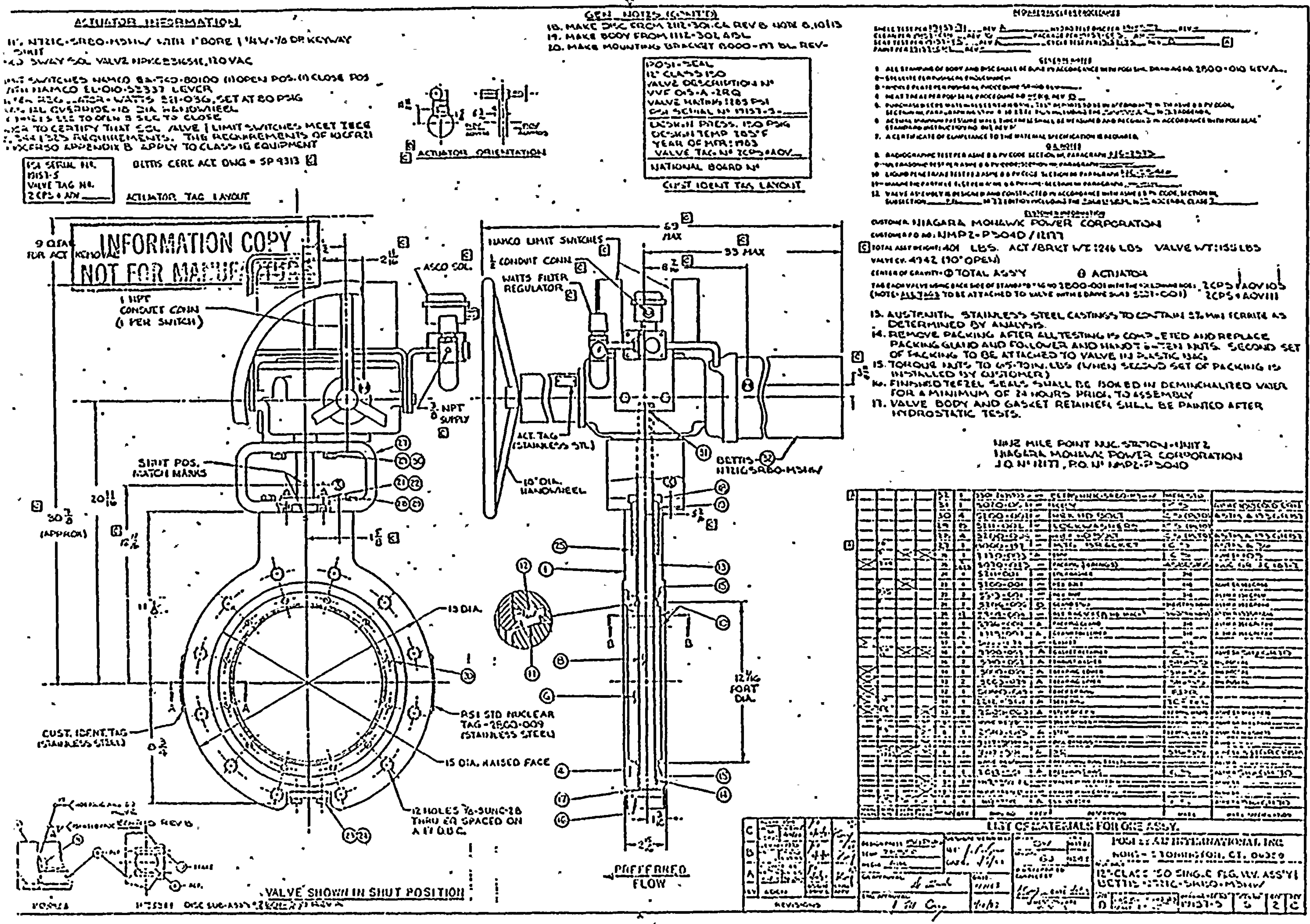
~~DELTA P= 0.0091 PSI~~



GEN. NOTES (CONT'D)
10. MAKE DISC FROM 3112-201-CA REV B NOTE 6,13,15
19. MAKE BODY FROM 1113-201-CA REV A NOTE 6,10,15
20. MAKE MOUNTING BRKT FROM 2000-178L REV-
POSI-SEAL
12" CLASS 150
DESIGN PRESS. 150 PSIG
DESIGN TEMP. 205°F
YEAR OF MFR.: 1985
NATIONAL BOARD Nº
CUST IDENT TAG LAYOUT
PSI SERIAL Nº
19151-4
ACTUATOR TAG LAYOUT
ACTUATOR ORIENTATION
FLOW
INFORMATION COPY
NOT FOR MANUFACTURE
ASCO SOL
1 NPT CONDUIT CONN (1 PER SWITCH)
WATTS FLTR REG.
SHUT POSITION MATCH MARKS
PSI STD. NUCLEAR TAG -2000-009 (STAINLESS STEEL)
CUST. IDENT. TAG (STAINLESS STEEL)
15 DIA. RAISED FACE
12 HOLES 7/8-9UNC-2B THRU EQ SPACED ON A 17.0 BC
(2) NAMCO LIMIT SWITCHES
18 DIA HANDWHEEL
ACT. TAG (STAINLESS STEEL)
BETTIS
PREFERRED FLOW
VALVE SHOWN IN SHUT POSITION
CUSTOMER NIAGARA MOHAWK POWER CORPORATION
NMP2-P5040/12177
TOTAL ASSY WEIGHT: 401 LBS ACT/BRKT WT: 214 LBS VALVE WT: 155 LBS
VALVE Cv 4942 (90° OPEN)
CENTER OF GRAVITY: TOTAL ASSY ACTUATOR
13. AUSTENITIC STAINLESS STEEL CASTINGS TO CONTAIN 5% MIN FERRITE AS DETERMINED BY ANALYSIS
14. REMOVE PACKING AFTER ALL TESTING IS COMPLETED AND REPLACE PACKING GLAND, FOLLOWER AND HAND TIGHTEN NUTS. SECOND SET OF PACKING TO BE ATTACHED TO VALVE IN PLASTIC BAG.
15. TORQUE NUTS TO 65-70 IN LBS. (WHEN 2ND SET OF PACKING IS INSTALLED BY CUSTOMER.)
NINE MILE POINT NUC. STATION UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. Nº 12177, P.O. Nº NMP2-P5040
LIST OF MATERIALS FOR ONE ASSY.
POSI-SEAL INTERNATIONAL INC.
NORTH STONINGTON, CT. 06359
12"-CLASS 150 SINGLE FLG. VLV ASSY.
BETTIS
19151-4



ACTUATOR INFORMATION
GEN. NOTES (CONT)
INFORMATION COPY
NOT FOR MANUFACTURE
ACTUATOR TAG LAYOUT
ACTUATOR ORIENTATION VIEWS
CUST IDENT TAG LAYOUT
NIAGARA MOHAWK POWER CORPORATION
9" CLEAR FOR ACT REMOVAL
ASCO SOL
1/2 NPT CONDUIT CONN.
3/8 NPT SUPPLY
WATTS FILTER REG
SHUT POSITION MATCH MARKS
2 HOLES 3/4-10UNC-2B 1" DP. FOR LIFTING
CUST IDENT TAG (STAINLESS STEEL)
RSL STD NUCLEAR TAG-2800-009 (STAINLESS STEEL)
16 1/4 DIA. RAISED FACE
12 HOLES 1"-8UNC-2B THRU EQ. SPACED ON A 18 3/4 D.B.C.
21 DIA.
10" DIA. HANDWHEEL
ACT TAG (STAINLESS STEEL)
(2) NAMCO LIMIT SWITCHES
PORT DIA.
PREFERRED FLOW
VALVE SHOWN IN SHUT POSITION
NINE MILE POINT NUC. STA. UNIT 2
NIAGARA MOHAWK POWER CORPORATION
LIST OF MATERIALS FOR ONE ASSY.
POSI-SEAL INTERNATIONAL INC
NORTH STONINGTON, CT. 06359
14" CLASS 150 SINGLE FLG VLV. ASS'Y


ACTUATOR INFORMATION
BETTIS CERT ACT DWG = SP 9313
ACTUATOR TAG LAYOUT
GEN. NOTES (CONT'D)
ACTUATOR ORIENTATION
POSI-SEAL
12" CLASS 150
VALVE DESCRIPTION No
DESIGN PRESS. 150 PSIG
DESIGN TEMP. 185°F
YEAR OF MFR: 1983
NATIONAL BOARD No
CUST IDENT TAG LAYOUT
CUSTOMER NIAGARA MOHAWK POWER CORPORATION
CUSTOMER P.O. NO. NMP2-P504D/1177
CENTER OF GRAVITY: ⊕ TOTAL ASS'Y ⊖ ACTUATOR
2CPS*AOV105
2CPS*AOV111
13. AUSTENITIC STAINLESS STEEL CASTINGS TO CONTAIN 5% MIN FERRITE AS DETERMINED BY ANALYSIS.
14. REMOVE PACKING AFTER ALL TESTING IS COMPLETED AND REPLACE PACKING GLAND AND FOLLOWER AND HAND TIGHTEN NUTS. SECOND SET OF PACKING TO BE ATTACHED TO VALVE IN PLASTIC BAG.
15. TORQUE NUTS TO 65-70 IN. LBS (WHEN SECOND SET OF PACKING IS INSTALLED BY CUSTOMER)
16. FINISHED TEFZEL SEALS SHALL BE SOAKED IN DEMINERALIZED WATER FOR A MINIMUM OF 24 HOURS PRIOR TO ASSEMBLY
17. VALVE BODY AND GASKET RETAINER SHALL BE PAINTED AFTER HYDROSTATIC TESTS.
NINE MILE POINT NUC. STATION - UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. No 1177, P.O. No NMP2-P504D
INFORMATION COPY
NOT FOR MANUFACTURE
9 CLEAR FOR ACT REMOVAL
ASCO SOL.
NAMCO LIMIT SWITCHES
1/2 CONDUIT CONN.
WATTS FILTER REGULATOR
69 MAX
53 MAX
1 NPT CONDUIT CONN (1 PER SWITCH)
3/8 NPT SUPPLY
ACT. TAG (STAINLESS STL)
10" DIA. HANDWHEEL
BETTIS N712C-SR80-M3HW
SHUT POS. MATCH MARKS
30 7/8 (APPROX)
13 DIA.
PSI STD NUCLEAR TAG -2500-009 (STAINLESS STEEL)
CUST. IDENT. TAG (STAINLESS STEEL)
15 DIA. RAISED FACE
12 HOLES 7/8-9UNC-2B THRU EQ SPACED ON 17 B.C.
12 1/16 PORT DIA.
VALVE SHOWN IN SHUT POSITION
PREFERRED FLOW
LIST OF MATERIALS FOR ONE ASSY.
POSI-SEAL INTERNATIONAL INC.
NORTH STONINGTON, CT. 06359
12" CLASS 150 SINGLE FLG. VLV. ASS'Y
REVISIONS

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

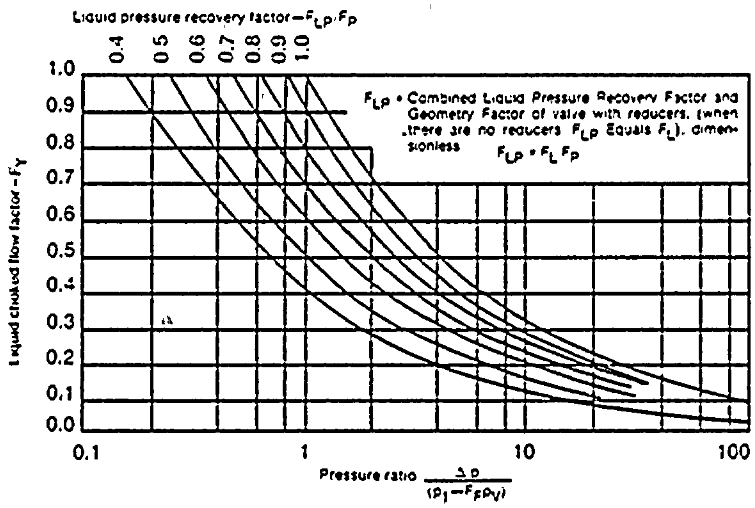
The flow coefficient or C_V of a valve is used to describe its inherent flow capacity. This value is defined as the number of U.S. gallons of water per minute at standard conditions (60°F and 14.7PSIA) that will flow thru a valve at a constant 1.0PSI pressure drop. Accordingly, a C_V value based on extensive 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:

$$C_{vp} = KD^2$$

WHERE:

D = ID of pipe equal to valve size, inches

K = Refer to Fig. 2

FIGURE 2

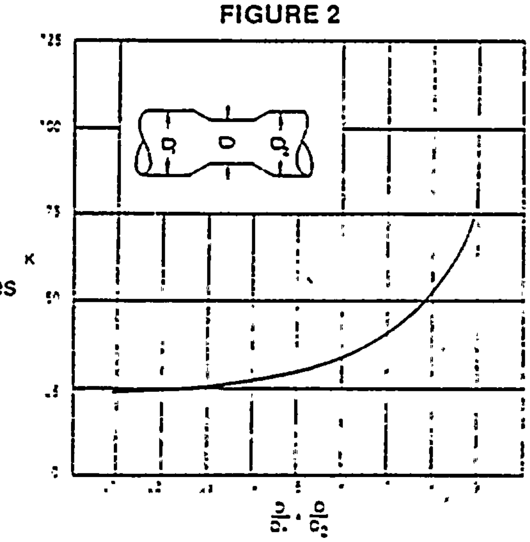


FIGURE 4

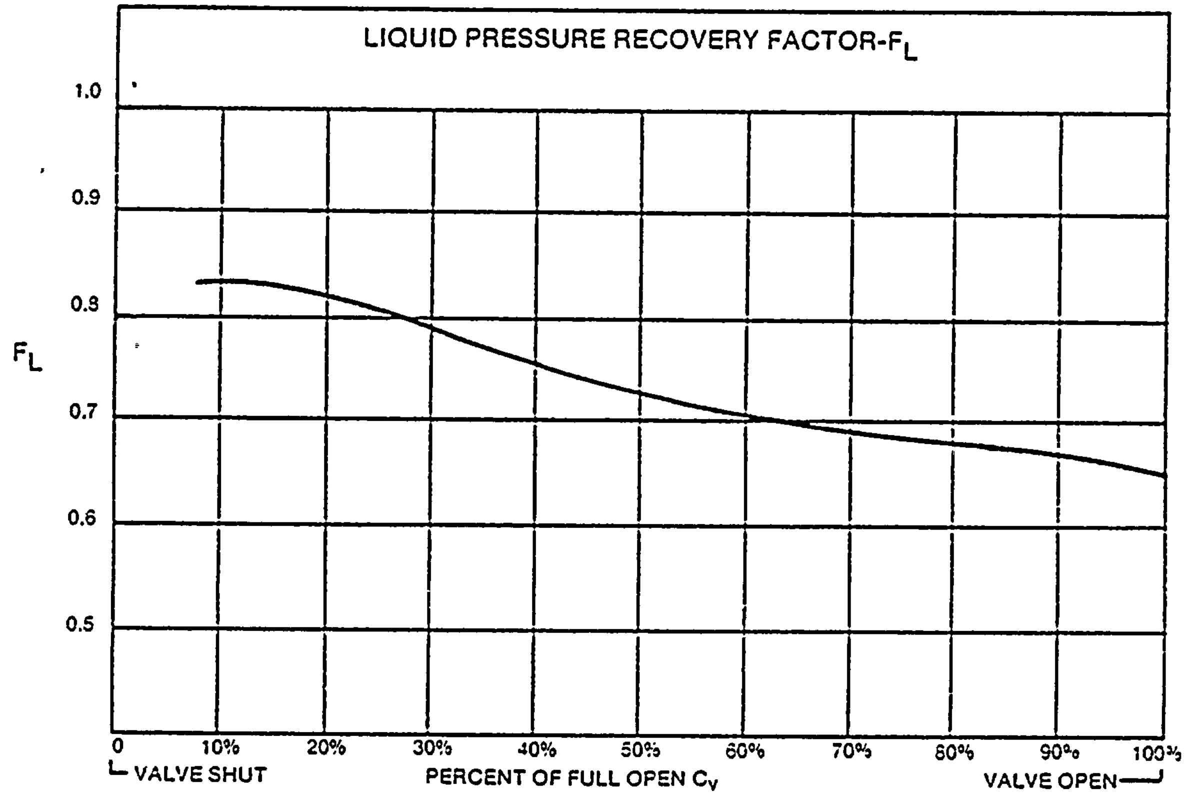
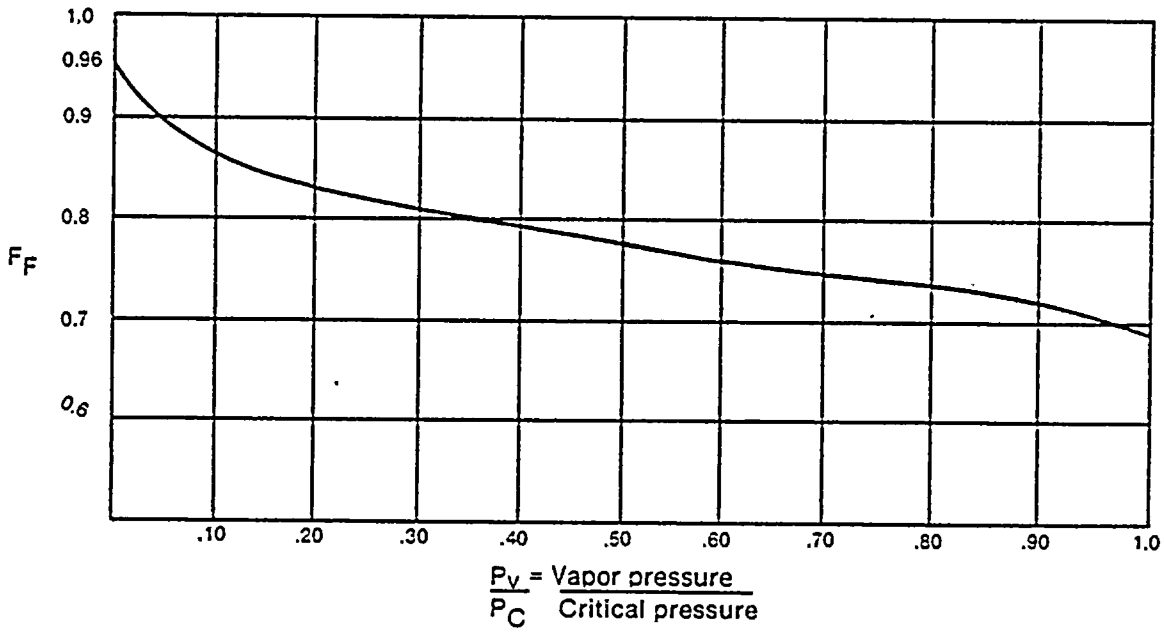


FIGURE 5



CRITICAL FLOW

$$Q_{MAX} = 907.12\, F_P C_V P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}$$

OR

$$C_{V\,MIN} = \frac{Q}{907.12\, F_P P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}}$$

$$\Delta P_c = F_K X_T P_1$$

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.

ΔP_c = 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

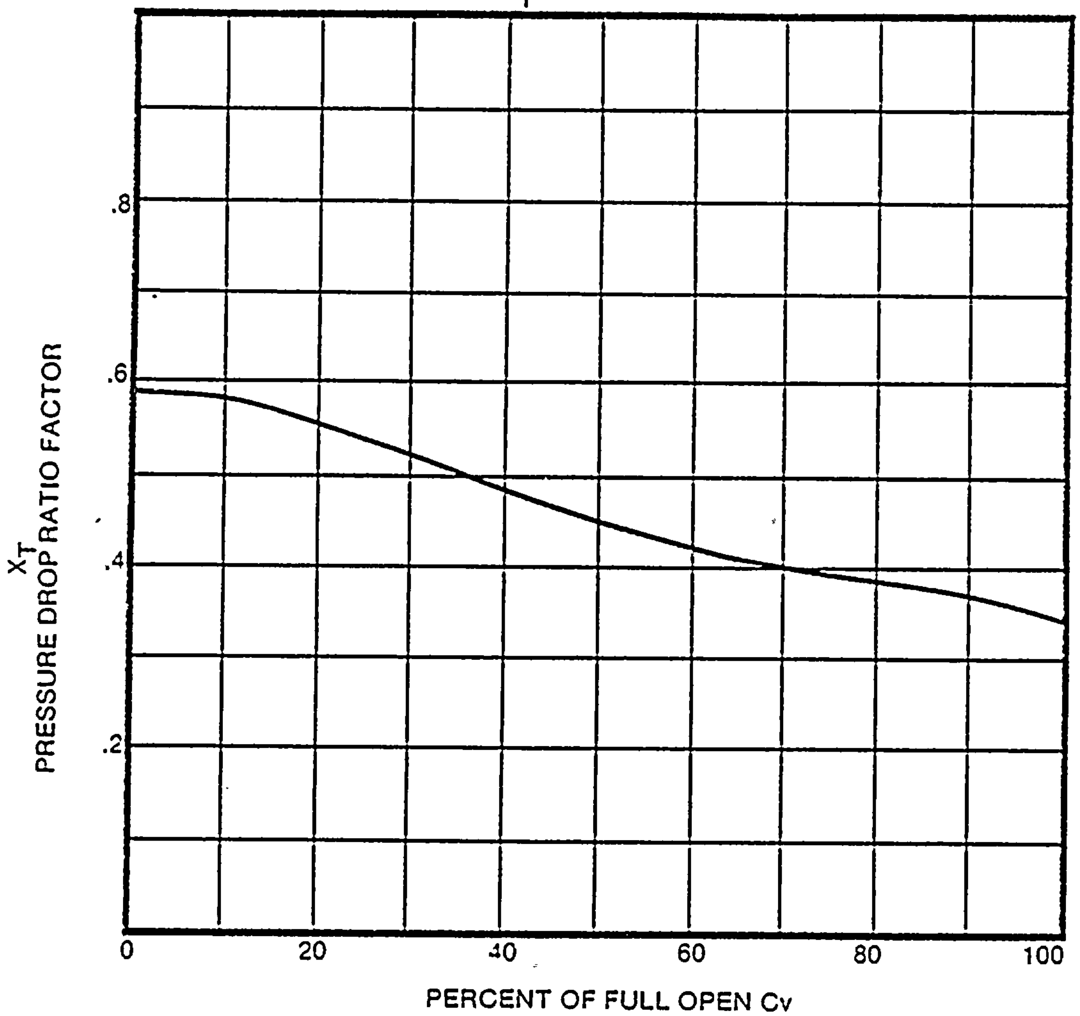


TABLE 1

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 60°F/60°F	GAS @ 60°F AIR=1
Acetic Acid	$HC_2H_3O_2$	60.05	245		612	841	1.05	
Acetic Anhydride	$(CH_3CO)_2O$	102.09	283			576		1.08
Acetone	C_3H_6O	58.08	133		455	691	0.79	2.01
Acetylene	C_2H_2		-119		97	911	0.62	0.91
Air	N_2O_2	28.97	-317		-221	547	0.86	1.0
Alcohol, Ethyl	C_2H_6O	46.07	173	2.3[1]	470	925	0.794	1.59
Alcohol, Methyl	CH_4O	32.04	148	4.63[1]	463	1174	0.796	1.11
Ammonia	NH_3	17.03	-28	114	270	1636	0.62	0.59
Aniline	C_6H_7N	93.12	365		798	770	1.02	
Argon	A	39.94	-302		-188	705	1.65	1.38
Benzene	C_6H_6	78.11	176	3.22[1]	552	714	0.88	2.69
Bromine	Br_2	159.83	138		575	1485	2.93	5.52
Butadiene	$CH_2CHCH:CH_2$	54.09	24			627		0.65
n-Butane	C_4H_{10}	58.12	31	51.6[1]	308	550	0.58	2.0
Butyl Alcohol	$C_2H_5CH_2CH_2OH$	74.12	232			711		2.55
Carbon Dioxide	CO_2	44.01	-109	835	88	1072	.80	1.52
Carbon Monoxide	CO	28.01	-314		-220	507	0.80	0.97
Carbon Tetrachloride	CCL_4	153.84	170		542	661	1.59	5.31
Chlorine	CL_2	70.91	-30	53	291	1119	1.42	2.48
Dowtherm A						454	0.85[2]	
Dowtherm E						383	[illegible][3]	
Ethane	C_2H_6	30.07	-127		90	709	0.37	1.05
Ethyl Chloride	C_2H_5CL	64.52	55			2750	0.9	2.22
Ethylene	C_2H_4	28.05	-155		48	742		0.97
Ethyl Ether	$C_4H_{10}O$				387	522		2.56
Fluorine	F_2	38.00	-305	300	-200	809	1.11	1.31
Helium	He	4.003	-454		-450	33	0.18	0.14
Hydrochloric Acid	HCL	36.47	-115				1.64	
Hydrogen	H_2	2.016	-422		-400	188	0.07	0.07
Hydrogen Chloride	HCL	36.47	-115	613	125	1198	0.86	1.26
Hydrogen Sulfide	H_2S	34.07	-76	252	213	1306	0.79	1.17
Isobutane	C_4H_{10}	58.12	11	72.2	274	529	0.56	2.01
Isopropyl Alcohol	C_3H_8O	60.09	180		455	779	0.78	2.08
Methane	CH_4	16.04	-258		-116	673	0.30	0.55
Methyl Chloride	CH_3CL	50.49	-11	80	290	967	0.99	1.74
Naphthalene	$C_{10}H_8$	128.16	424				1.14	4.43
Nitric Acid	HNO_3	63.02	187				1.5	
Nitrogen	N_2	28.02	-320		-233	492	0.81	0.97
n-Octane	C_8H_{18}	114.23	258	0.54[1]	564	362	0.71	3.94
Oxygen	O_2	32.00	-297		-181	730	1.14	1.105
n-Pentane	C_5H_{12}	72.15	96	15[1]	386	485	0.63	2.49
Phenol	C_6H_5OH	94.11	358		786	889	1.07	
Phosphoric Acid	H_3PO_4	98.00	415				1.83	
Propane	C_3H_8	44.10	-44	190[1]	206	617	0.51	1.52
Propylene	$CH_3CH:CH_2$	42.08	-54		198	661		0.61
Proplyl Alcohol	$CH_3CH_2CH_2OH$	60.09	208			735		0.80
Proplyl Chloride	$CH_3CH_2CH_2CL$	78.54	115			664		0.89
Refrigerant 11	CCL_3F	137.38	75	13.4	388	635		5.04
Refrigerant 12	CCL_2F_2	120.93	-22	71.2	234	597		4.2
Refrigerant 21	$CHCL_2F$	102.93	48	8.4	353	750		3.82
Refrigerant 22	$CHCLF_2$	86.48	-41	122.5	205	715		
Styrene	C_8H_8	104.15	293	0.22[1]	706	580	0.91	3.59
Sulfur Dioxide	SO_2	64.06	14	54.4	316	1142	1.39	2.21
Toluene	C_7H_8	92.14	231	1.03[1]	605	611	0.87	3.13
Water	H_2O	18.016	212	0.95	706	3206.2	1.00	0.62

