REVISIONS				
LTR	CALC	DATE	APPV	DATE
A	BR	1/13/82	[illegible]	1/15/8[illegible]

POSI-SEAL INTERNATIONAL, INC.

North Stonington, CT 06359

Stone & Webster Engineering
J.O. No. 12177
Spec. No. P304D
RELEASED FOR: RETURN TO SUPPLIER / ENG & DESIGN / FABRICATION / FOR CONSTRUCTION
APP - Approved
AAR - As Noted As Required
UNA
SLI
FIO - For Information Only
Date 2/12/86
By [illegible]
EdAu 3/11/86

LOCA & SEISMIC ANALYSIS

CUSTOMER: Niagara Mohawk Power Corp.

UNIT: Nine Mile Point Nuclear Station - Unit 2

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

SPEC. NO.: NMP2-P304D

REPORT NO.: 33375SL-001

CALCULATED BY: [signature]

DATE: 7/17/84

APPROVED BY: John M. Cory

DATE: July 18, 1984

REVISION A - Revised Pages 1,2,5,6,7,8,10,24 and 27 thru 36
Added Page 37

Revised Appendices A,B,C,D,E and F

Deleted Appendices G and H

The revision was made to take into effect having elbows upstream of Valves AOV107 and 109, and to decrease the disc pin allowable stress to 21120 psi.

The revision also addressed the fact that all the valves are to be installed in the preferred direction.

TABLE OF CONTENTS

ENCLOSURE (1) Valve Assembly Dwgs 19157-3 Rev. B
19157-4 Rev. A
19157-5 Rev. D
(2) Posi-Seal Technical Bulletin No. 2, dated June 1982
(3) Derivation of Hydrodynamic Torque Curves
(4) Posi-Seal Technical Bulletin No. 1A, dated June 1982

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
(d) Stone & Webster Letter No. 9M2-15,128 dated December 13, 1983
(e) Stone & Webster Dwg 12177-EB-15AJ-9
(f) Stone & Webster Dwg 12177-EB-15N-10
(g) Stone & Webster Dwg 12177-EB-15P-9
(h) Stone & Webster Dwg 12177-EB-15F-9
(i) Stone & Webster Dwg 12177-EB-15G-8
(j) Stone & Webster Sketch EB-15F
(k) Stone & webster Sketch EB-15G
(l) Stone & Webster Telex, dated 11/19/85

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

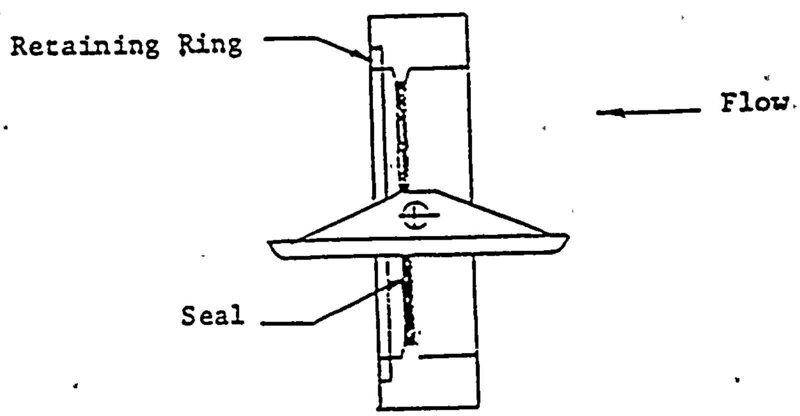


Figure 1

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

ıg No.	AOV106	AOV104	AOV108	AOV110
ɜi Item No.	3	3	3	3
ıse No.	1A	1B	2A	2B
ılve Size	14"	14"	14"	14"
ɛttis Actuator Model	N721C-SR80	N721C-SR80	N721C-SR80	N721C-SR80
ctuator Max Allow Torque	22,500	22,500	22,500	22,500
ıx Torque Resulting from a LOCA (in.lbs)				
ɾeferred Direction				
80°	6170	6519	5848	9584
70° Max Opening	–	–	–	7496
ılculated losing Times (Sec.)				
No Flow	1.5	1.5	1.5	1.5
Preferred Direction				
Valve Opened to 90°	.8	1.00	.8	–
Valve Opened to 70°	–	–	–	.65
Required Closing Time	5.0	5.0	5.0	5.0