1. Vapor Pressure in PSIA @ 100°F
2. Specific Gravity @ 494.3°F.
3. Specific Gravity @ 350.4°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	1.004	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		

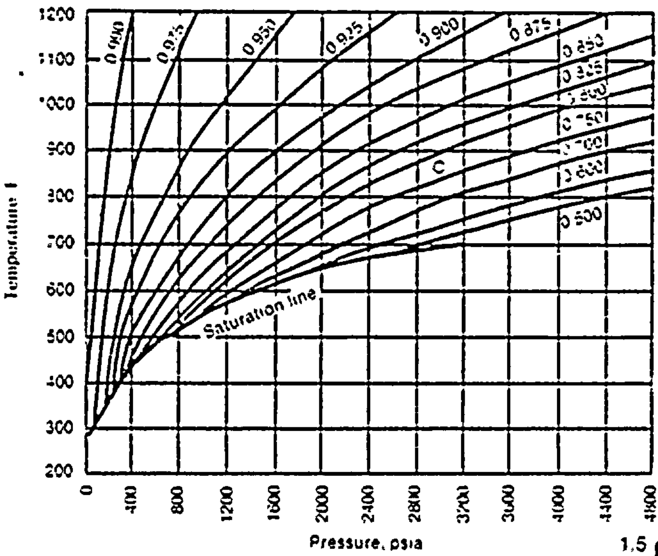


FIGURE 10
COMPRESSIBILITY FACTORS
FOR SUPERHEATED STEAM

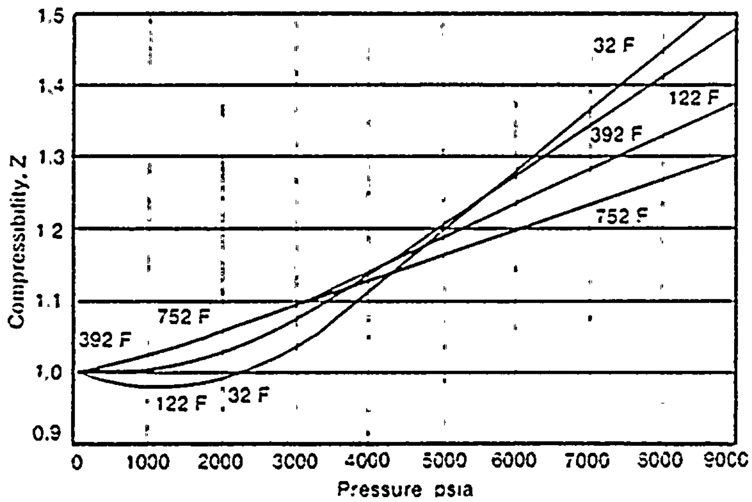


FIGURE 11
COMPRESSIBILITY FACTORS
FOR NITROGEN

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	98.34
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	1268.9	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

-o-

HYDRODYNAMIC TORQUE

OF

HIGH PERFORMANCE TRUNNION VALVES

ing
ves

The increased use of High Performance Trunnion (Offset Buterfly) Valves used increased use in high flow applications and therefore, a need for accurate prediction of the Hydrodynamic Torque behavior of this type valve. Improper actuator sizing, structural damage and control instability possible consequences of using inaccurate Hydrodynamic Torque data.

The Trunnion Valve is essentially a modified butterfly valve with the stem offset from the disc sealing surface. See Figure 1. Normally, type of valve exhibits high opening and closing torques with operating depreciating as the valve disc rotates 90° to the fully open position. on occasions where a considerable quantity of fluid is being pumped valve, the Hydrodynamic Torque may exceed the opening torque or sufficient magnitude that the actuator will be unable to further open valve.

Realizing the importance of having accurate Hydrodynamic Torque data, Seal International, Inc. in North Stonington, Conn. launched an extensive program inorder to obtain this data. At Posi-Seal's new Hydraulics Laboratory, (See Figure 2 for schematic of lab), Hydrodynamic Torque data ... on valve sizes 1 1/2" through 14" for valve classes 150 through ... Additional data was taken on a 14" - 900 and a 14" - 1500 lb. valve. ... recorded for both preferred and non-preferred fluid flow, measured ... 10 degrees of valve rotation. Inorder to obtain the Hydrodynamic factors, the valve torque was measured while both opening and closing ... By averaging the above data, stem packing and bearing friction were negated and pure Hydrodynamic Torque was obtained. The above torque when divided by the differential pressure across the valve the Hydrodynamic Torque factor for that particular valve at that location. This data was statistically analyzed on Posi-Seal's

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namic Torque
rag forces
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

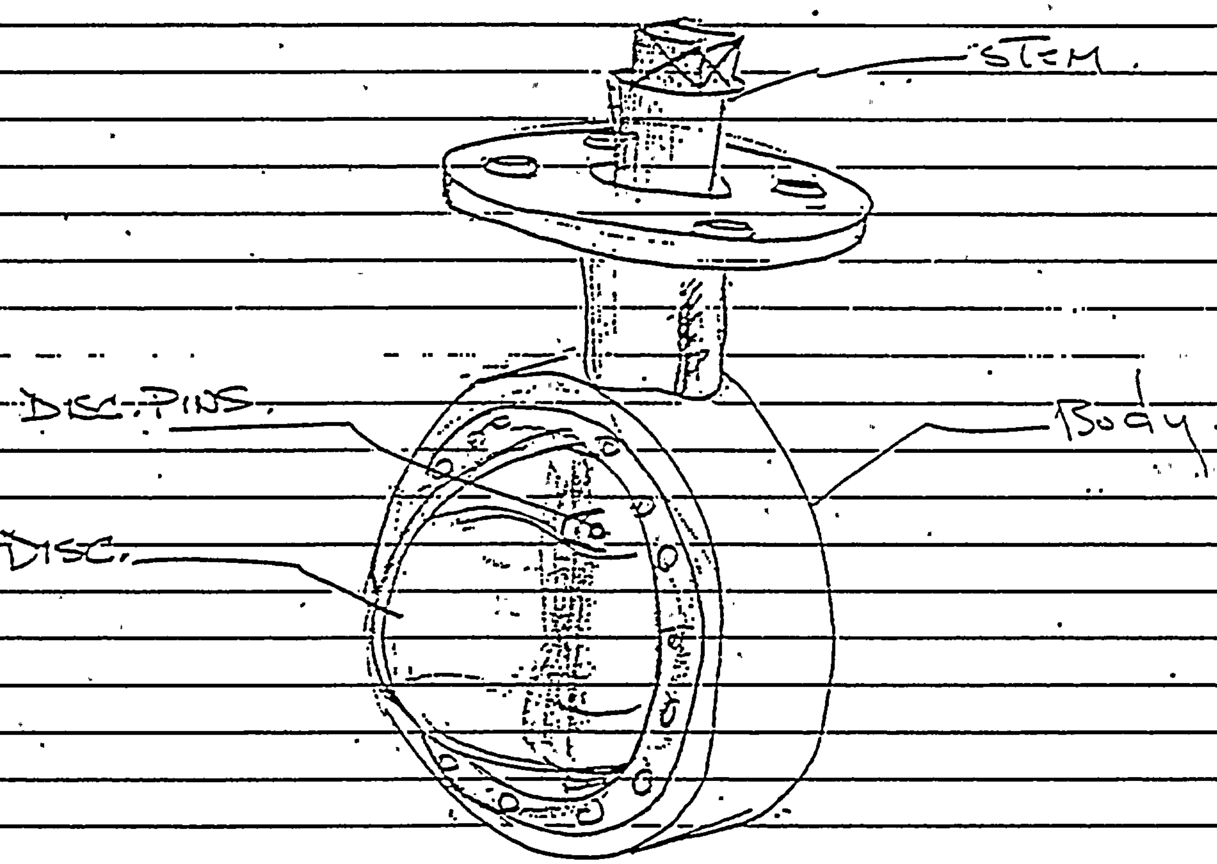
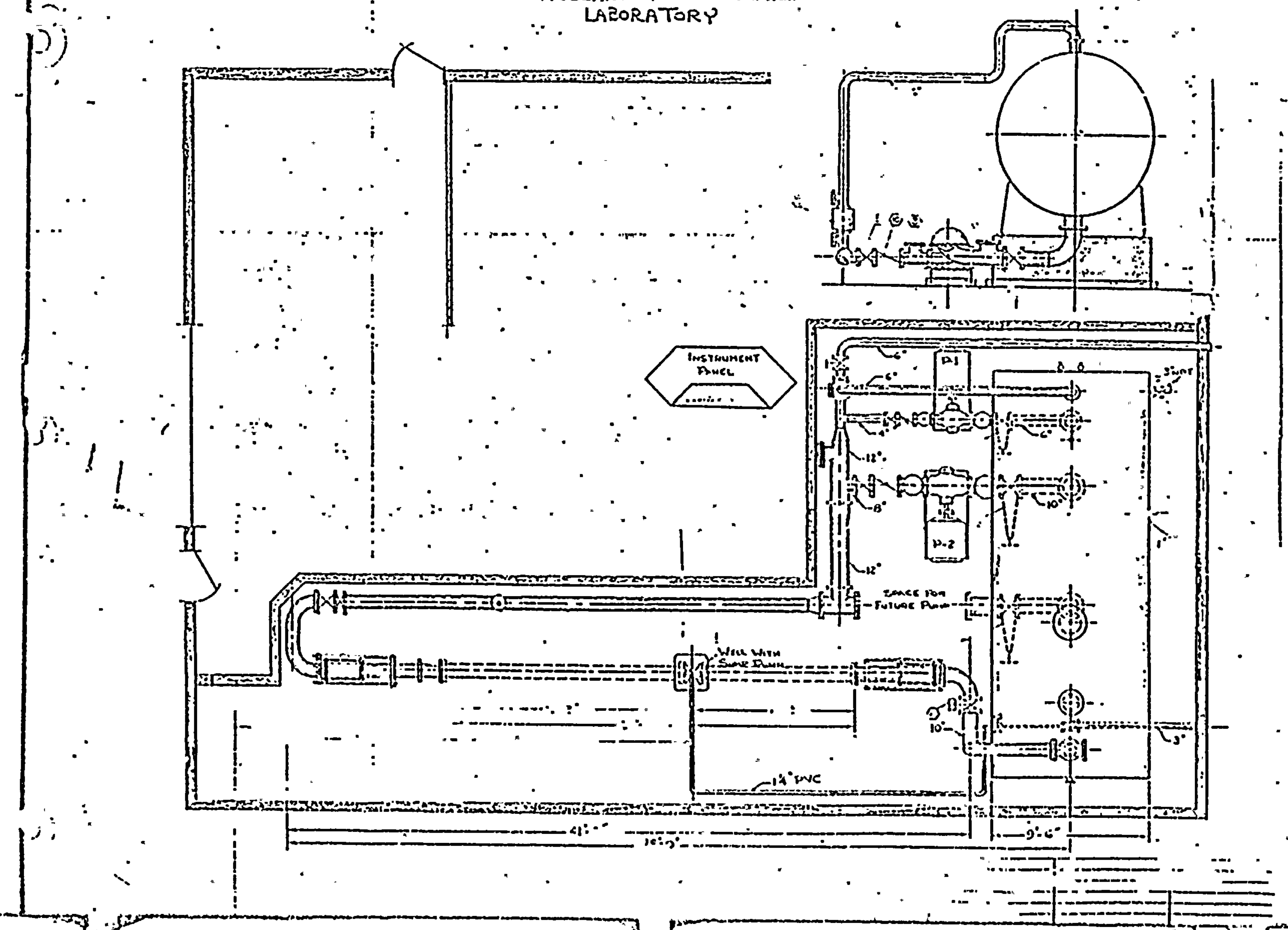
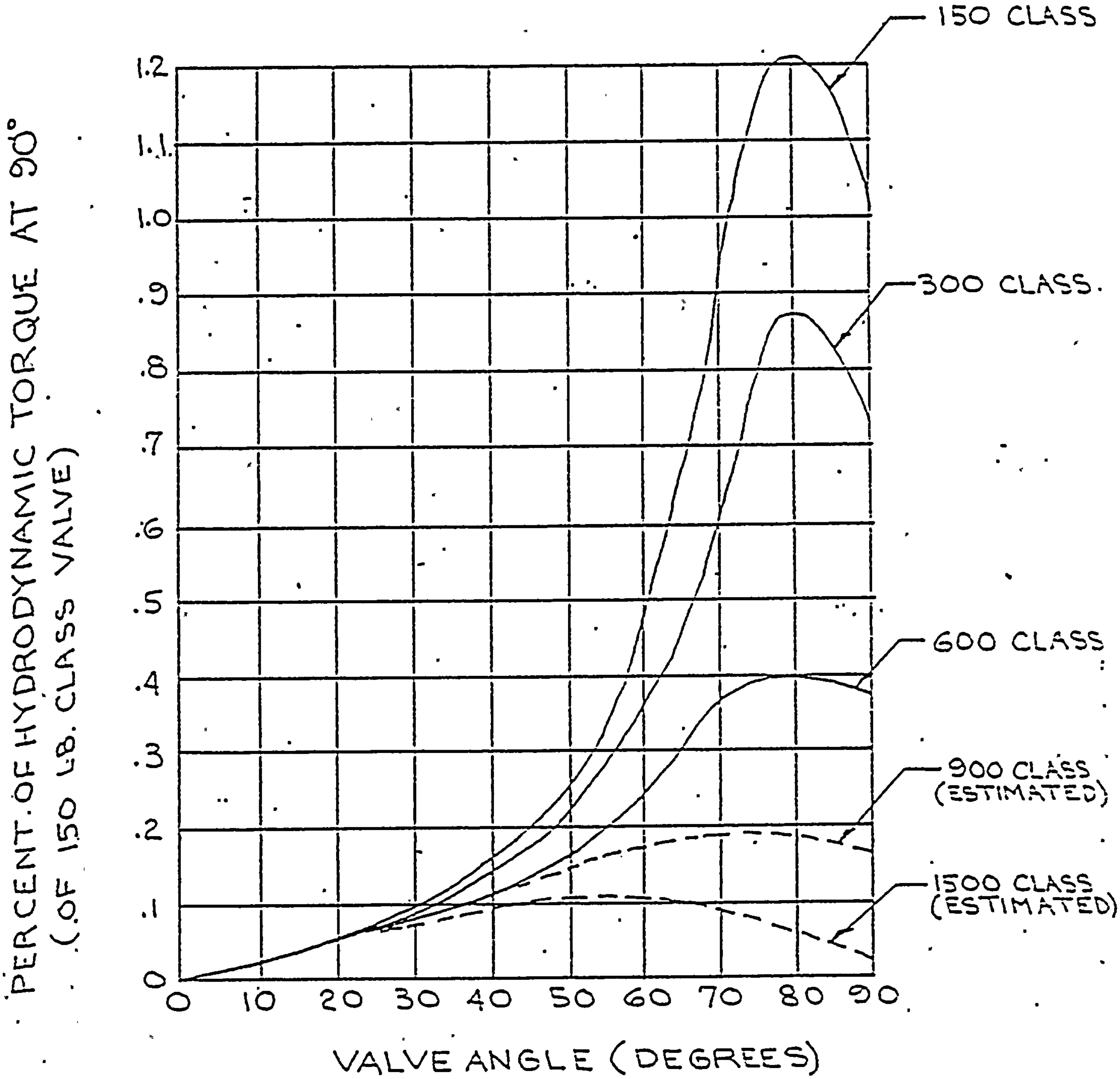