Λ

RESULTS

Maximum Torques Resulting from a LOCA and Closing Times

; No.	AOV102	AOV105	AOV109	AOV111
[Item No.	4	5	4	5
se No.	3A	3B	4A	4B
lve Size	12"	12"	12"	12"
:tis Actuator Model	N721C-SR80	N721C-SR80	N721C-SR80	N721C-SR80
:uator Max Allow Torque	22,500	22,500	22,500	22,500
: Torque Resulting from a LOCA (in.lbs) eferred Direction				
30°	3991	4100	4319	6776
70° Max Opening	3321	2542 (Seating Torque)	3590	-
50° Max Opening	-	-	-	2611
lculated osing Times (Sec.)				
lo Flow	1.5	1.5	1.5	1.5
?referred Direction				
Valve Opened to 70°	.65	1.05	.60	-
Valve Opened to 60°	-	-	-	.75
Required Closing Time	5.0	5.0	5.0	5.0

Tag No.	Size	Max Valve Opening	Opening of Max Torque	Flow Direction	Actuator Bolt Calc	Actuator Bolt Allow	Bracket Bolt Calc	Bracket Bolt Allow	Bracket Calc	Bracket Allow	Valve Neck Calc	Valve Neck Allow	Stem Calc	Stem Allow	Disc Pin Calc	Disc Pin Allow
AOV106	14"	90°	80°	Preferred	15019	37500	20400	37500	3765	18900	1722	23400	14522	52800	14808	21120
AOV104	14"	90°	80°		16457		21209		3819		1761		15175		15646	
AOV108	14"	90°	80°		14788		20255		3701		1705		13902		14035	
AOV110	14"	90°	80°		18168		24240		5105		2166		21138		23002	
		70°	70°		16649		23319		4689		2049		17048		17990	
AOV107	12"	90°	80°		14791		21158		3312		9639		12987		22937	
		70°	70°		14371		20812		3178		9550		11274		19086	
AOV105	12"	90°	80°		14860		25347		3366		3146		13267		23563	
		70°	0°		13897		24782		3054		3023		9313		14609	
AOV109	12"	90°	80°		15000		21332		3378		9684		13830		24822	
		70°	70°		14538		20950		3231		9585		11960		20632	
AOV111	12"	90°	80°		16632		26431		3903		3376		20203		38943	
		60°	60°		13938		24806		3068		3029		9484		15005	

NOTE: The allowable stresses are based on 1.5 times the allowable given in [illegible]

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 opening of valves AOV105, 107, 109 and 110 be restricted to 70 degrees and 60 degrees for valve AOV111. 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 AOV107, 109, 110 and 111 should be orientated as shown in Figures 8, 10 and 13 on Pages 27, 29 and 33.

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 60 and 70 degrees remains for Stone & Webster to determine. See Page F-1 and F-2 in Appendix F.

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°

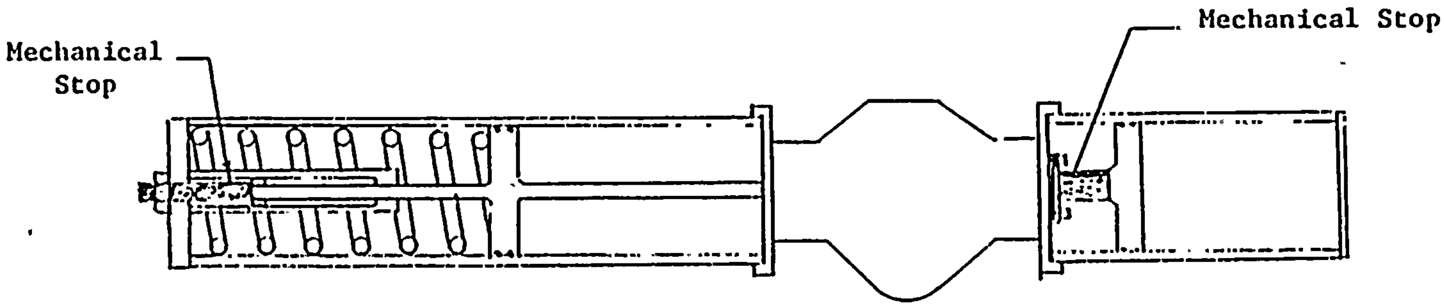


Figure 1

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
	C	12" Valve AOV105	Cycles Close with piping upstream of Valve AOV107 broken off
Case 4	A	12" Valve AOV109	Cycles Close
	B	12" Valve AOV111	Cycles Close
	C	12" Valve AOV111	Cycles Close with piping upstream of Valve AOV109 broken off

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 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. The head loss due to other restrictions, h_L, can also be ignored since the equation will be used across one resistance at a time.

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

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 $^{\circ}R$

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

$X = \Delta P/P_1'$

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

$$V_S = \sqrt{\frac{4637\ K_1\ P'_1}{\rho}}$$ per Ref. (b)

Determination of the flow conditions will be performed as follows:

1. Calculate density at the end condition

$$\rho_{N+1} = \left(\frac{P'_{N+1}}{P'_N}\right)^{1/K_1} \rho_1$$

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

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

Derived from equations 1.3, 2.2 and 2.5 of Ref. (b)

where $K = K(1) + K(2) + \ldots + K(N+1)$ = Total resistance of the system

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

For I = 1 to N

$\rho = \rho(I)$

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

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

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

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

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

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

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

and recalculate P(I+1)

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

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

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

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

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

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

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

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

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

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

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

Simulation of the Actuator Stroking the Valve Close

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

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

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

T_{flow} = The torque due to aerodynamic flow caused by the LOCA.

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.

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

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

Where W = Water

F = Fluid

ρ water = 62.4 lbs/ft^3

V_F = Calculated in the determination of the flow conditions

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

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

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

The total aerodynamic torque equals

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

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

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

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

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

$$T_{Air} = .04326\ T_{4W}\ \frac{T_1}{P_1} \left(\frac{Q}{253.6\ C_v}\right)^2$$

$$T_{Steam} = .0269\ T_{4W}\ \frac{T_1}{P_1} \left(\frac{Q}{263.6\ C_v}\right)^2$$

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

For critical flow the equations can be simplified to:

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

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

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

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

Pneumatic Torque (T_{air})

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

Where A = Area of piston

D_c = Cubic Displacement

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

P = Working Pressure of Actuator

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

V = Specific Volume - SCF

R = Radius of Scotch Yoke (See Figure 4)

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

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

$P1$ = Previous pressure (See Note Below)

ΔV = Change in Volume

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

dt = Change in Time

Q = Flow thru solenoid valve or quick exhaust

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

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

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

G = Specific Gravity of Air = 1

T = Temperature ° Rankine = 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.