FIGURE No.: 2

SCHEMATIC OF POST-SEAL RESEARCH & DEVELOPEMENT LABORATORY

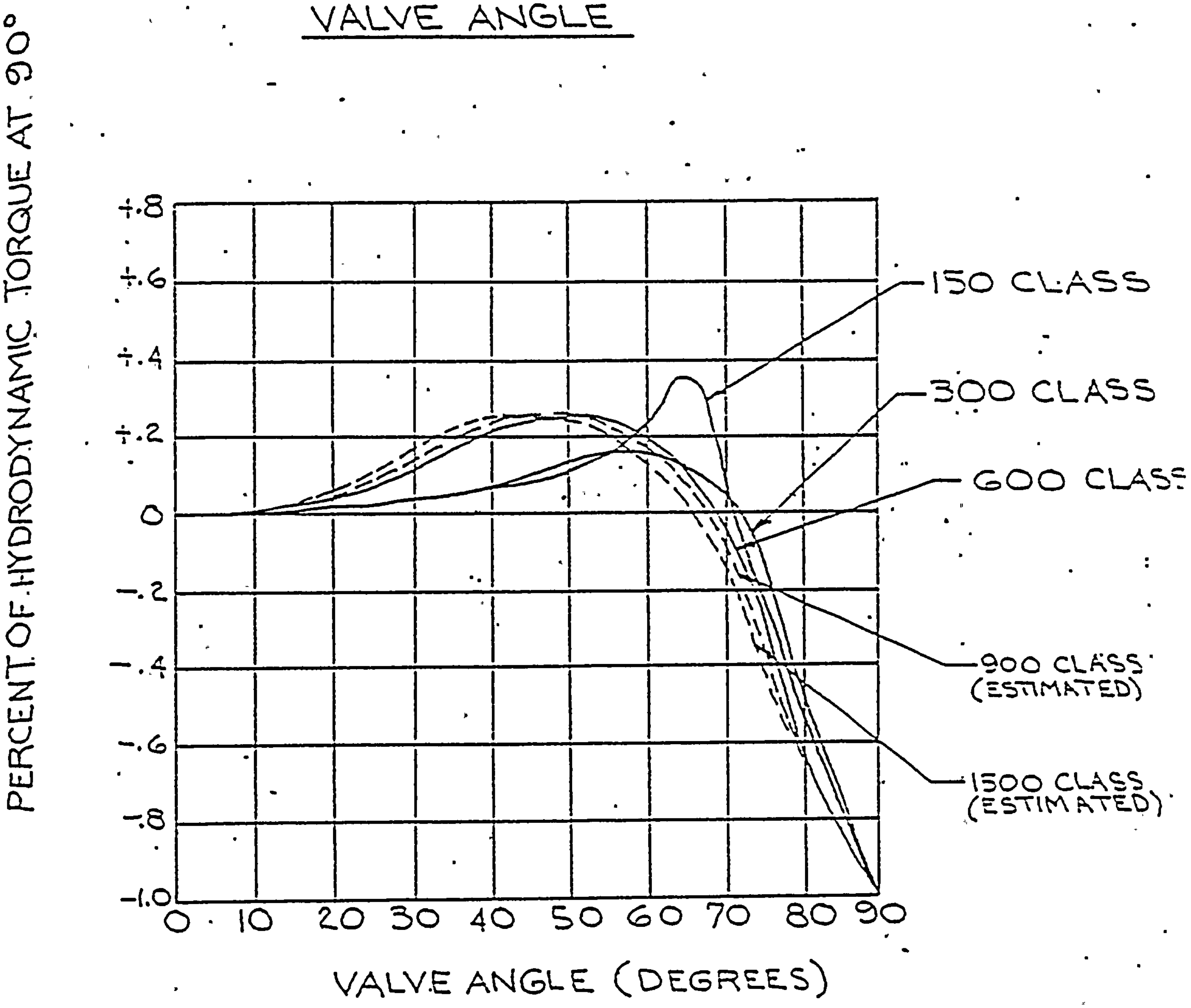


HYDRODYNAMIC TORQUE VS VALVE ANGLE

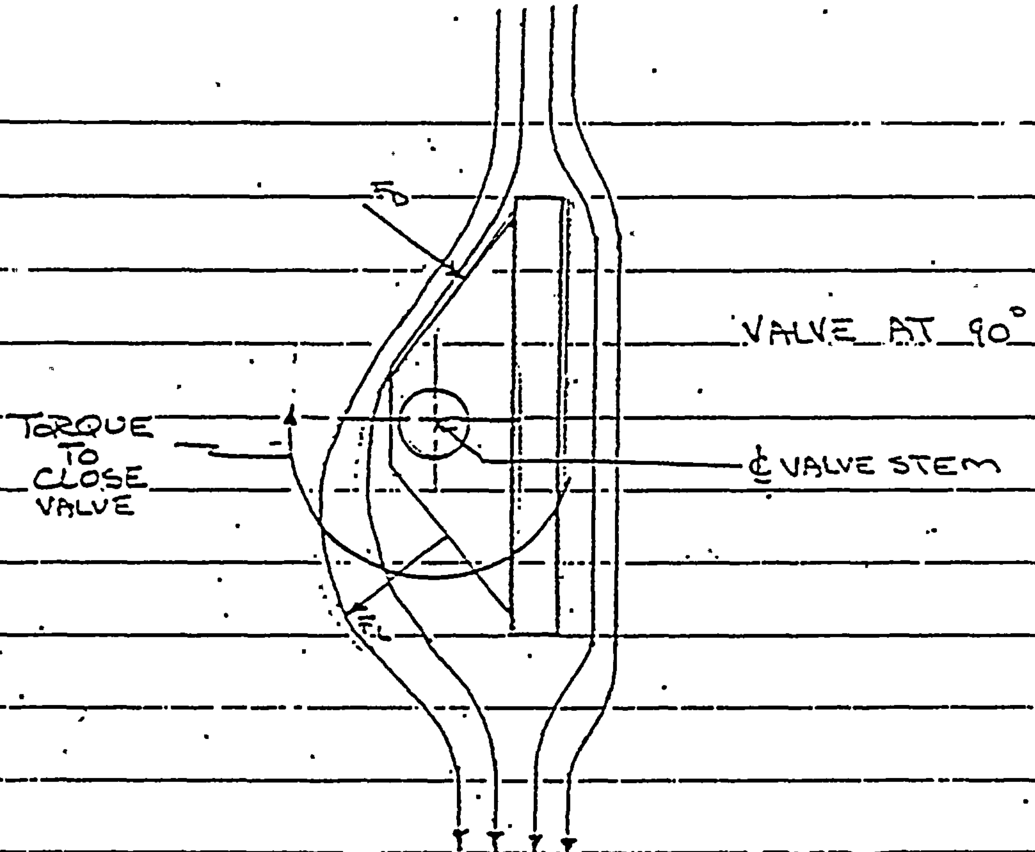


PREFERRED DIRECTION

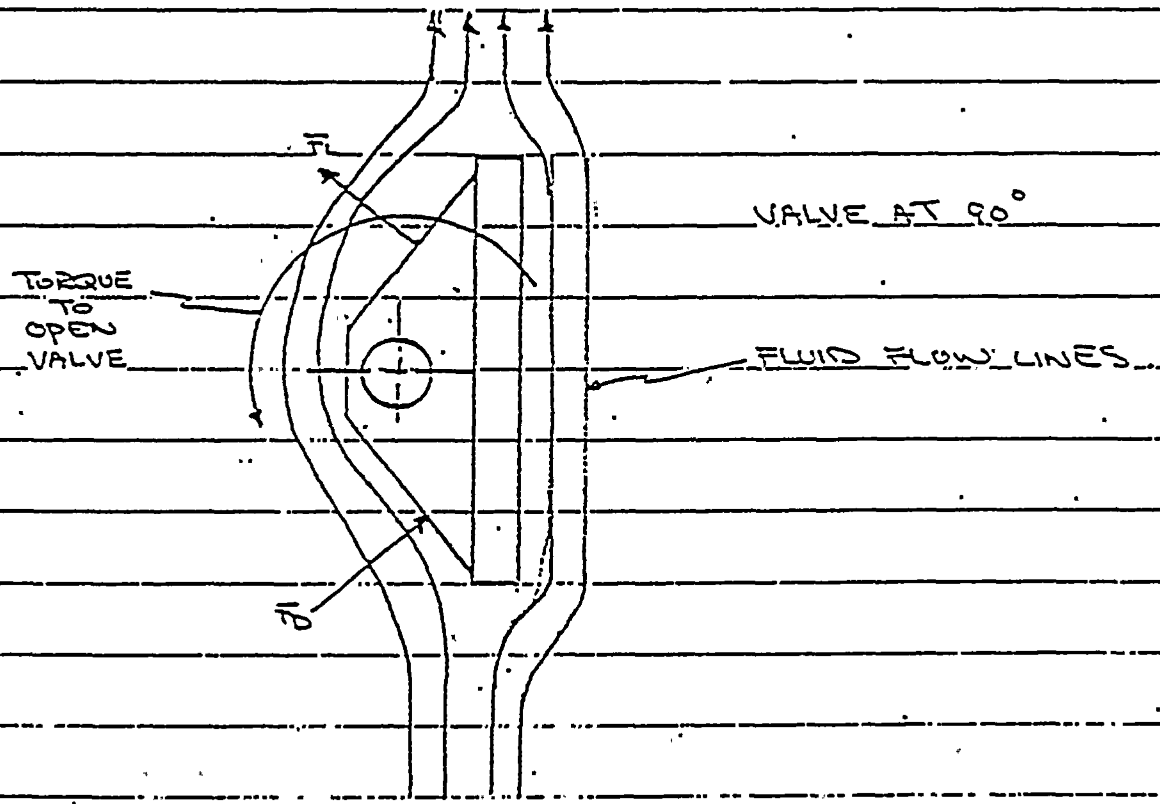
HYDRODYNAMIC TORQUE VS VALVE ANGLE



NON PREFERRED DIRECTION

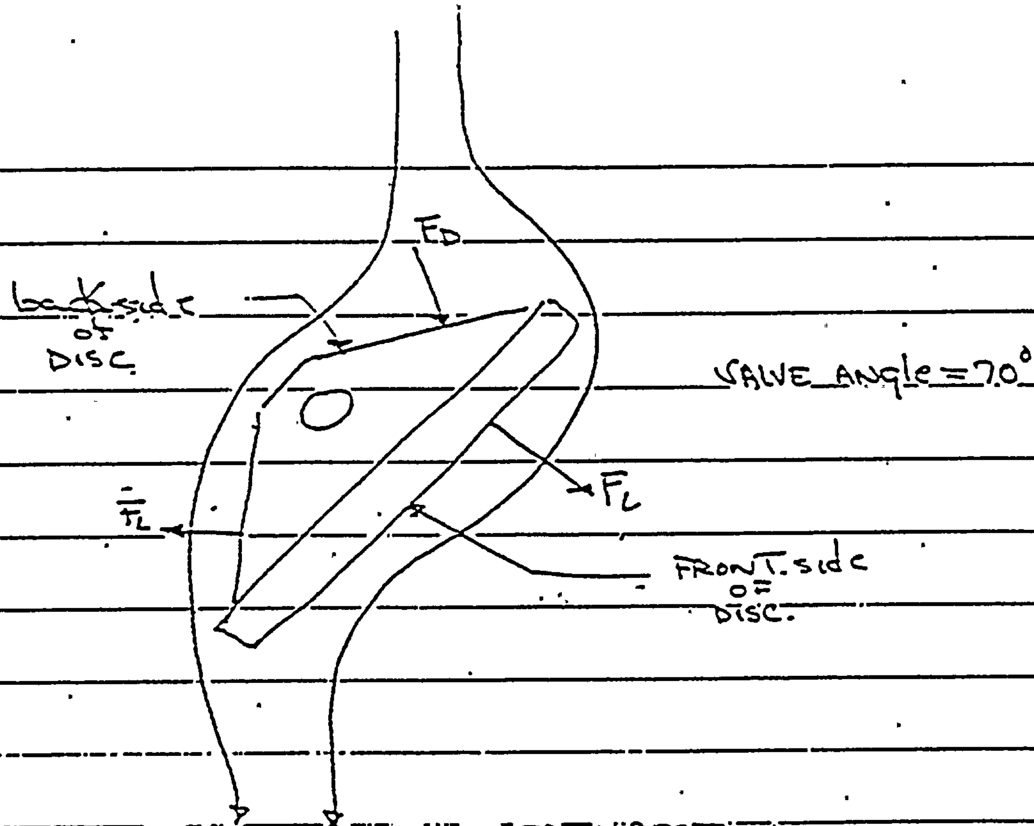


FLOW IN PREFERRED DIRECTION

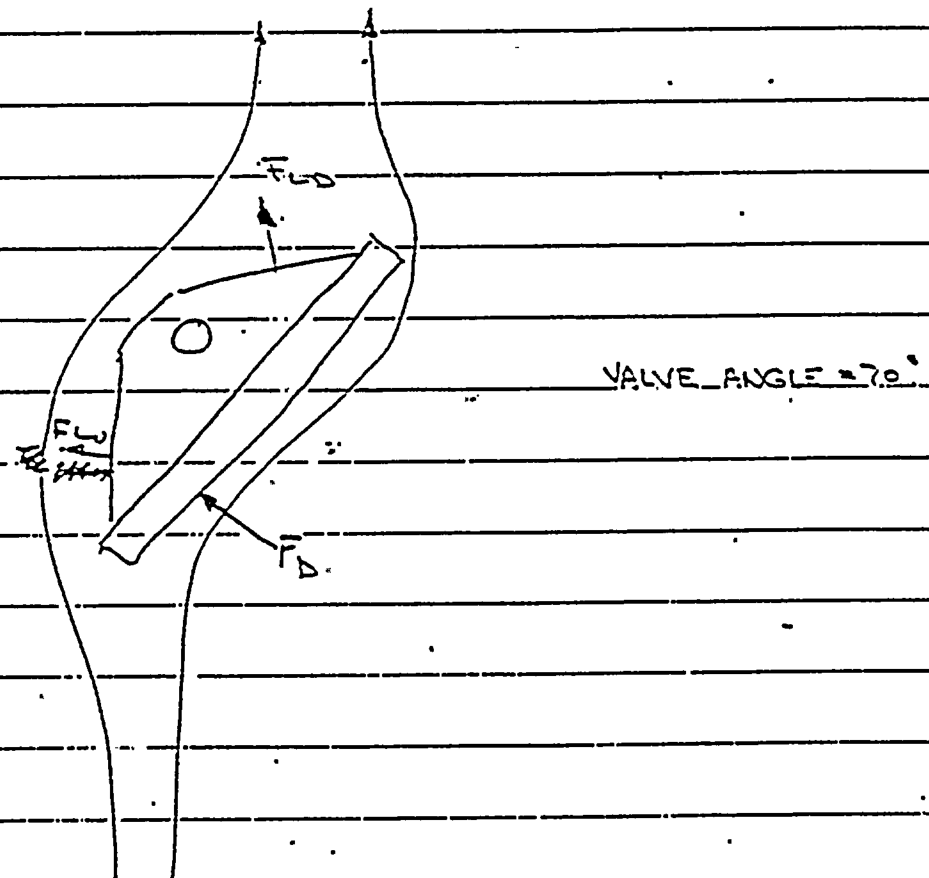


FLOW IN NON-PREFERRED DIRECTION.

FIGURE 5



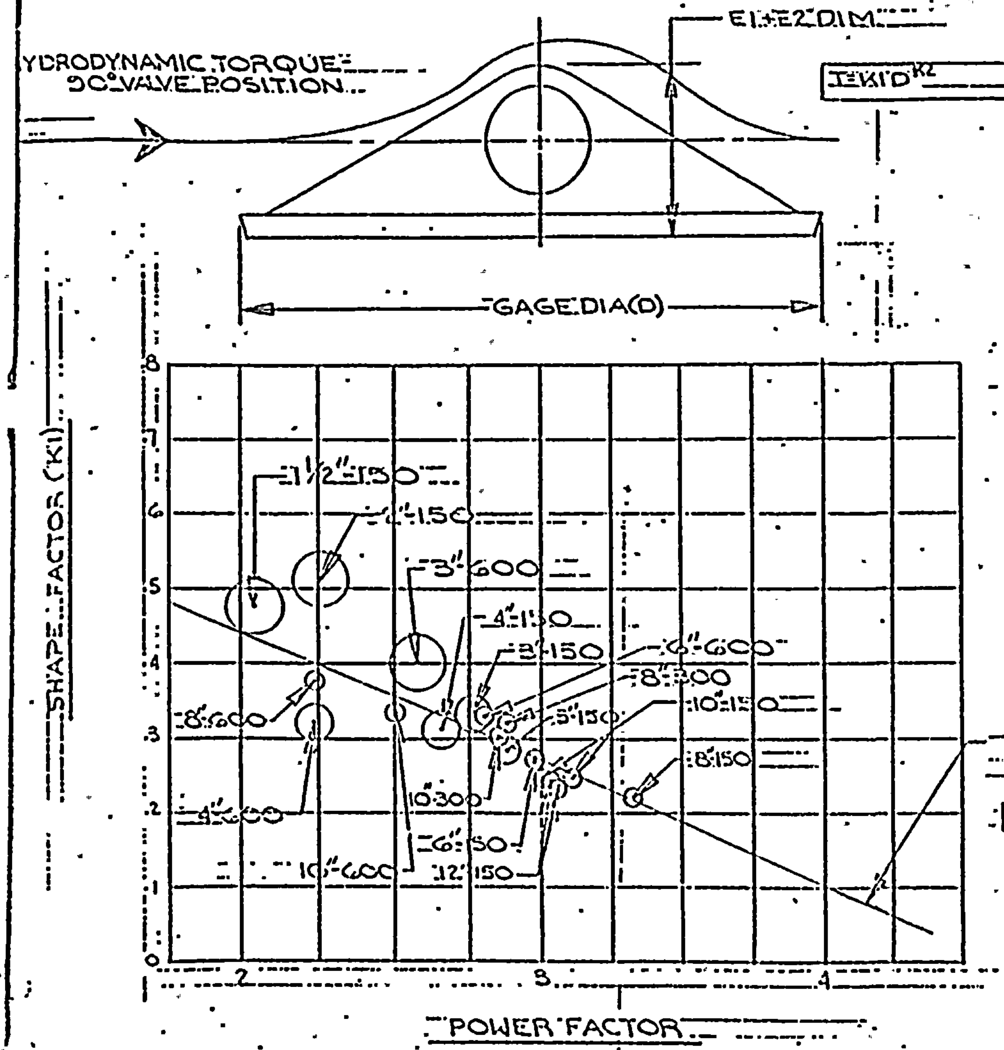
FLOW IN PREFERRED DIRECTION.



FLOW IN NON-PREFERRED DIRECTION

FIGURE 6

SHAPE FACTOR VS. POWER FACTOR



$T = K1 D^{K2}$

T = HYDRODYNAMIC TORQUE (IN-LBS)
D = DISC. GAGE DIA. (IN).
K1 = SHAPE FACTOR

$= \dfrac{E1 + E2}{D}$

K2 = POWER FACTOR

$= B_0 + B_1 K1$

B_0, B_1 = COEFFICIENTS DETERMINED BY LINEAR REGRESSION ANALYSIS OF EMPIRICAL DATA

OR:

$K2 = \dfrac{LN[T/K1]}{LND}$

$B_0 = +4.6098$
$B_1 = -5.9150$

PER LEAST SQUARES REGRESSION ANALYSIS

K2 = 4.6098 - 5.915 K1

FIGURE 7

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. 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	6.3
	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

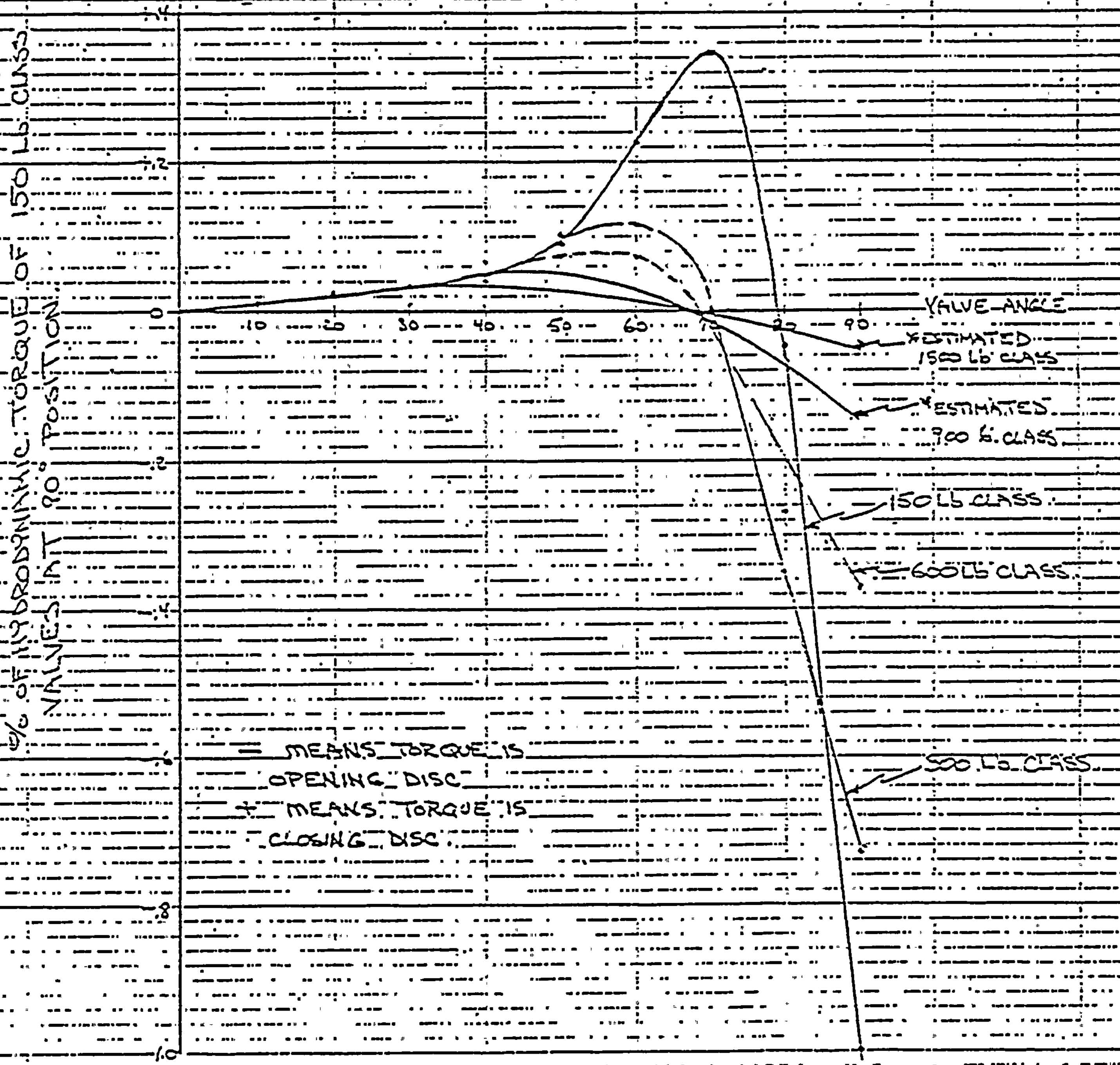
+5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title: NON-PREFERRED DIRECTION　　Page

Calc. By　　Checked By

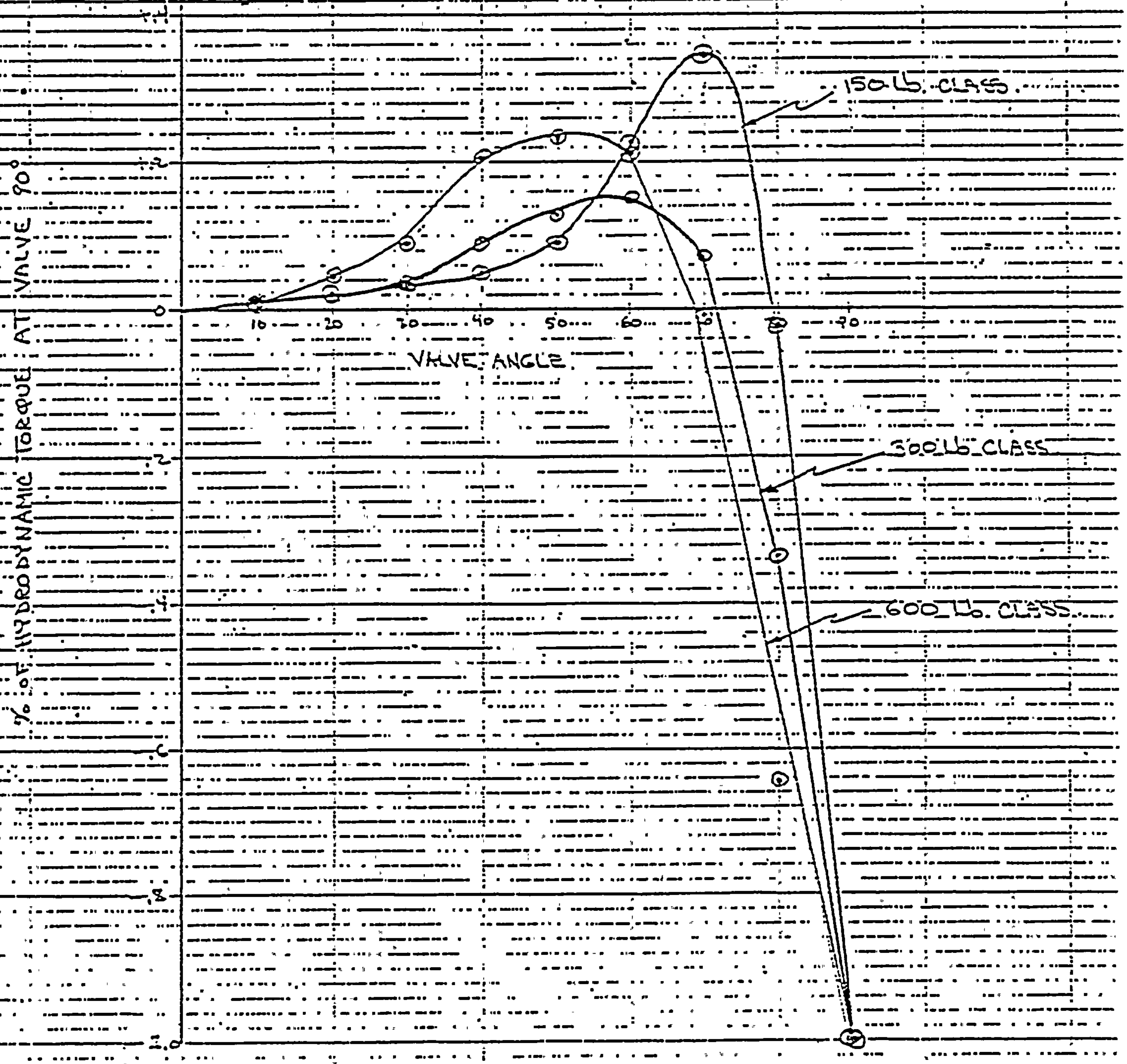
HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE



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	(=17.8) =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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

Calc. By: NON-PREFERRED DIRECTION Checked By: DANSEN 8/8/78

ANGLE	VALVE SIZE – % OF TORQUE @ 90°				
	5" – 150	6" – 150	8" – 300	10" – 300	AVG.
90	−40.85 (−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)	+.058
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 (+.071)	+1.65 (+.015)	+2 (+.009)	+.020

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES — Page

Calc. By: NON-PREFFERRED DIRECTION — Checked By: QANSEN 8/16/78

ANGLE	VALVE SIZE - % OF TORQUE AT 90°			
	6" - 600	8" - 600	10" - 600	AVG.
90	−46.775 (−1.0)	−75 (−1.0)	−129.45 (−1.0)	(−1.0)
80	−20.53 (−.44)	−52.5 (−.7)	−101.2 (−.782)	−.641
70	+2.93 (+.063)	−8.25 (−.11)	+8.75 (+.068)	+.007
60	+11.936 (+.255)	+13.1 (+.175)	+28.75 (+.222)	+.217
50	+12.435 (+.266)	+17.1 (+.228)	+28.855 (+.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

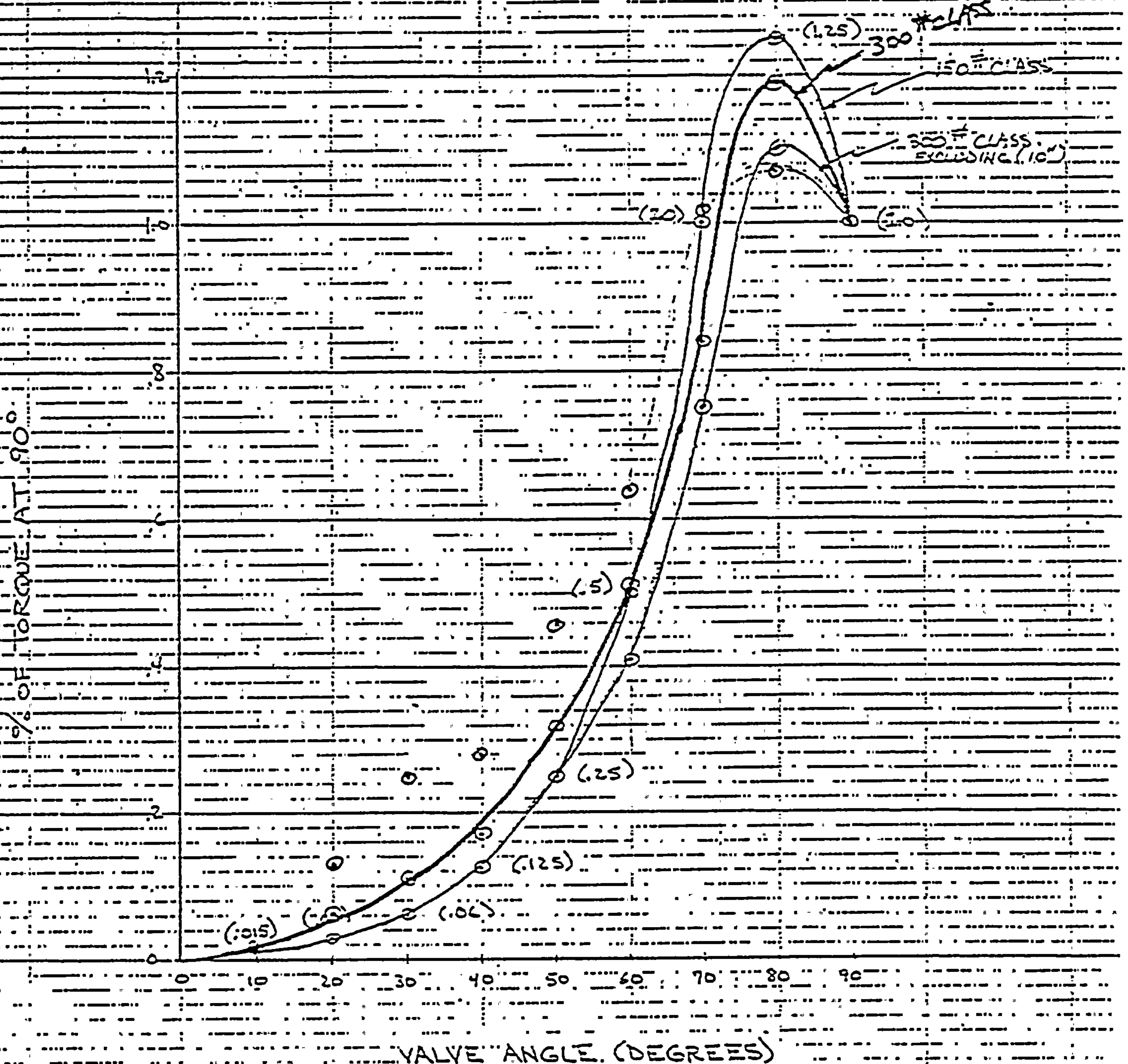
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: Page:

Calc. By: PREFERRED DIRECTION. Checked By: OANSEN 8/8/78

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

Calc. By: PREFERRED DIRECTION Checked By: OANSEN 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	(61.55) .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.

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

Calc. By: PREFERRED DIRECTION Checked By: OANSEN 8/2/78

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.) 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	[illegible]
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

le HYDRODYNAMIC TORQUES Page

Calc. By PREFERRED DIRECTION Checked By DANSEN 8/7/78

ANGLE	VALVE SIZE = % TORQUE @ 90°						
	20"-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~~ 1.25	~~(151) .65~~	(326) 1.03	(434) 1.25	1.21	[1.2
70	(227) .93	(345) 1.04	~~(83) .39~~	(234) .74	(322) .92	.91	[.9
60	(122) .50	(186) .56	~~( )~~	(115) .37	(183) .52	.49	[.5
50	(59) .24	(104) .31	~~( )~~	(59) .16	(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	[.0
10	(3) .01	(11) .03	~~( )~~	(8) .02	( ) .03	.02	[.0

(8)

DELETE NOT GOOD DATA

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] DATE: 12/16/77 Checked By:

VALVE SIZE: 150

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON / BUNE

WATER TEMPERATURE (TANK): 66 °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		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

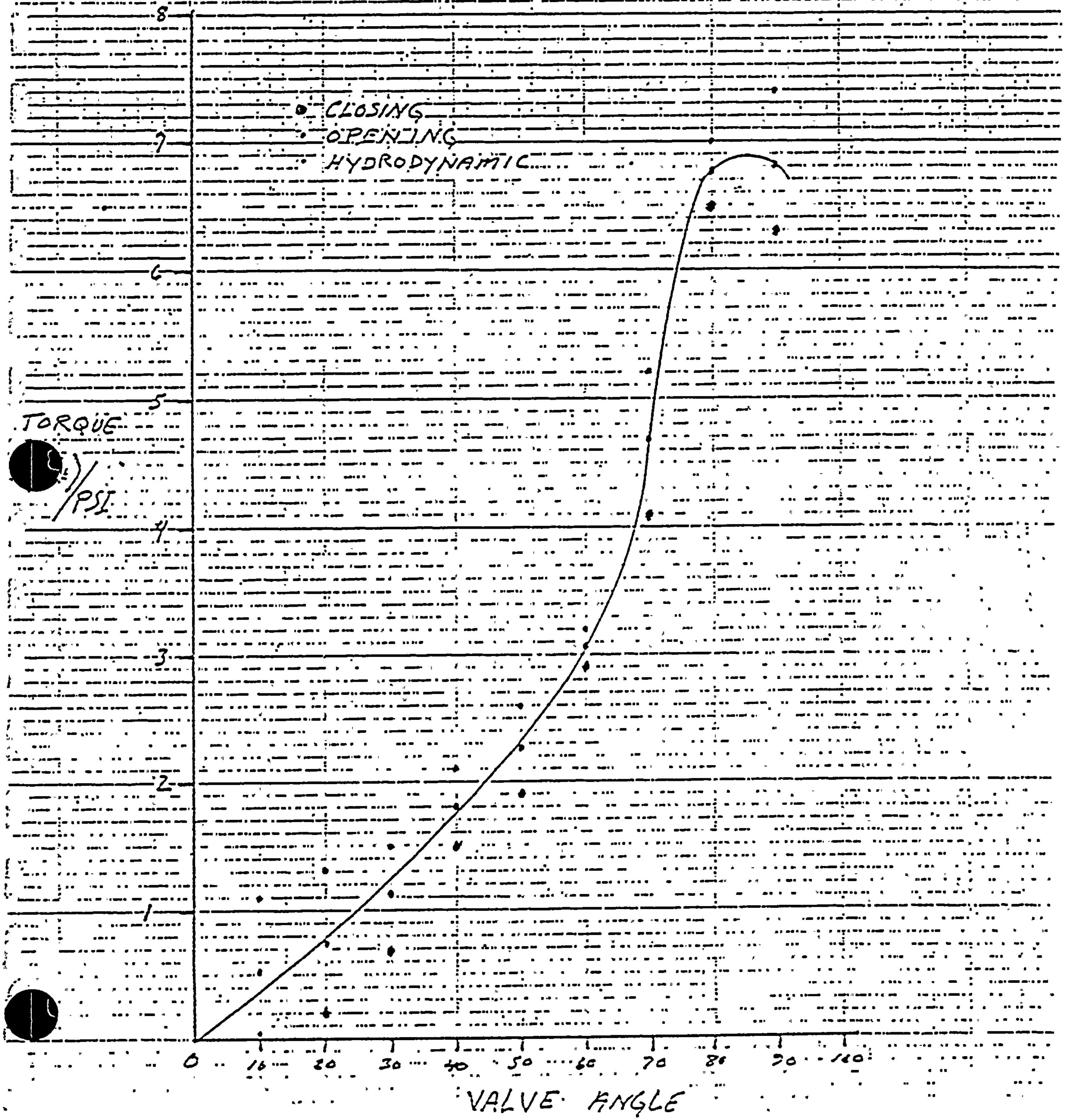
0 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 3-150LO HYDRODYNAMIC TORQUE CURVE Page

Calc. By C.L... (STEM - UP STREAM) Checked By

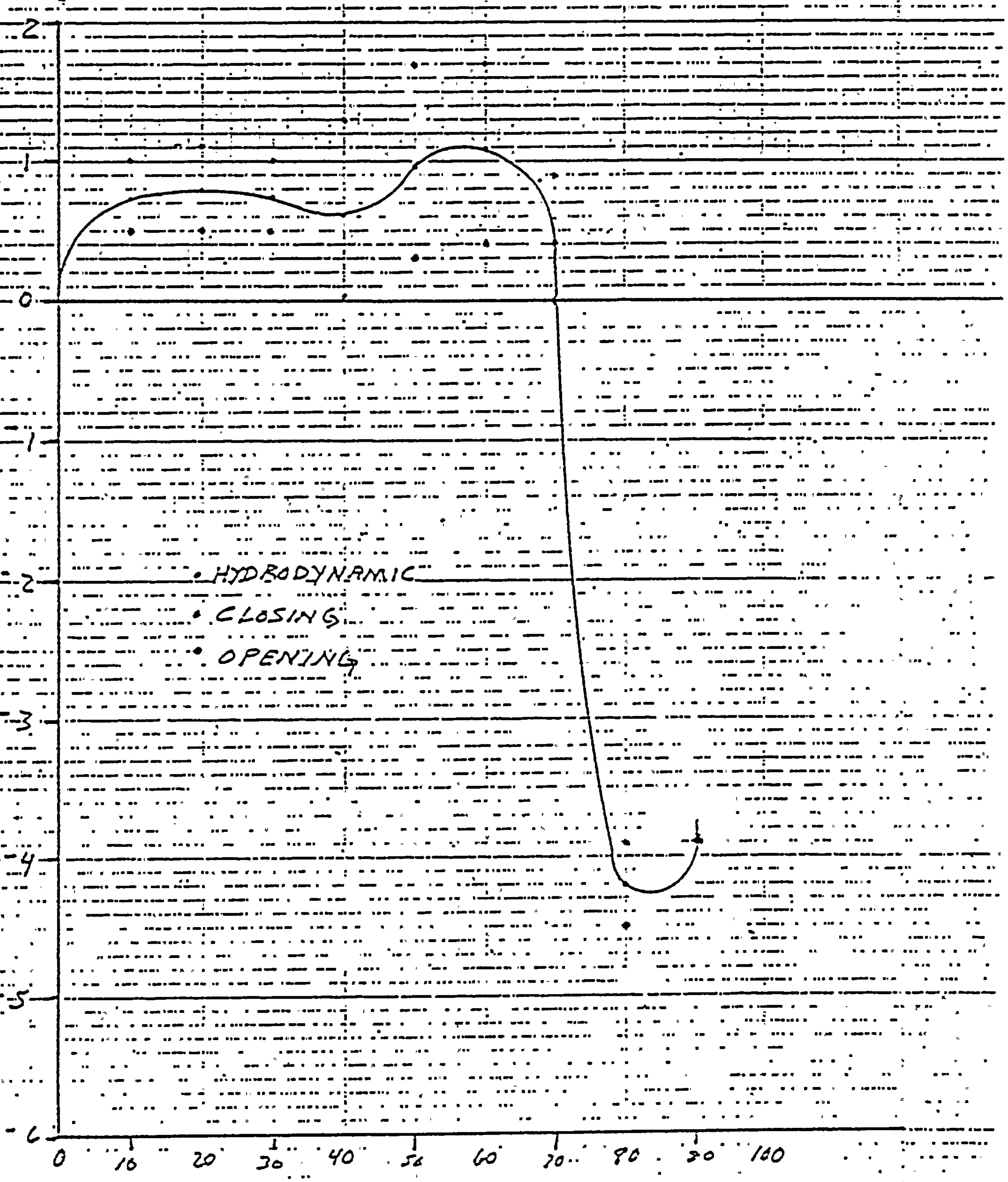


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 3" 150LB - HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (STEM DOWN STREAM) Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] 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

POSI-SEAL INTERNATIONAL, INC.

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

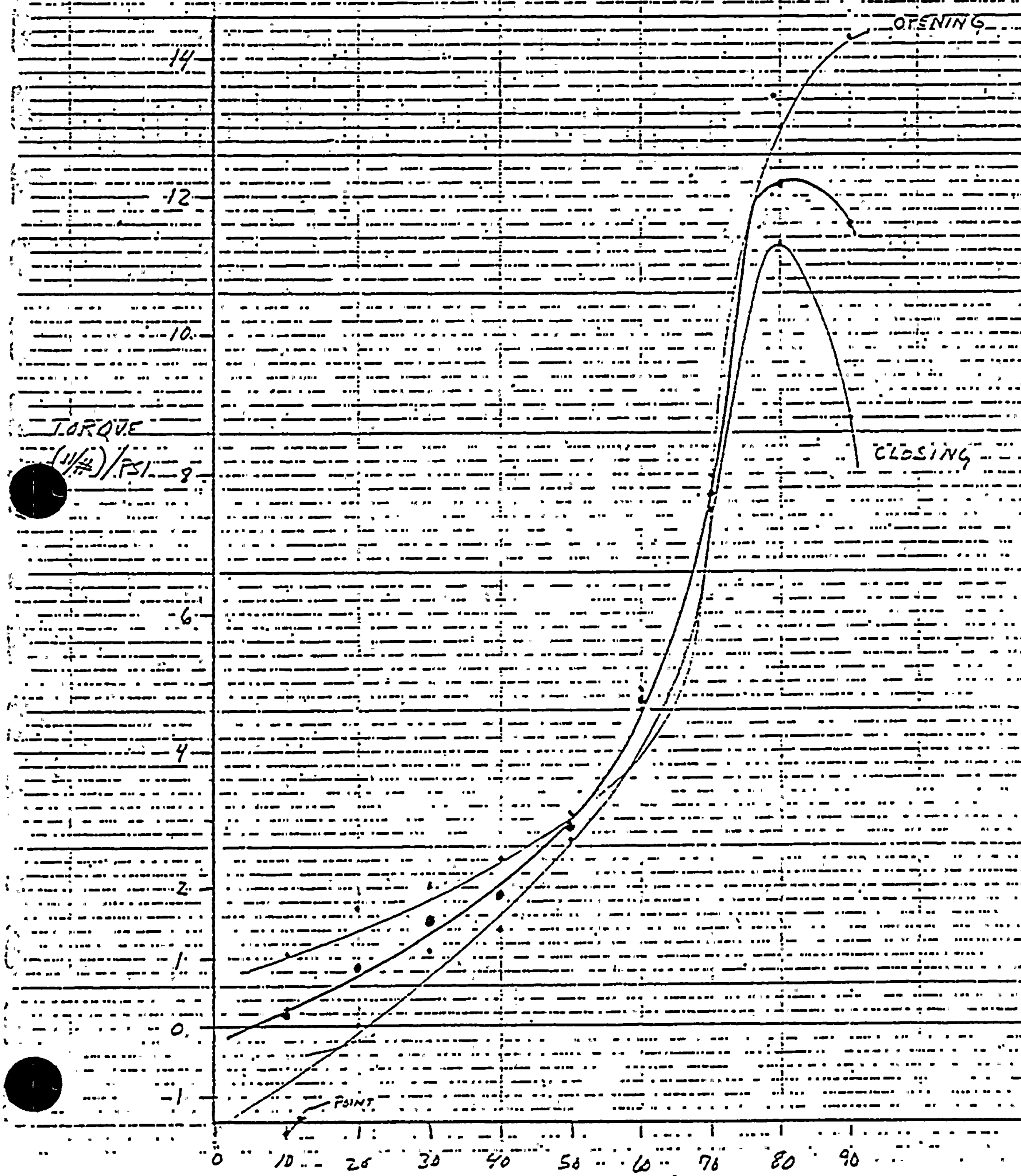
5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB : HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (STEM UPSTREAM) Checked By

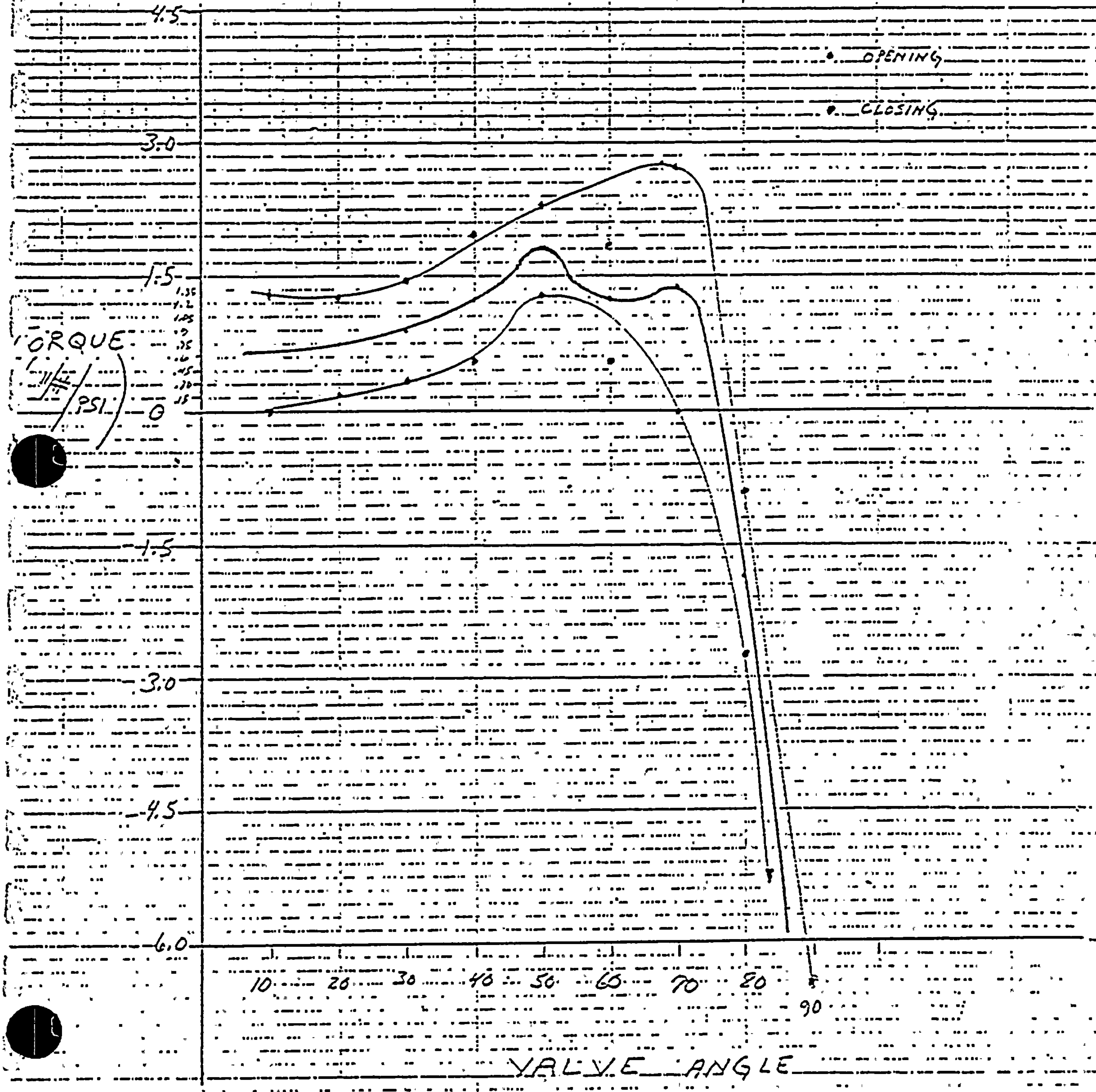


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB HYDRODYNAMIC TORQUE CURVE Page 2-4

Calc. By C. Livorsi (STEM DOWN STREAM) Checked By



POSI-SEAL INTERNATIONAL, INC.

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): 57 °F

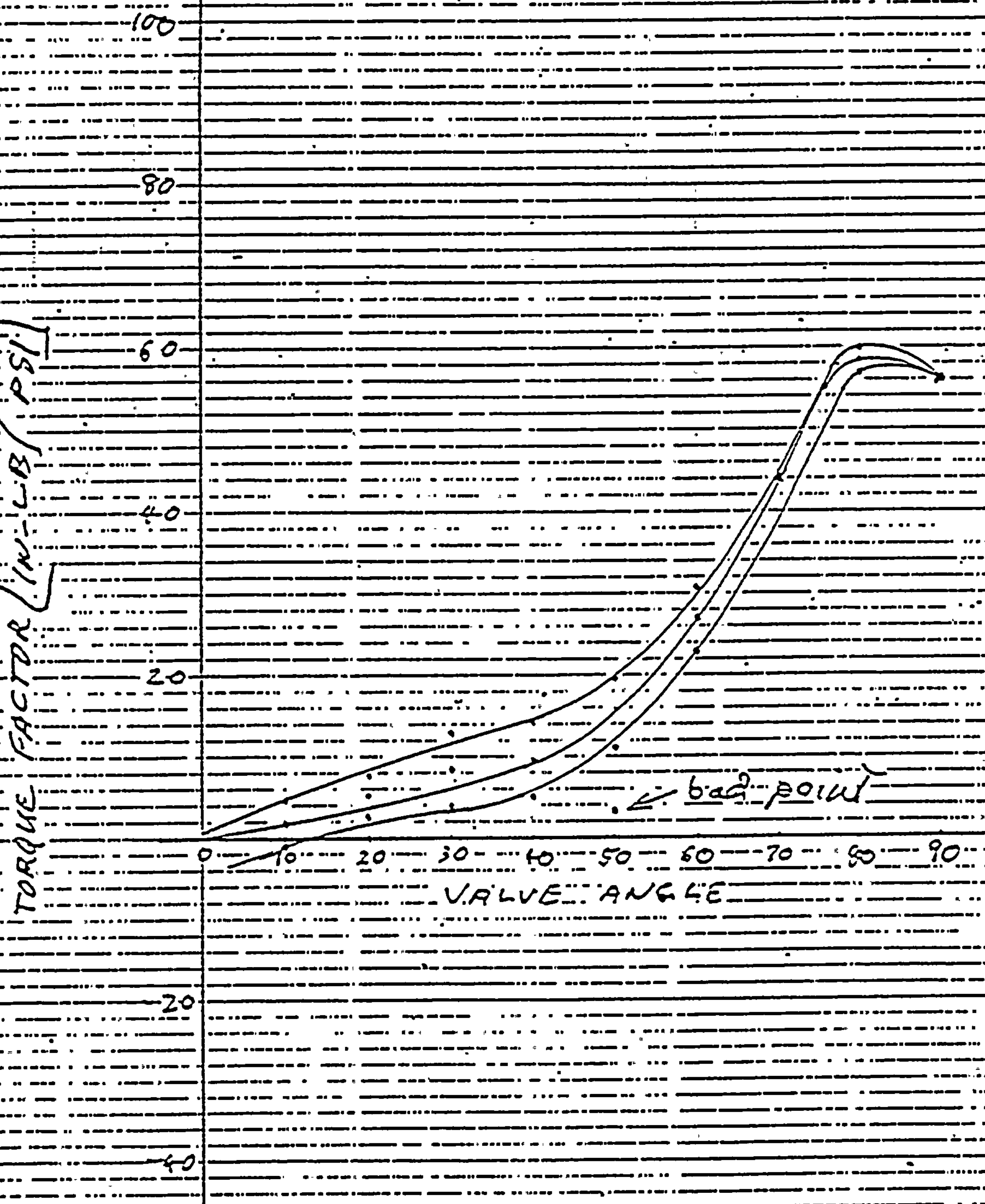
DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
	0					
	10	18.1	12		−50	−4.17
	20	18.6	14		0	0
~~OPENING~~ CLOSING	30	18.6	~~13.5~~		~~35~~ 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	60.37
	90	18.4	11		600	54.55
	90	18.6	12.8		700	54.69
	80	18.4	12.5		750	60
	70	18.6	13 12.7		550 700	42.3
	60	18.4	13		440	33.85
OPENING	~~50~~ 45	18.9	15		300	20
~~CLOSING~~	40	18.4	12.5		150	12
	30	18.4	14		125	8.93
	20	18.3	11.5		100	8.7
	10	18.1	13.5		80	5.93
	0					

PACKING TORQUE: IN-LB OPENING

IN-LB CLOSING

PREFERRED DIRECTION



POSI-SEAL INTERNATIONAL, INC.

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	
OPENING	0					
	10		38.5		180	
	20		49		150	
	30		6.2		80	
	40		7.8		110	
	50		8.2		160	19.5
	60		6.5 13		206 540	38.8 21.5
	70		8.75 15		500 650	45.7 43
	80		8.5 11.2		530 650	63.3 58
	90		4.1 8.5		500 500	54.9 55.5
CLOSING	90		9.1 8.5		510 500	
	80		11.5 11		700 600	10.8 5.5
	70		16.7 16.2		730 750	43.7 46
	60		14.5	22.6	350 520	24.1 23
	50		10.5		150	2.4
	40		12.5		60	
	30		15		60	
	20		34		90	
	10		50.5		25	
	0					

PACKING TORQUE: IN-LB OPENING

IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By R. DANSEN 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
OPENING	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					

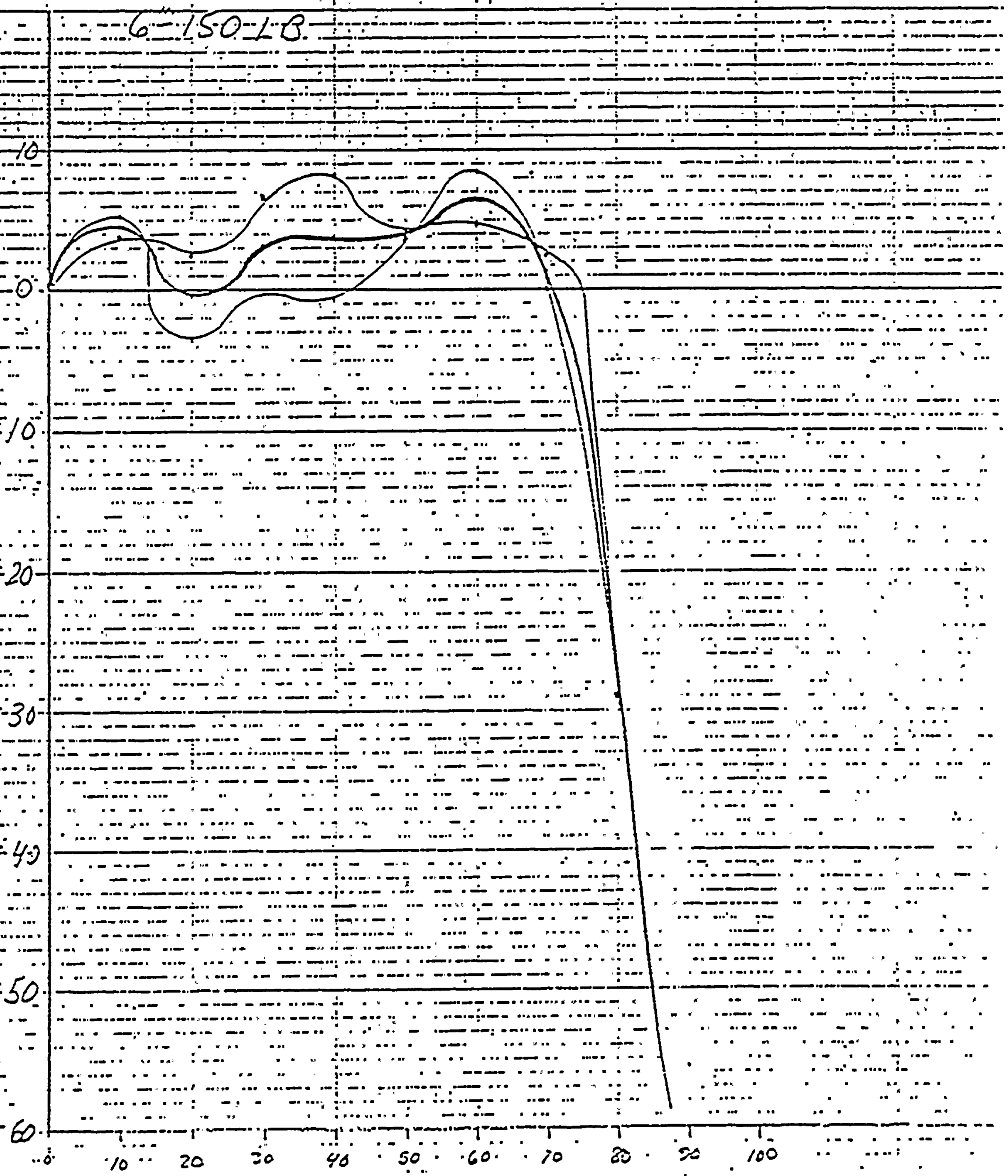
PACKING TORQUE: 10 IN-LB OPENING

10 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (STEM DOWN STM) Checked By



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	[illegible]
OPENING	0	69.5	65.			400	
	10		59.5			400	1.68
	20		56			4.25	7.6
	30		51.5			5.50	10.7
	40		43			725	16.8
	50		31			775	25.
	60		18			740	41.1
	70		8.5			700	92.3
	80		4.5			650	144.
	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	4.8
	0					375	

PACKING TORQUE: 160 IN-LB OPENING
80 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 6

Calc. By C. Liucresi DATE Checked By

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	
	0				900 ft#	
	10		58		350	6.03
	20		56		350	6.25
OPENING	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		
	90		3.0		550	183
	80		3.0	ΔP @ 85° = 2.5	0	0
	70		7.5	T @ 85° = -30	500	66.7
	60		16	ΔP @ 75° = 5.5	550	34.4
	50		28	T @ 75° = 375	400	14.3
CLOSING	40		39.5		250	6.3
	30		46		100	2.2
	20		54.5		0	0
	10		58		100	1.7
	0				900 ft#	

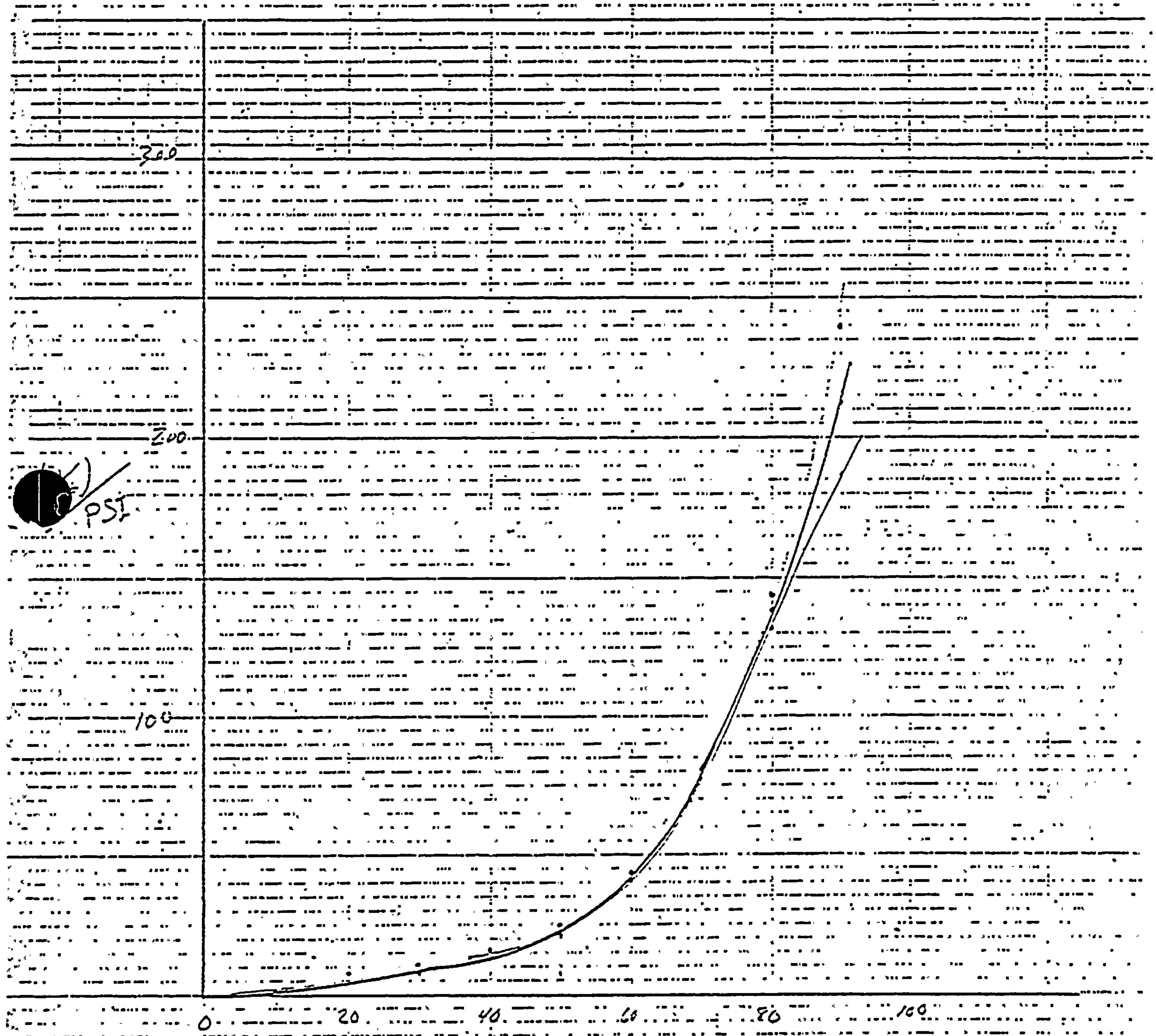
PACKING TORQUE: 150 IN-LB OPENING
100 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8" 150 LB HYDRODYNAMIC TORQUE (PREFERED) Page

Calc. By C. LIVORSI Checked By



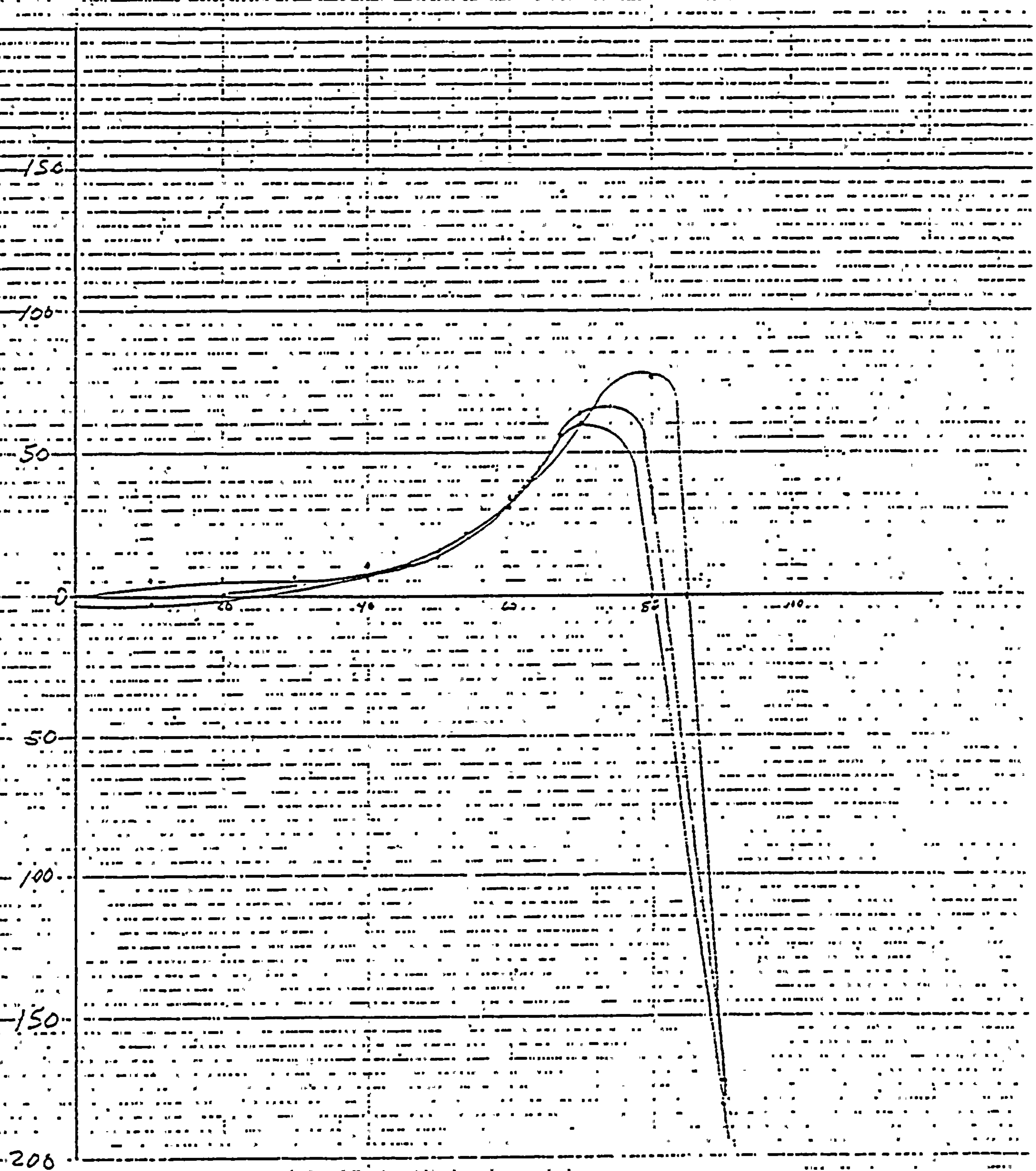
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" - 150

Title HYDRODYNAMIC TORQUE CURVE (UNPREFERED) Page

Calc. By C. LIVORST Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION (F1) Page ____

Calc. 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): 98° °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]
OPENING	0	54.9	~~[illegible]~~ 51	0	+1250 / 1150 / 120	
	10	54.9	50.5	395	850	16.5
	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	~~[illegible]~~ 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	363.65
	90	[illegible]	[illegible]	2685	600	[illegible]
		~~46~~	~~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	[illegible]
	50	42	7.0	2538	~~[illegible]~~ 350–400	57.2
	40	45	17.0	2260	375	22
	30	51	32.0	1800	225	10
	20	~~[illegible]~~ 54	51	1195	0	
	10	61	56	360	0	
	0					

PACKING TORQUE: 50 IN-LB OPENING

50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION (#2) Page

Calc. By AC 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	IF Δ
OPENING	0	~~36.8~~	~~16.5~~	~~218~~	~~320~~	
	10	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	
	20	~~[illegible]~~	10.5 ~~[illegible]~~	~~[illegible]~~ 578	~~600~~ 400	
	30	42.8 41.6	10.5 ~~32~~	1575 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	3594	700	200
	80	16.6	2.5 ~~[illegible]~~	3596	700	280
	90	~~16.6~~	~~1.75~~	~~3595~~	~~450~~	259.1
		↓	↓	↓		
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~~	~~125.8~~
	50	26.5	~~17.5~~ 13.0	3572	800	
	40	49.5	14.0	2140	450	
	30	57.2	11.0	1170	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

Calc. 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	[illegible]
OPENING	0	7.5/37.5				
	10	~~[illegible]~~ 45.7/46.3	38/23.5	300/252	850/750 ~~[illegible]~~	1100/1175
	20	17.5 45.2	17.5		700	40
	30	8.5 →			450	55
	40	17.5 →			700	51
	50	7.0 →			575	82
	60	5.0 →			625	135
	70	25 →			625	250
	80	20 →			725	363
	90	15 →			550	[illegible]
CLOSING	90		1.5		400	[illegible]
	80		2.0		575	[illegible]
	70		3.0		650	[illegible]
	60		6.0		600	[illegible]
	50		13.0		450	35
	40		26.0/18.5		300 / 150	12/8
	30		23		100	[illegible]
	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

Calc. By DATE 6/20/77 Checked By

CAVITATION MEASUREMENTS - CONTROL 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	28
	30		43.5		1575	36
	40		28.5		1450	51
	50		13.5		1100	81
	60		6.25		925	148
	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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] DATE: 6/21/77 Checked By

VALVE SIZE: 10" - 150

VALVE DIRECTION: ~~SEAT UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON/BUNA

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	-3[illegible]
CLOSING	90		1.8		-700	-33[illegible]
	80		1.8		-50	-25
	70		3.0		+200	69
	60		6.5		+450	69
	50		13.5		+275	20
	40		~~[illegible]~~ 8.5		-75	-9
	30		16.5/19/30.5		-50 / -50 / -275	-3 / -[illegible]
	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

Calc. By [illegible] DATE: 6/21/77 Checked By:

Full open - Control Valve

VALVE SIZE: 10" 150

VALVE DIRECTION: ~~[illegible]~~ / 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		+700
	70				
	80				
	90				
CLOSING	90				
	80				
	70				
	60		6.5		+350
	50		13.5		+200
	40		25		0
	30		39.5		−400
	20		51.0		−700
	10		58.5		−800
	0				

PACKING TORQUE: 50 IN-LB OPENING

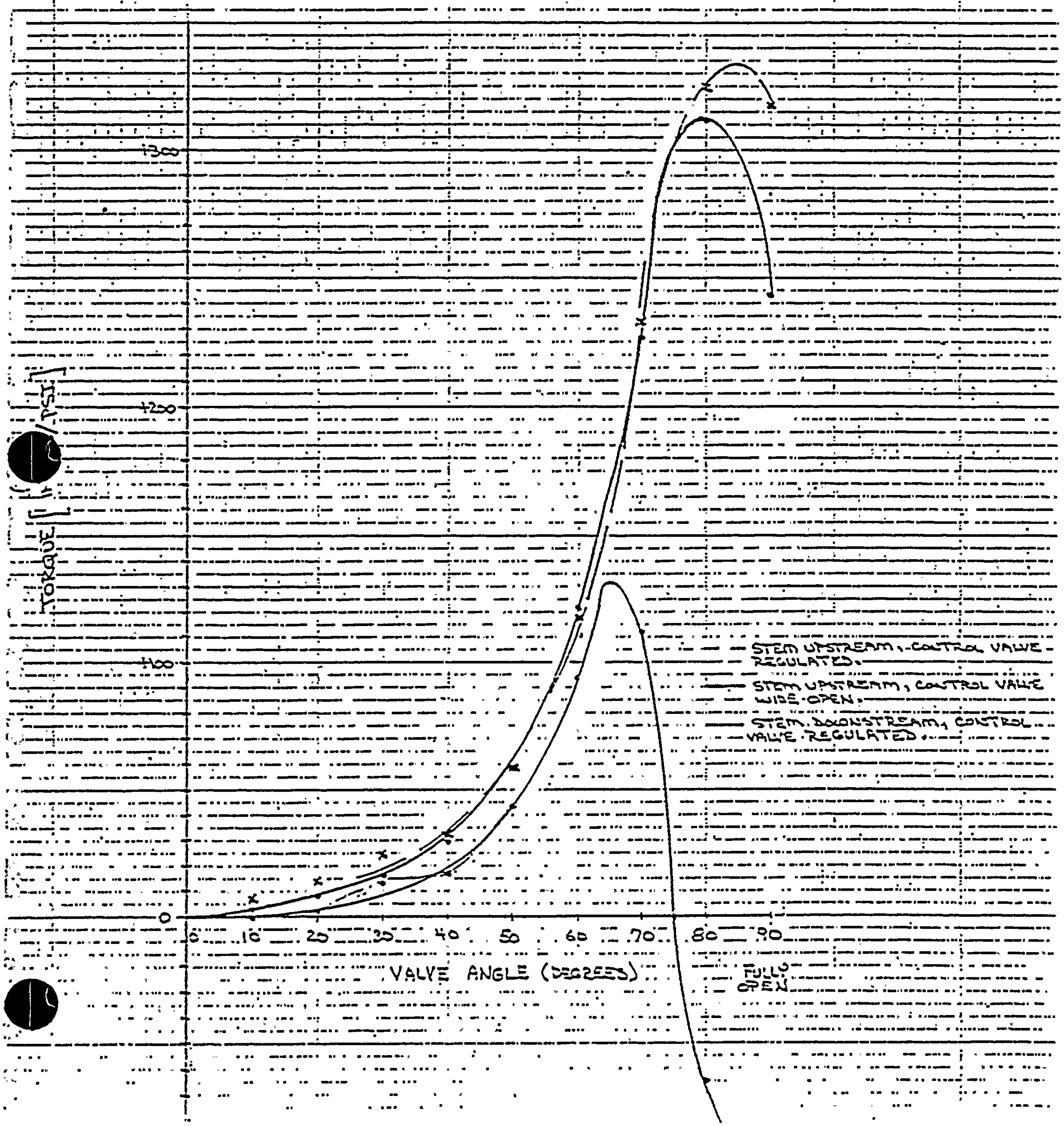
: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title TORQUE VS. VALVE ANGLE 10"-150 Page

Calc. By R. QANSEN Checked By



POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By C. LIVORSI DATE Checked By

VALVE SIZE: 12-150

VALVE DIRECTION: STEM UPSTREAM ☒ / 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

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 2

Calc. By C. Liroksi DATE: Checked By

VALVE SIZE : 12" 150

VALVE DIRECTION : ☒ STEM UPSTREAM / ☐ 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	6.2 / 55	1200 / 1060		
	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	.7	310	333	
CLOSING	90	.7	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	1260		

PACKING TORQUE : 150 IN-LB OPENING

150 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. 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	27	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	160	125	
	70	1.6	280	175	
	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

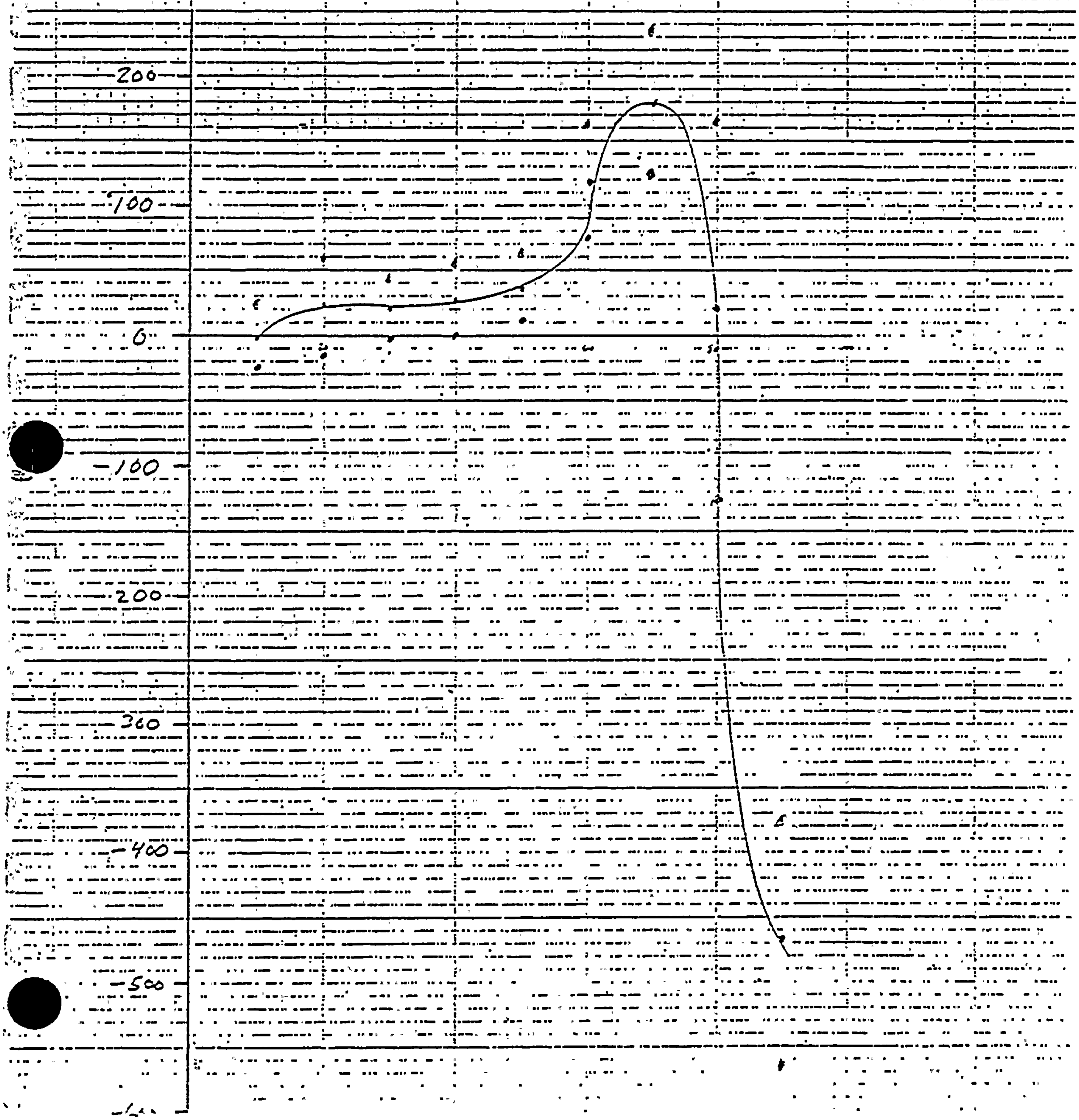
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE 12" 150 Page

Calc. By C. LIVORSI Checked By

STEM DOWNSTREAM

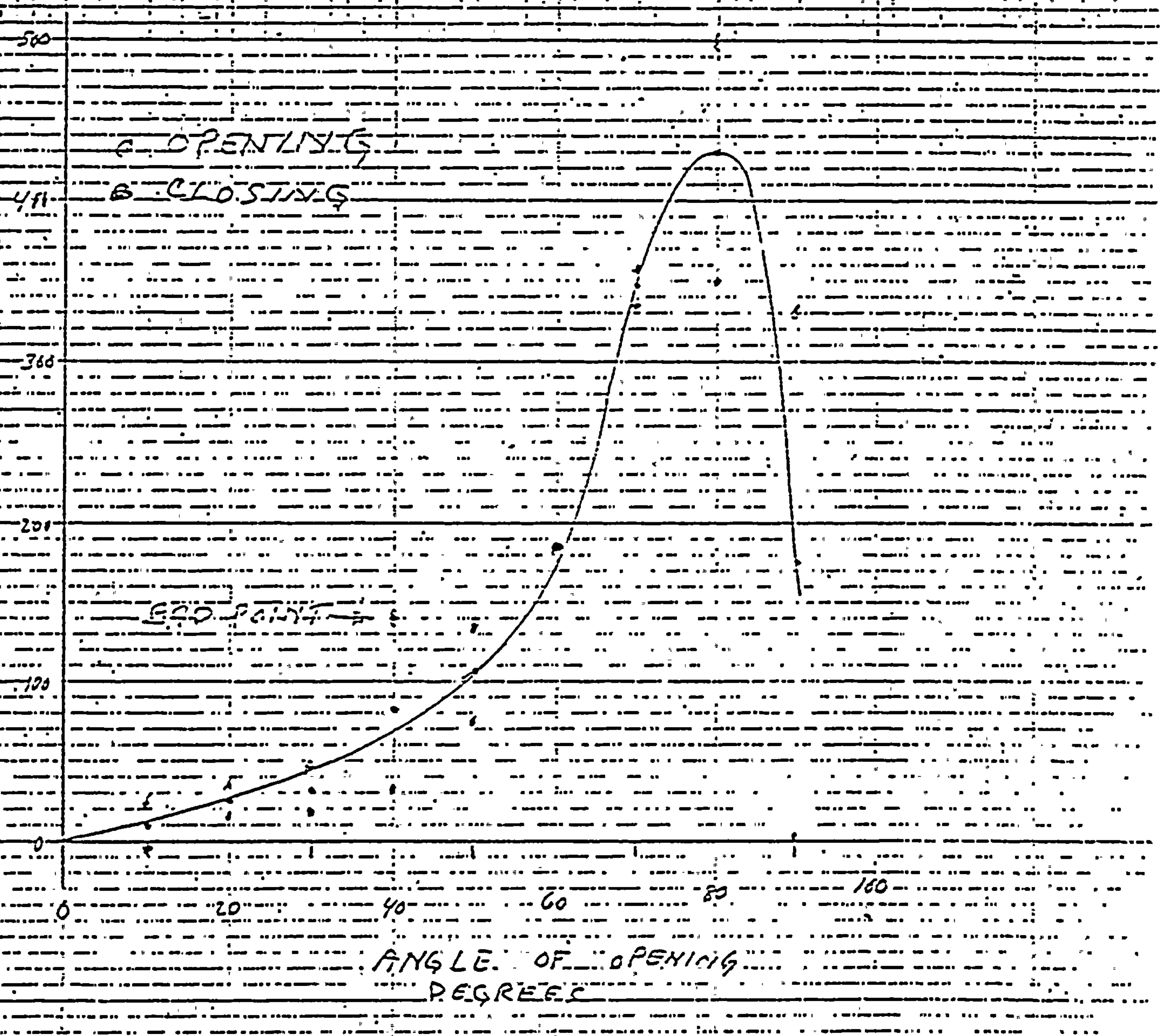


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 STEM UP STREAM HYDRO DYNAMIC TORQUE CURVE Page

Calc. By C. LIVERSI Checked By

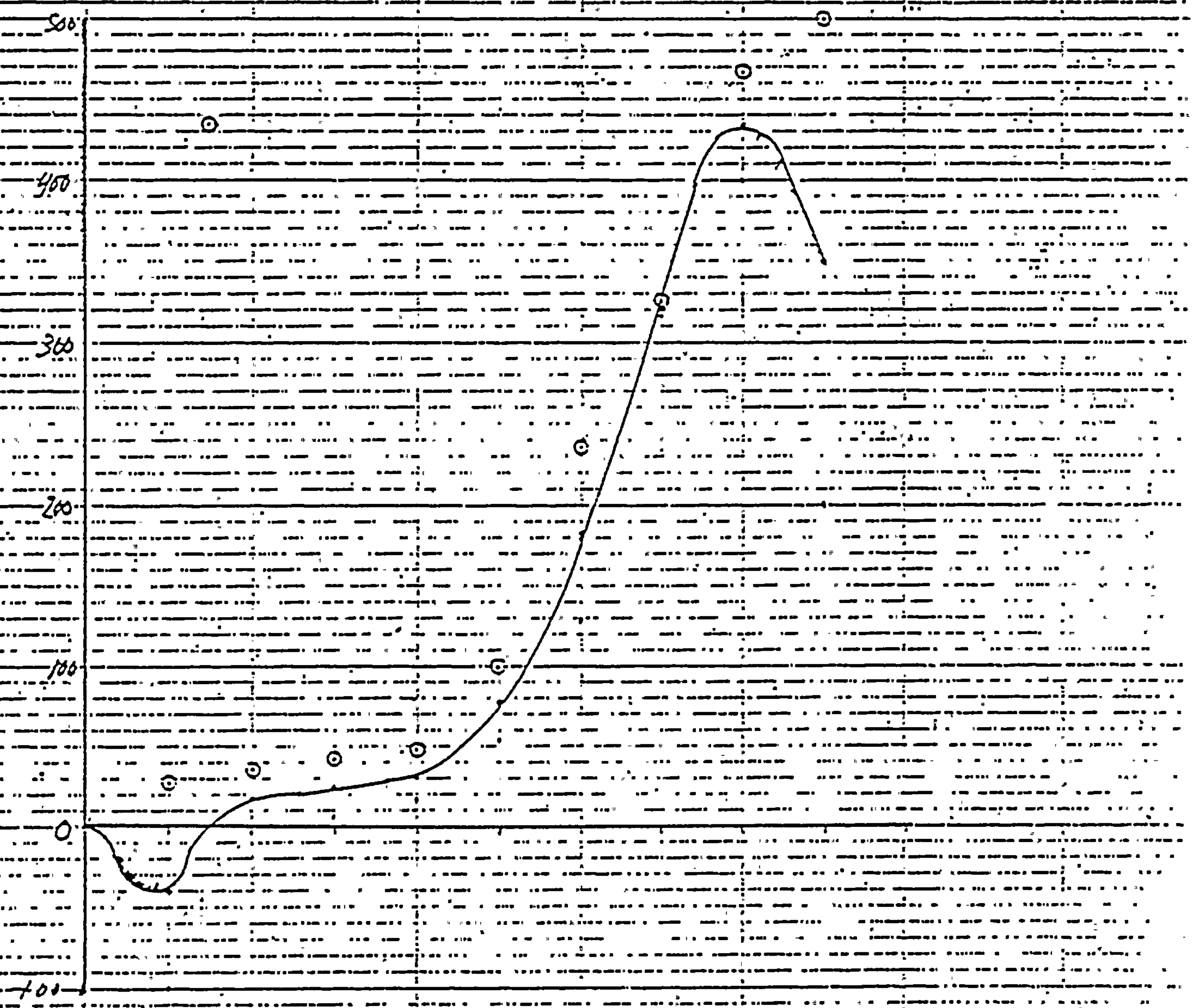


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 (PREFERED) HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. Livorsi Checked By



POSI-SEAL INTERNATIONAL, INC.

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)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN	
OPENING	0					
	10	49.5	525	11	21.5 675	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

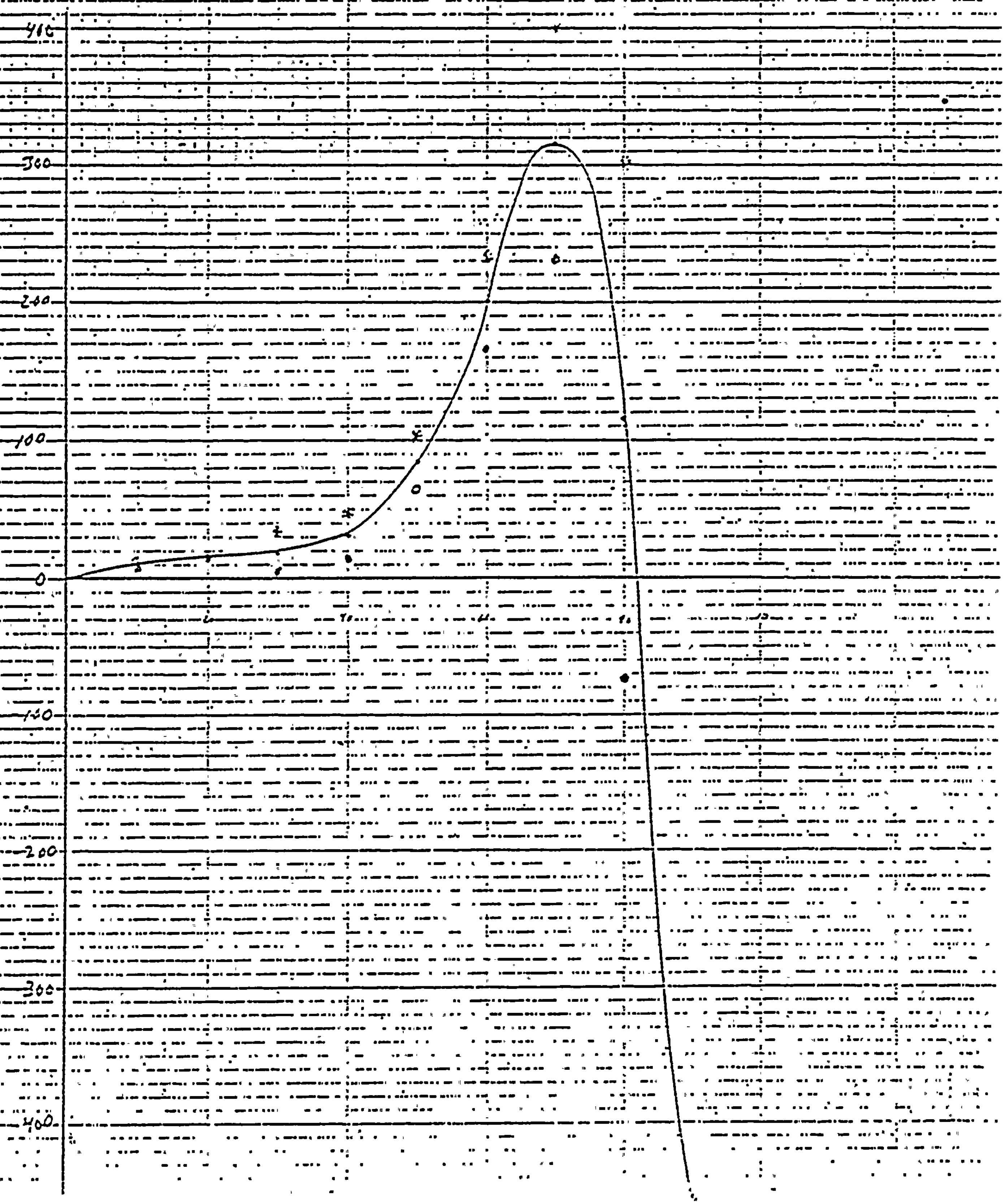
: 5 FT-LB ~~IN-LB~~ CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 14" 150 STEM DOWN STREAM Page

Calc. By C. LIVORSI Checked By



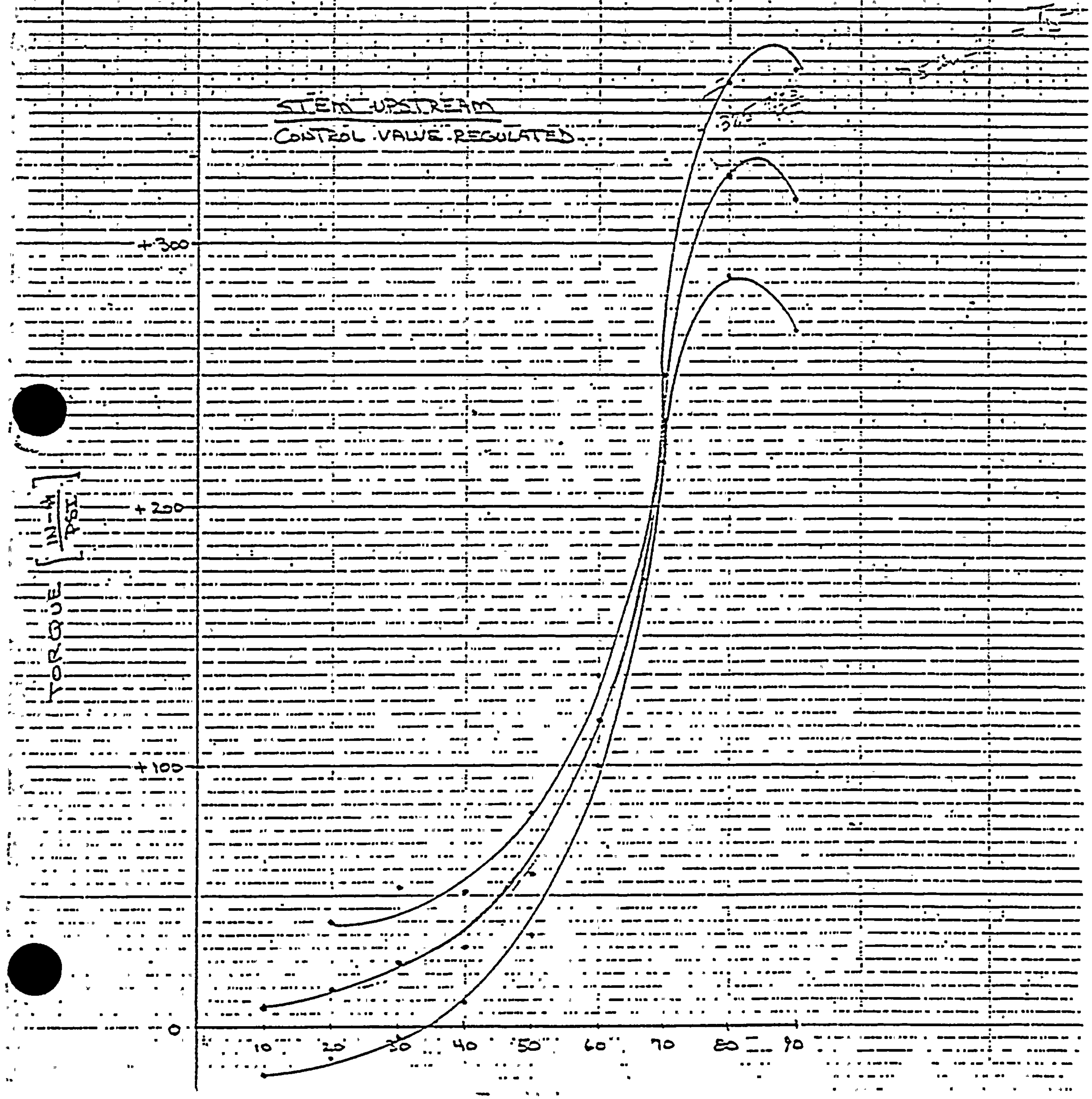
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title TORQUE VS. VALVE ANGLE Page

Calc. By R. QANSEN Checked By

10" - 150

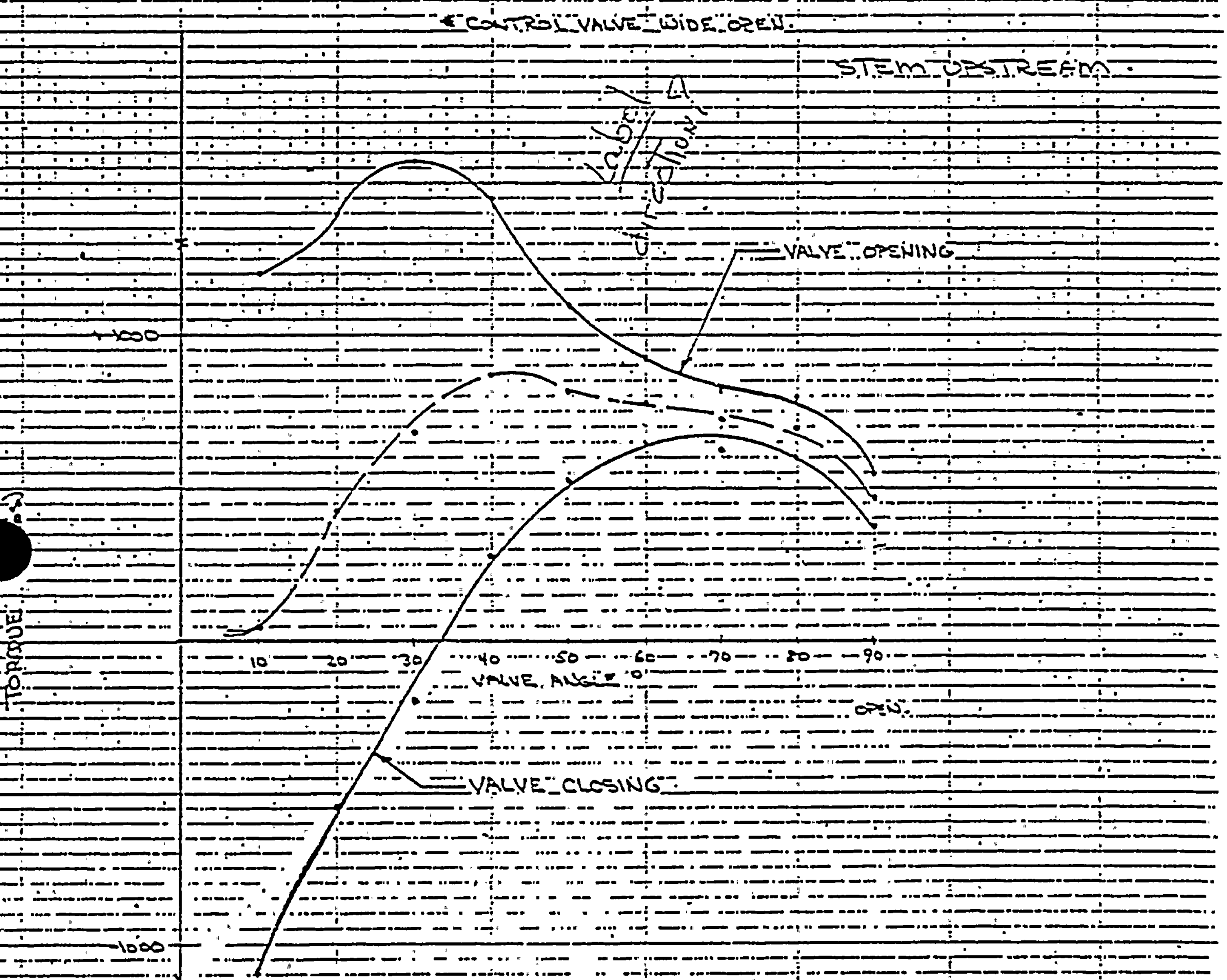


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title VALVE TORQUE - 10" - 150 Page

Calc. By Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. 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	COMENTS + 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

Calc. 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: 200 IN-LB OPENING

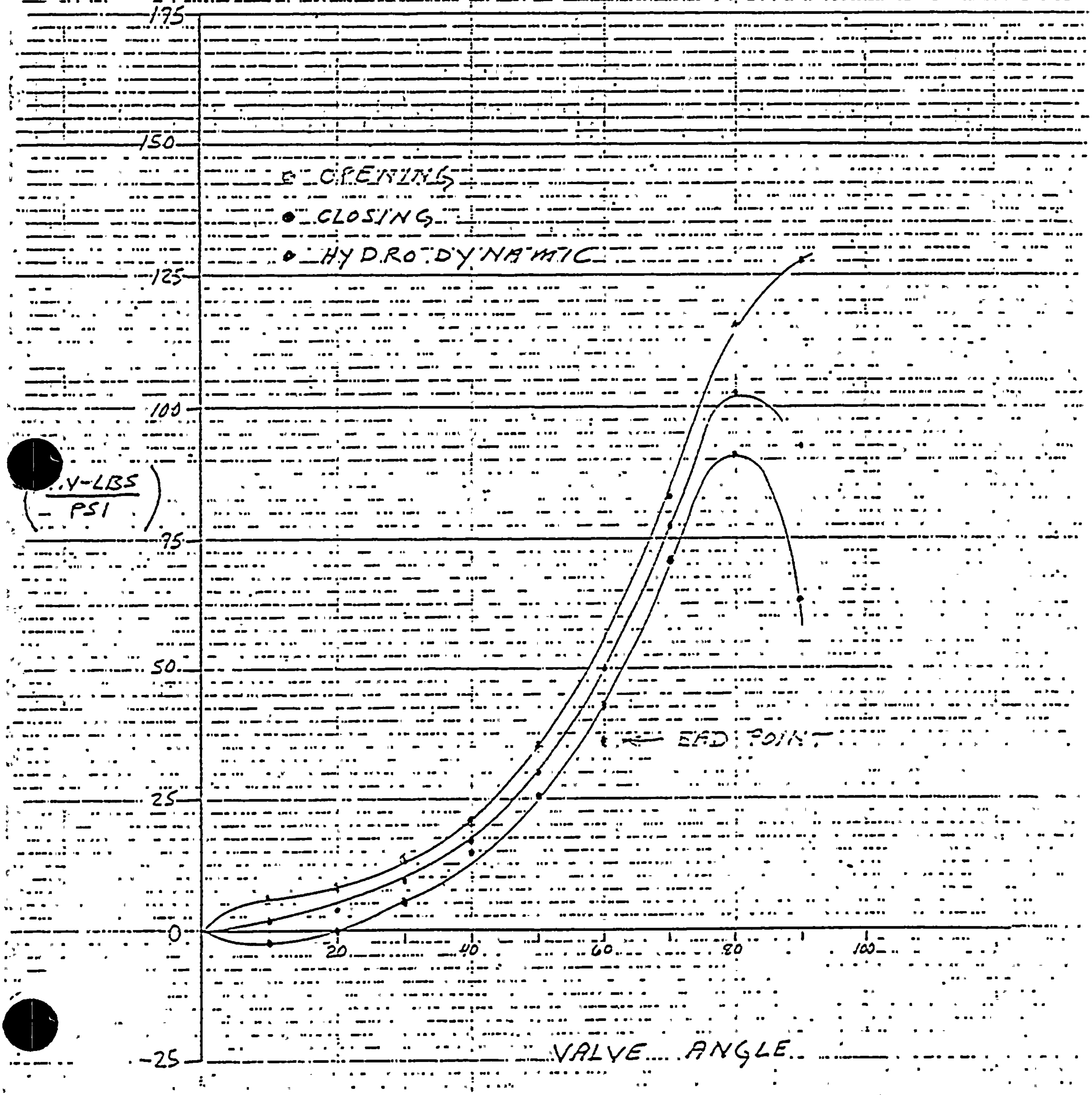
200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: 8" 300LB HYDRO DYNAMIC TORQUE CURVE   Page

Calc. By: C. LIVORSI   Checked By:

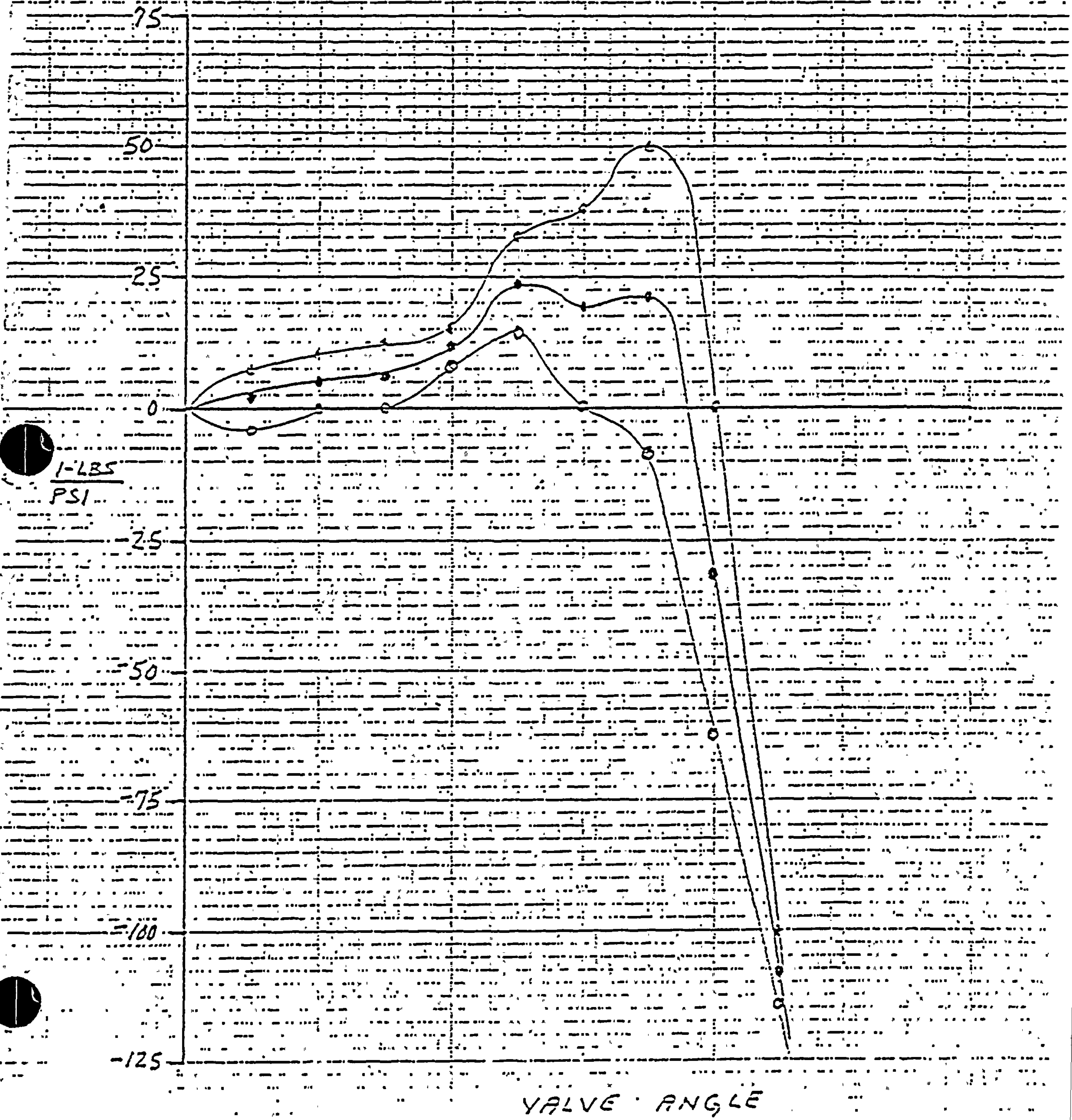


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8"-300 HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (UNPREFERED) Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By GANSEN 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		10		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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By QUANSEN DATE: 7/20/77 Checked By:

VALVE SIZE: 10" 300

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNS~~

VALVE SEAL TYPE: TEFLON / BORA

WATER TEMPERATURE (TANK): 87 °F

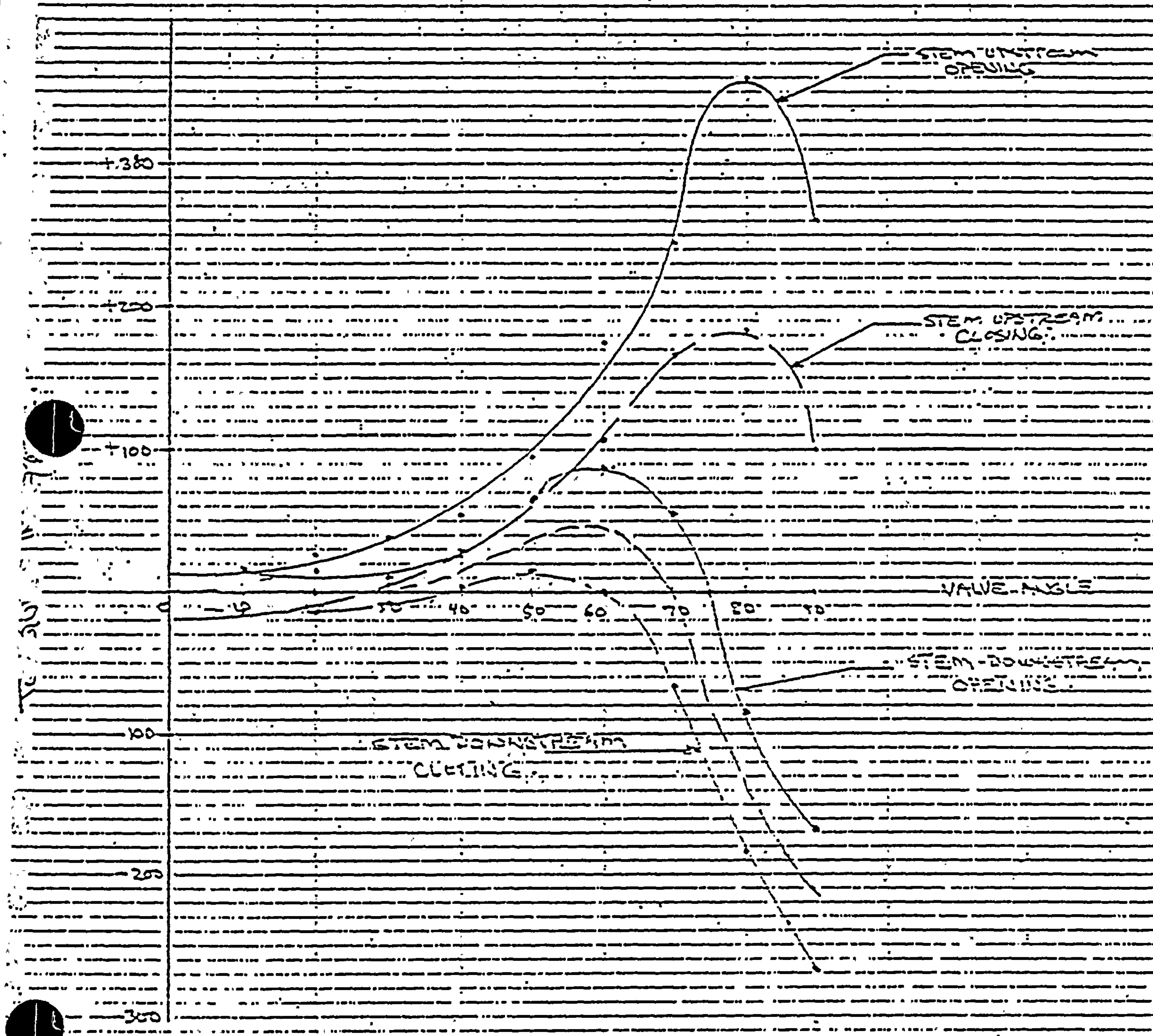
DISC TYPE & DWG:

	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		26		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		16		650
	30		17.5		75
	20		26		0
	10		55 20		650 300
	0	0	~~X~~	0	~~X~~

PACKING TORQUE: 200 IN-LB OPENING

250 IN-LB CLOSING

TORQUE VS. VALVE ANGLE



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By GANSEN DATE 3/21/77 Checked By

VALVE SIZE: 3" -600

VALVE DIRECTION STEM UPSTREAM / STEM DOWNSTREAM

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		41.5		−5
	20		46.5		10
	10		47.5		+25
	0				

PACKING TORQUE: 10 IN-LB OPENING

5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 3/21/73 Checked By:

VALVE SIZE: 3" - 600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTRE

VALVE SEAL TYPE: TEFLON / RING

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		35		+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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] 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		19		+250
	90		16.5		+150
CLOSING	90		16.5		+175
	80		19		+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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By OLSEN 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 [illegible] 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	[illegible]
	40		25		+400	+6
	50		19.5		+450	[illegible]
	60		20.5		+450 +4.95	
	70		15		+250 +4.67	0
	80		10.5/18.5		0 250	-13
	90		15.5		650	[illegible]
			X		X	
CLOSING	90		15.5		800	[illegible]
	80		19.0		525	-27
	70		18.5		200	-10
	60		26		+50	[illegible]
	50		28		+50	[illegible]
	40		33		0	0
	30		34		275	-8.0
	20		32.5		350	-10
	10		39		350	-9.9
	0	41	X	41	X	

PACKING TORQUE: 175 IN-LB OPENING

: 225 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] 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]

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB		
OPENING	0		X	6	X		X
	10		30.5	59.5	+250	6.6	+325
	20		33	58.5	+300	9.1	+50
	30		24	55.5	+300	12.5	+45
	40		25	49.5	+300	12	+55
	50		26.5	44.5	+400	15.1	+625
	60		20	32.5	+450	22.5	+900
	70		19.5	24.5	+650	33.3	+8
	80		19.2	19.0	+1025	53.4	+9
	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	38.9	+6
	70		24.2	24.4	+825	34.1	+9
	60		20.5	31.5	+225	11	[illegible]
	50		24.5	43.5	+100	4.1	+2
	40		34.5	50.5	+25	.7	[illegible]
	30		34.5	55.5	50	1.4	[illegible]
	20		38.5	58	75	1.9	[illegible]
	10		34.8	60.5	275	5.1	[illegible]
	0	0	X	7	X		X

PACKING TORQUE: 75 IN-LB OPENING

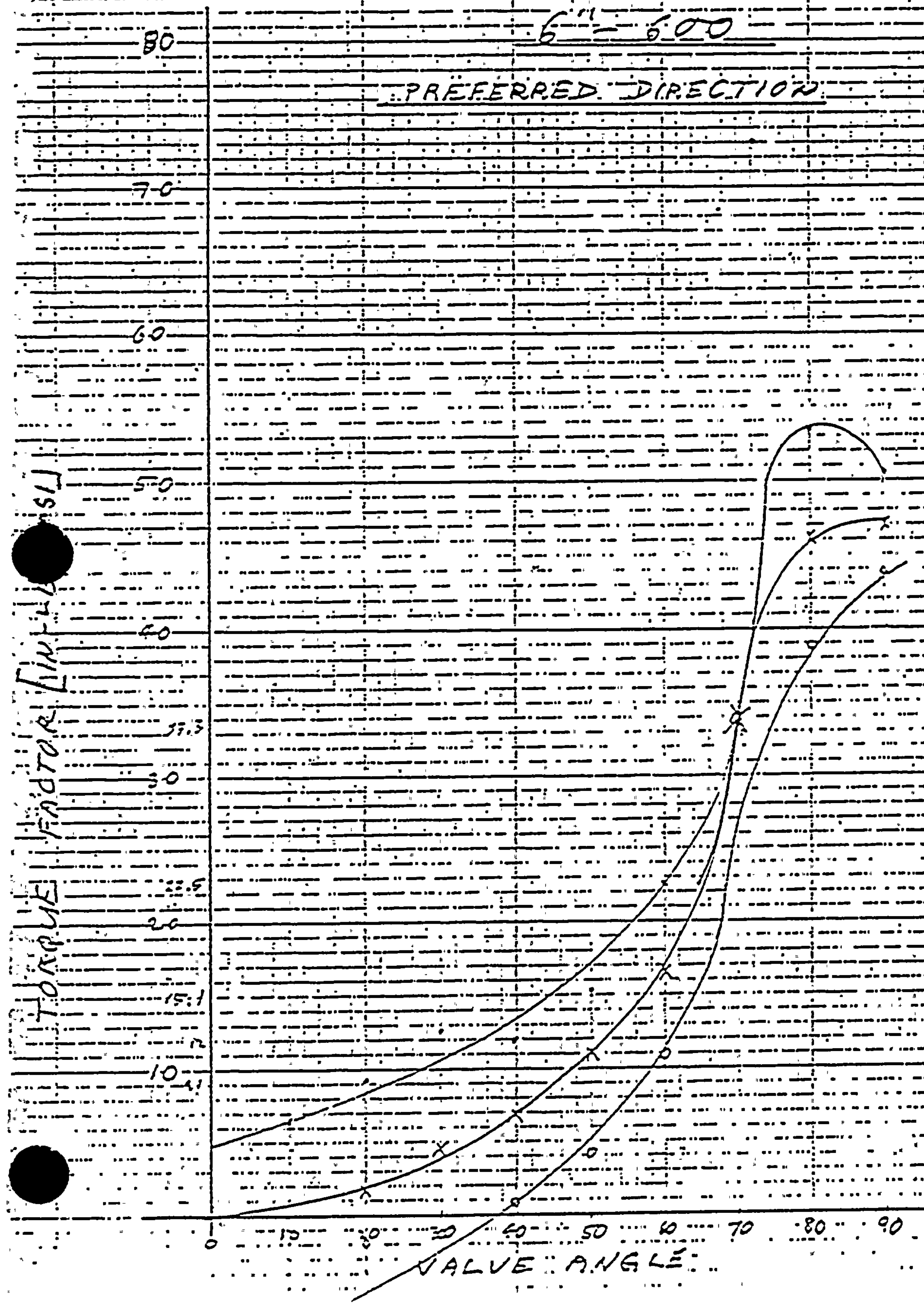
25 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

Calc. By J. CORY 8/23/77 Checked By



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

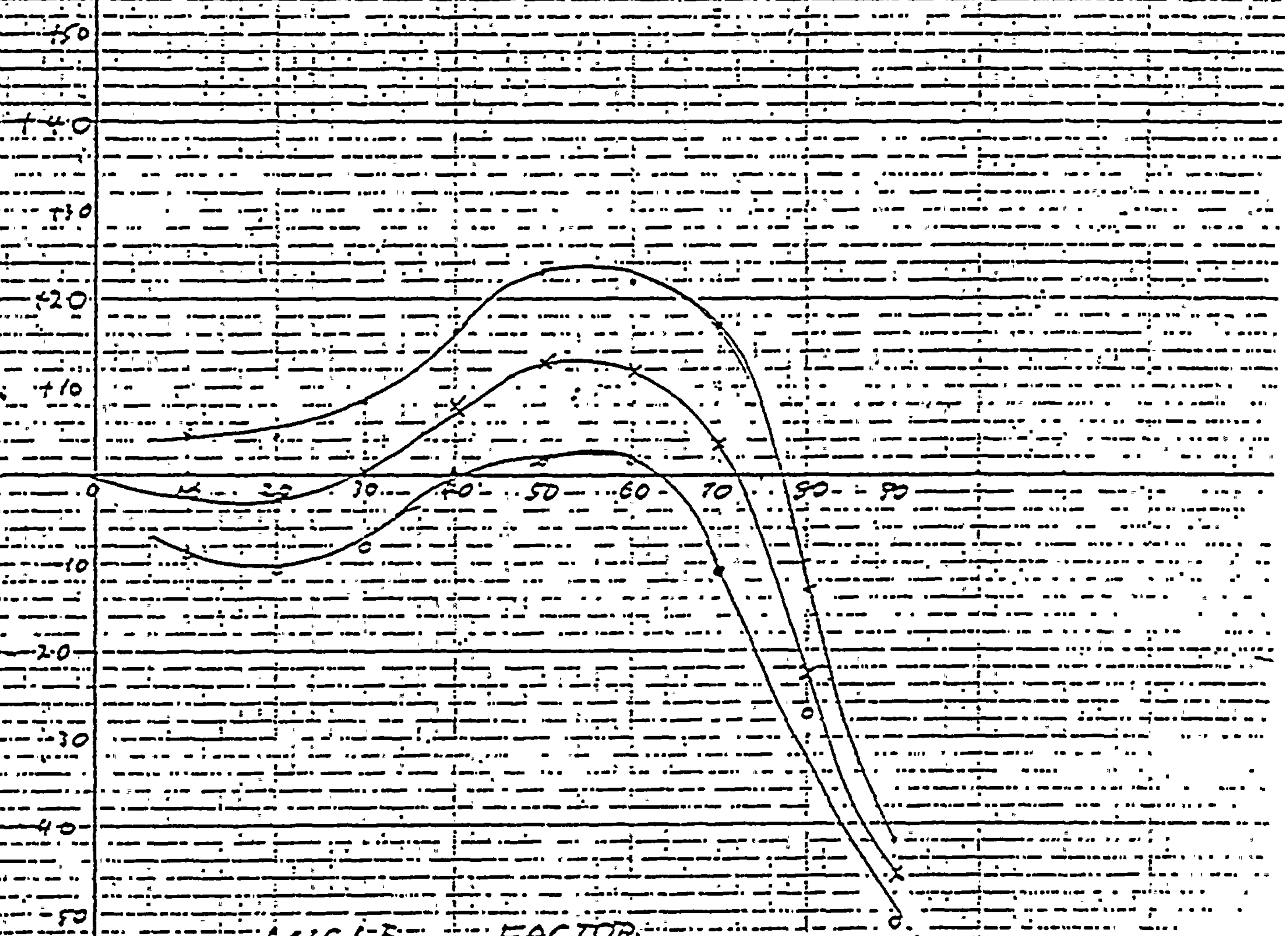
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

Calc. By J CORY 8/23/77 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
90	-[illegible]

Title: HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By C. Livorsi 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
	80	5.0	−125	−25	NEG
	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. LIVOLSI DATE: Checked By:

VALVE SIZE: 8" 600

VALVE DIRECTION: STEM UPSTREAM ☒ / STEM DOWNS ☐

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	142.5	
	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	325	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

: 150 IN-LB CLOSING

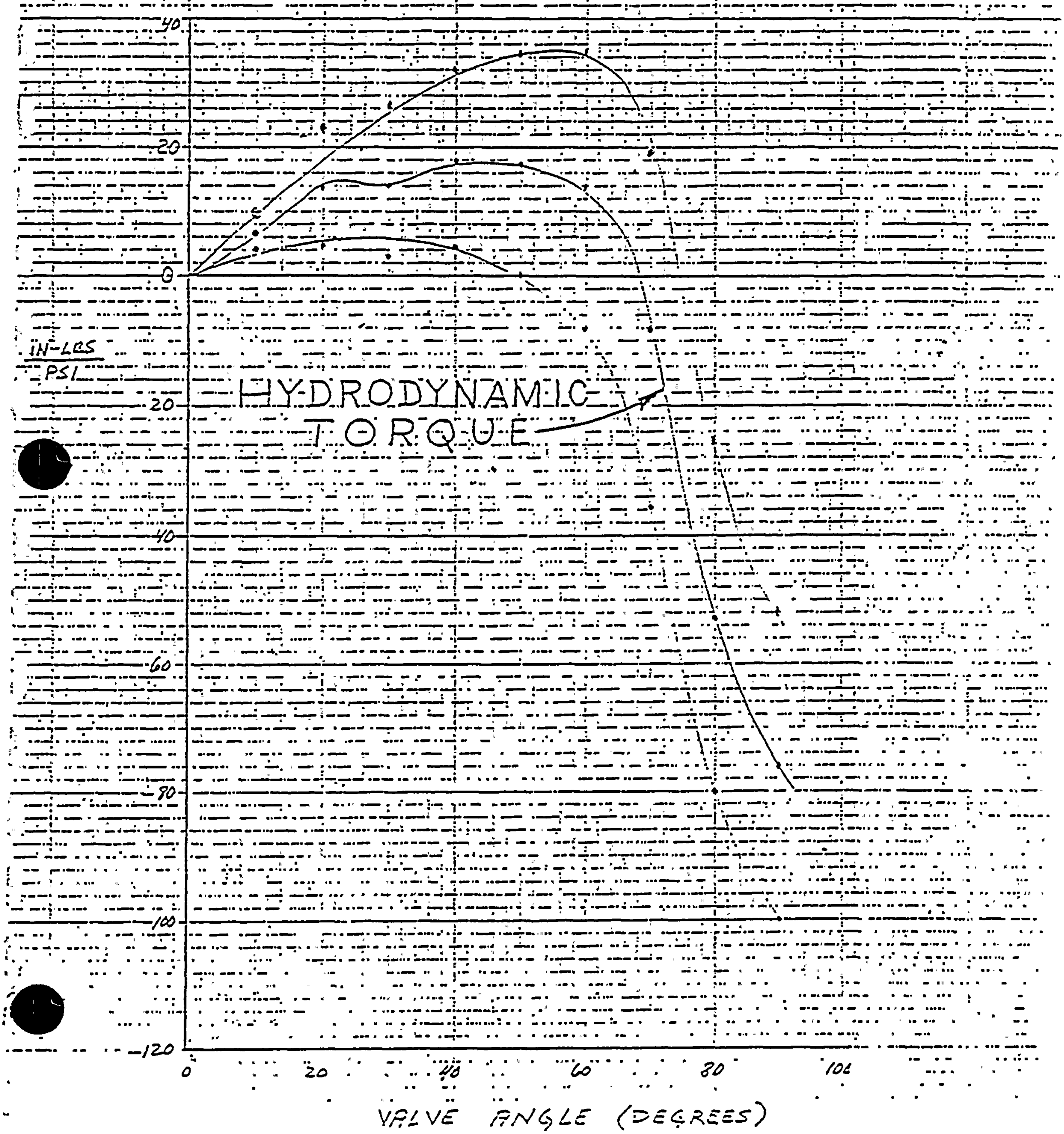
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" 600 LB

Title HYDRODYNAMIC TORQUE CURVE (NON-PREF. DIRECTION) Page

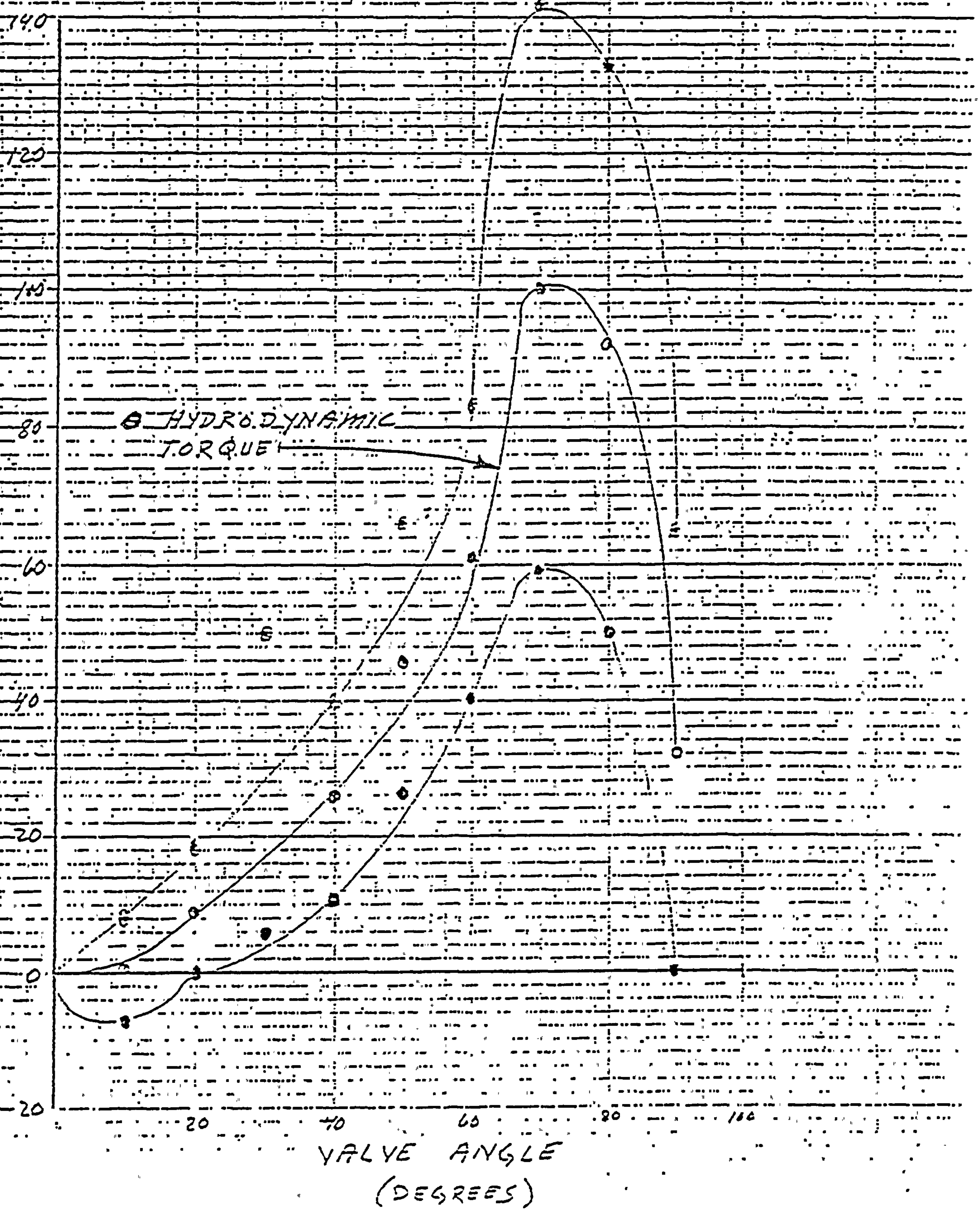
Calc. By: C. LIVORSI Checked By:



8" 600 L.B. ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE (PERF. DIRECTION) Page

Calc. By C. LIVORSI Checked By



ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ØLSEN DATE: 8/3/77 Checked By

Control valve - regulated

VALVE SIZE: 10" - 600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNST.

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 84 °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~~		
	10		~~47~~ 38.5		+900 ✓
	20		~~32~~ 25.5		+1200 ✓
	30		~~28.3~~ 25		~~+1550~~ +1500
	40		~~[illegible]~~ 24		~~+1800~~ +1750
	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	~~85~~ 85		4.5		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	9	~~X~~	0	

PACKING TORQUE: 350 IN-LB OPENING

450 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] 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		+900
	40		24.5		~~[illegible]~~ 500
	50		14.0		+1100
	60		9.1		+950 +500
	70		5.8		+600 +400
	80		4.3 4.7		381 ~~[illegible]~~ 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		450
	20		32		750
	10		37		800
	0		X		X

PACKING TORQUE: ~~50~~ 450 IN-LB OPENING

~~450~~ 150 IN-LB CLOSING

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [illegible] 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		~~60~~ +1500
	20		48.5		+950
	30		37		+725
	40		25.5		+250
	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		1250
	80		4.2		800
	70		6.4		550
	60		7.8		500
	50		14.0		325
	40		24.5		−325
	30		37.2		575
	20		49.0		950
	10		57.5		1025
	0		X		X

PACKING TORQUE: ~~850~~ 750 IN-LB OPENING

~~[illegible]~~ 750 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 ☐

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 DOWNST ☒

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-LBS~~ OPENING

: 70 ft-LBS ~~IN-LB~~ CLOSING

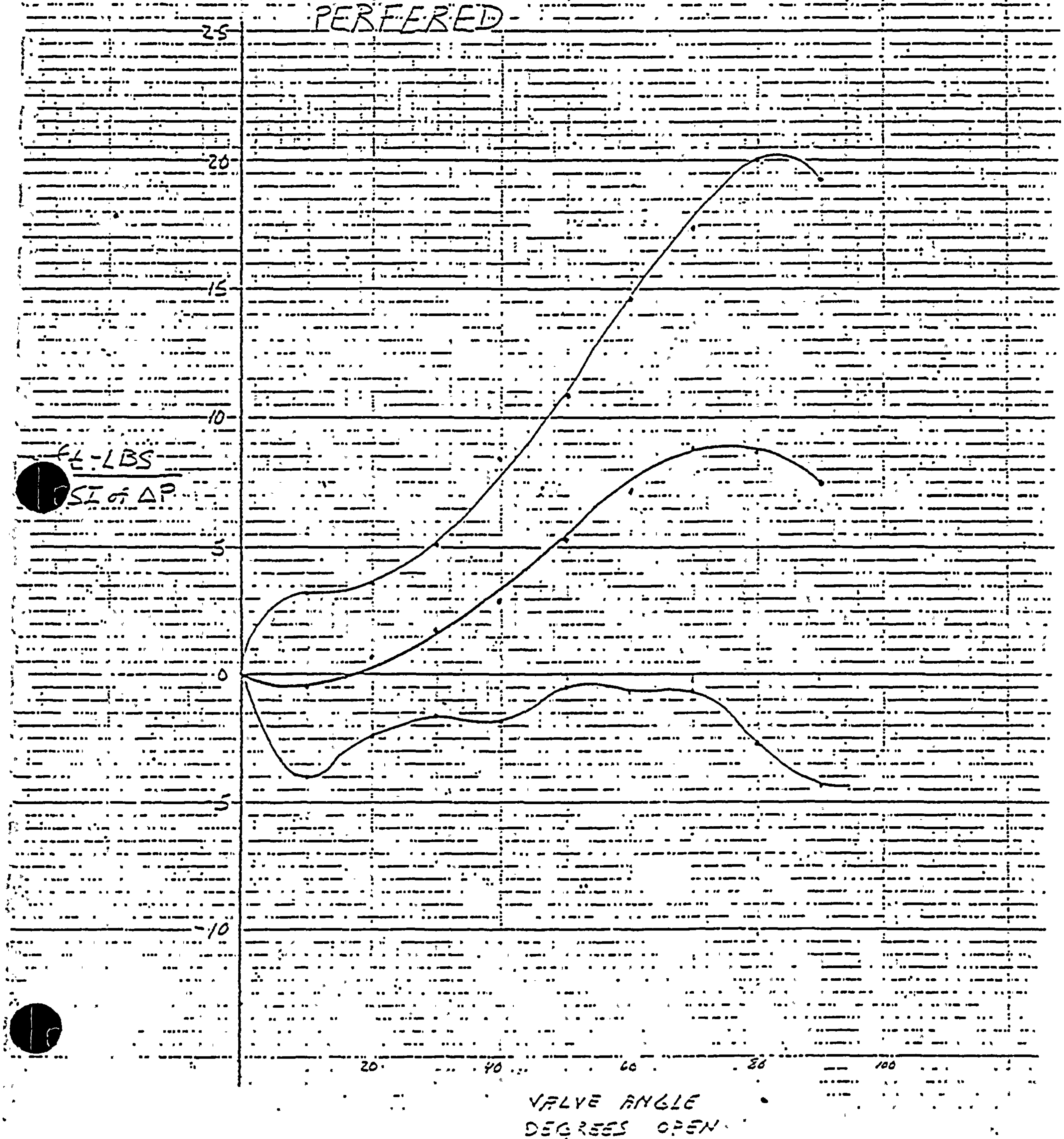
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. Livorsi Checked By

PERFERED

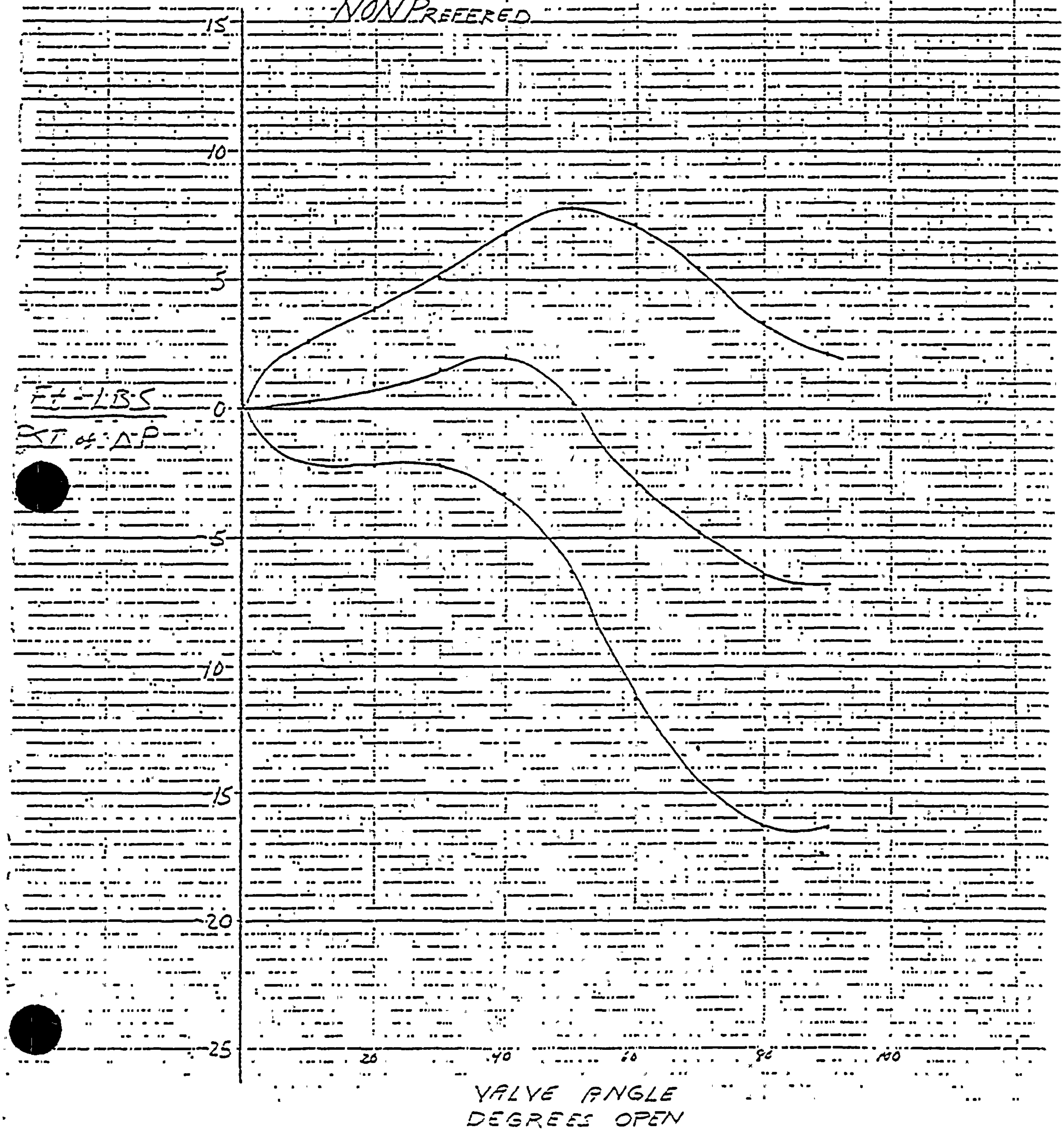


POS-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

c. By C. LIVORSI Checked By



POSI-SEAL INTERNATIONAL, INC.

Innovators in Flow Control

TECHNICAL BULLETIN NO. 1A

Operating torque values and Actuator sizing

JUNE 82

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 x PSIΔP) = 70 + 986 + (10.10 x 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 I

CLASS 150 STANDARD 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"	529	49	397	902	541	451	1804	2074	3.23	2.15
10"	680	63	510	1398	839	699	2796	3215	6.44	4.29
12"	756	70	567	1972	1183	986	3944	4535	10.10	6.73
14"	832	77	624	2424	1454	1212	4848	5575	13.66	9.11
16"	907	84	680	3164	1898	1582	6328	7277	19.44	12.96
18"	1058	98	794	3994	2396	1997	7988	9186	28.64	19.09
20"	1210	112	907	4914	2948	2457	9828	11302	40.28	26.85
24"	1512	140	1134	7564	4538	3782	15128	17397	77.48	51.65
30"	1814	168	1361	11982	7189	5991	23964	27558	147.28	98.19
36"	2268	210	1701	17426	10456	8713	34852	40080	267.76	178.51
42"	2419	672	1814	23795	14277	11897	47590	54728	390.00	....
48"	2722	756	2041	30864	18518	15432	61728	70987	569.00	....
54"	2722	756	2041	39849	23909	19924	79698	91653	734.70	....
60"	3024	840	2268	49280	29568	24640	98561	113345	1010	....
66"	3326	924	2495	59937	35962	29969	119875	137856	1351	....
72"	3629	1008	2722	71355	42813	35677	142709	164115	1754	....

CLASS 150 150PSI RATING

VALVE SIZE	PRELOAD = $T_1 + T_2$								STATIC PRESSURE TORQUE PER PSI T_3	
	T_1			T_2						
	A	B	C	E	F	G	H	J	316 M.S.	REXNORD
24"	1210	112	907	7194	4316	3597	14388	16546	58.96	39.31
30"	1512	140	1134	12038	7223	6019	24076	27687	123.32	82.21
36"	1663	154	1247	17420	10452	8710	34840	40066	196.28	130.85
42"	1966	546	1474	23846	14308	11923	47693	54847	317.50	....
48"	2268	630	1701	31069	18642	15535	62139	71460	477.30	....
54"	2268	630	1701	39849	23909	19924	79698	91653	612.12	....
60"	2268	630	1701	49484	29691	24742	98969	113814	760.30	....
66"	3024	840	2268	59937	35962	29969	119875	137856	1228	....
72"	3024	840	2268	71661	42997	35830	143322	164820	1468	....

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

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

TABLE 3
TORQUE VALUES (In. Lbs.)
Class 600 Posi-Seal Trunnion Valves

VALVE SIZE	PRELOAD TORQUE ($T_1 + T_2$)									STATIC PRESSURE TORQUE PER PSI T_3	
	T_1				T_2						
	A	B	C	D	E	F	G	H	J	316 M.S.	REXNORD
3"	342	AVAILABLE ON APPLICATION	257	95	120	72	NOT AVAILABLE IN CLASS 600	AVAILABLE ON APPLICATION	276	0.27	.18
4"	454		340	126	202	121			465	0.63	.42
6"	529		397	147	496	298			1141	1.77	1.18
8"	907		680	252	770	462			1771	4.73	3.15
10"	1058		794	294	1234	750			2838	8.85	5.9
12"	1361		1021	378	1724	1034			3965	15.89	10.59
14"	1512		1134	420	2078	1247			4779	21.29	14.19
16"	1814		1361	504	2698	1619			6205	33.17	22.11
18"	2117		1588	588	3532	2119			8124	50.64	33.76
20"	2419		1814	672	4238	2543			9747	69.4	46.27
24"	2722		2041	756	6422	3853			14770	118.4	78.93

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 — available on application
(C) Graphite jam packing
(D) Teflon jam packing

T_2 (E) Metal seal ring with and without rubber back-up ring, Kel-F ring without rubber back-up ring
(F) Tefzel seal ring with rubber back-up ring
(G) Not available on Class 600
(H) Metal seal ring with Teflon insert and rubber back-up ring — available on application
(J) Metal seal ring with Tefzel, or Kel-F insert and rubber back-up ring (urethane insert available on application)

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.

By utilizing torque values T_1 and T_3 along with the applicable disc hydrodynamic lift and drag torque values T_4 or T_5 listed in Tables 4 thru 9, the total valve operating hydrodynamic torque TH_T can be calculated as follows:

RETAINING RING DOWNSTREAM

$TH_T = T_1 + (T_3\Delta P) + (T_4\Delta P)\ G_f$

RETAINING RING UPSTREAM

$TH_T = T_1 + (T_3\Delta P) + (T_5\Delta P)\ G_f$

TH_T = Total valve operating hydrodynamic torque, in. lbs.

T_1 = Packing torque, in. lbs. Tables 1, 2, and 3.

T_3 = Stem bearing friction torque (static pressure torque per PSIΔP), in. lbs. Tables 1, 2, and 3.

T_4 = Disc hydrodynamic lift and drag torque, in. lbs. Flow into valve with retaining ring downstream.

T_5 = Disc hydrodynamic lift and drag torque, in. lbs. Flow into valve with retaining ring upstream.

ΔP = Differential pressure across valve, PSI.

G_f = Specific gravity of liquid at flowing conditions.

$$G_f = \frac{\text{Density of liquid at flowing conditions}}{\text{Density of water at standard conditions}}$$

EXAMPLE:

A. Requirement — What is the total valve hydrodynamic torque of a 12" CLASS 150 Valve with teflon chevron packing, flowing water into the valve from the stem side (retaining ring downstream) with a calculated ΔP of 10 PSI at the 70° disc open position.

B. Solution —

$TH_T = T_1 + (T_3\Delta P) + (T_4\Delta P)\ G_f$

$TH_T = 70 + [10.10\ (10)] + [692\ (10)]\ 1.0$

$TH_T = 7091$ in. lbs.

Where —

T_1 = 70 in. lbs.

T_3 = 10.10 in. lbs.

T_4 = 692

G_f = 1.0

NOTE:

When in doubt about the maximum total valve hydrodynamic torque for a specific application, contact Posi-Seal factory for assistance.

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	225931	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 5

CLASS 150 STD. RATING

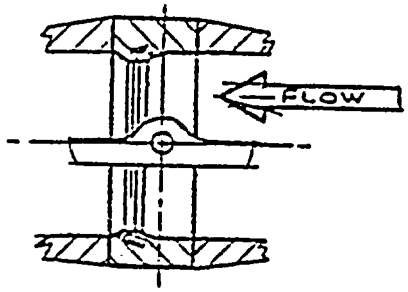
Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque – T_5

VALVE SIZE	T_5 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
......	....	....	....	....	....	....	....	....	....
......	....	....	....	....	....	....	....	....	....
3"	0	0	0	0	0	1	1	0	–5
4"	0	0	0	0	1	3	4	0	–13
6"	0	1	2	2	5	13	19	–1	–56
8"	2	4	8	10	18	46	69	–4	–204
10"	3	6	13	16	.29	75	112	–6	–330
12"	7	15	30	38	68	175	258	–15	–761
14"	11	23	47	59	106	271	402	–23	–118
16"	20	41	82	102	184	471	697	–41	–2052
18"	32	64	129	162	292	746	1103	–64	–3245
20"	49	99	198	248	447	1144	1691	–99	–4974
24"	107	214	429	536	966	2468	3649	–214	–10734
30"	231	462	925	1156	2081	5320	7864	–462	–23131
36"	942	1884	3768	4710	8479	21669	32032	–1884	–94213
42"	1140	2281	4563	5704	10268	26242	38793	–2281	–114098
48"	1632	3265	6531	8164	14696	37558	55521	–3265	–163299
54"	3694	7388	14777	18471	33248	84968	125605	–7388	–369428
60"	5583	11165	22330	27913	50244	128402	189812	–11165	–558270
66"	7471	14942	29884	37355	67240	171835	254018	–14942	–747112
72"	11497	22995	45990	57488	103479	264447	390922	–22995	–1149773
CLASS 150 150 PSI RATING									
24"	127	255	510	637	1148	2934	4337	–255	–12758
30"	428	857	1715	2144	3860	9864	14582	–857	–42890
36"	896	1792	3584	4480	8064	20609	30466	–1792	–89607
42"	1601	3202	6405	8007	14412	36832	54448	–3202	–160142
48"	2706	5412	10824	13530	24354	62240	92007	–5412	–270609
54"	3668	7336	14673	18341	33015	84372	124724	–7336	–366835
60"	7214	14428	28857	36072	64929	165931	245290	–14428	–721442
66"	7471	14942	29884	37355	67240	171835	254018	–14942	–747112
72"	15062	30124	60248	75310	135559	346428	512112	–30124	–1506212

1. T_5 values = in. lbs. per PSIΔP.
2. Except as noted, T_5 values are positive acting to shut valve.
3. Negative (–) T_5 values act to move the disc to th full open (90°) position.
4. 0 T_5 values $\cong <$ 1.

TABLE 6

CLASS 300 STD RATING



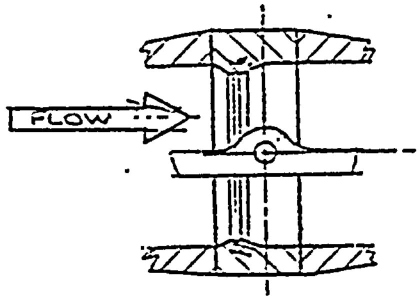
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

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 7

CLASS 300 STD RATING



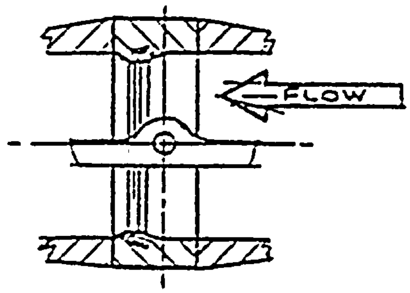
Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque – T_5

VALVE SIZE	T_5 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
......	......	......	......	....	....	....	....	....	....
......	......	......	......	....	....	....	....	....	....
3"	0	0	0	0	0	1	1	0	−5
4"	0	0	0	0	1	3	4	0	−13
6"	0	1	2	2	5	13	19	−1	−56
8"	0	1	2	6	8	10	4	−22	−68
10"	1	3	6	14	21	24	11	−53	−162
12"	3	7	14	31	46	53	24	−117	−355
14"	4	9	19	44	64	74	34	−163	−495
16"	6	12	24	55	80	93	43	−204	−620
18"	14	28	57	129	187	215	100	−474	−1438
20"	15	30	61	138	200	231	107	−508	−1540
24"	20	41	83	187	271	313	146	−689	−2088
30"	71	143	286	644	931	1074	501	−2364	−7165
36"	143	287	574	1292	1867	2154	1005	−4739	−14363
42"	343	686	1372	3087	4459	5145	2401	−11319	−34300
48"	214	429	858	1930	2788	3217	1501	−7078	−21451

1. T_5 values = in. lbs. per PSIΔP.
2. Except as noted, T_5 values are positive acting to shut valve.
3. Minus T_5 values are negative and act to move the disc to the full open (90°) position.
4. 0 T_5 values ≅ < 1.

TABLE 8

CLASS 600 STD RATING



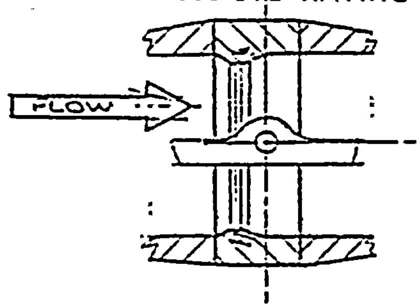
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

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 $\cong < 1$.

TABLE 9

CLASS 600 STD RATING



Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque — T_5

VALVE SIZE	T_5 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	0	1	2	3	2	0	−6	−13
8″	0	2	3	8	9	9	−2	−22	−43
10″	1	5	9	21	24	22	−6	−55	−105
12″	1	7	13	30	35	32	−9	−82	−154
14″	2	10	18	41	48	43	−12	−110	−208
16″	2	13	25	55	64	58	−16	−147	−279
18″	3	16	30	66	76	70	−20	−177	−334
20″	3	15	28	63	73	66	−19	−168	−317
24″	12	63	115	255	293	268	−76	−677	−1278

1. T_5 values = in. lbs. per PSIΔP.
2. Except as noted, T_5 values are positive acting to shut valve.
3. Negative (—) T_5 values act to move the disc to the full open (90°) position.
4. 0 T_5 values $\cong < 1$.

III. AERODYNAMIC TORQUE

Aerodynamic torque resulting from gaseous flow is negligible compared to Hydrodynamic torque. However, when in doubt concerning a specific application (such as applications where flow is sonic) consult the factory.

IV. ACTUATOR SELECTION

Published torque values for Posi-Seal Trunnion Valves include adequate safety factors and do not require additional safety factors. However, when sizing actuators for specific valve torque requirements, decrease the published actuator torques by at least 10% to allow for a realistic safety factor in actuator selection. When selecting fail safe actuators, the torque output at the end of the actuator spring stroke (ending torque) should be used as the basis for actuator selection. When the operating ΔP used for actuator selection is less than maximum line pressure, contact the factory for sizing torque.