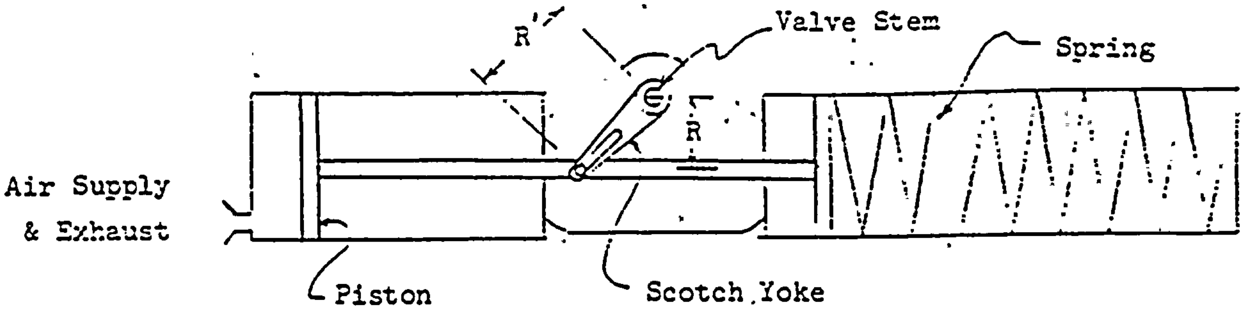


Figure 4

Forces acting on Scotch Yoke Pin

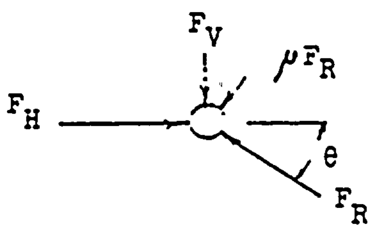


Figure 5

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

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

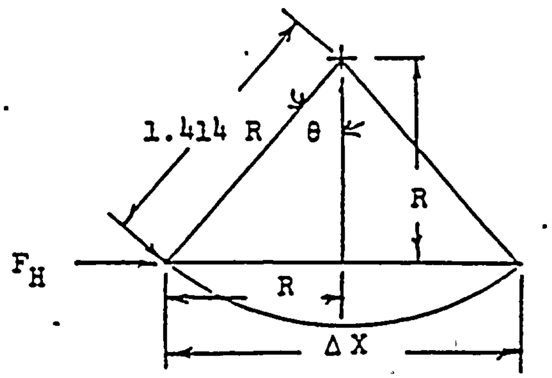
$$\therefore \quad T_R = \frac{T}{\cos\theta\,(\cos\theta + \mu\sin\theta)}$$

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

Spring Torque (T_{spring})

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

Figure 6



$\theta = 45°$

$\Delta X = 2R$

K = Springrate

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

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

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

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

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

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

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
1A	B-5
1B	B-17
2A	B-25
2B	B-30
3A	B-35
3B	B-40
3C	B-45
4A	B-49
4B	B-54
4C	B-59

As can be seen in Appendix A just upstream from valves AOV107, 109, 110 and 111 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.

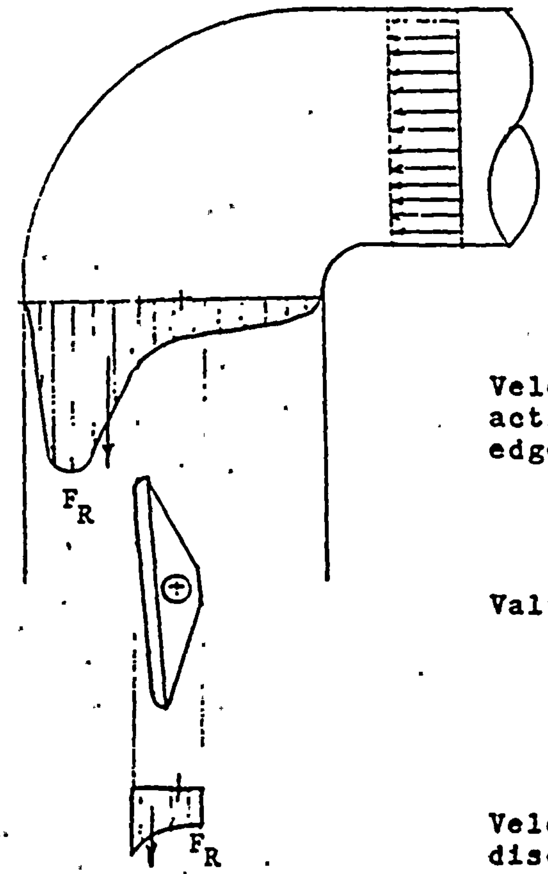
2. Determine the load based on the principles of impulse and momentum.

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.



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.

Figure 7

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

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

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

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

where Q = Flow - SCFH

$$F = \frac{.0764\ Q\ V\ G}{32.2\ (3600)} = \frac{Q\ V\ G}{1.517 X 10^6}$$

G = Specific Gravity

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

$$F = \frac{.0764\ Q\ V}{32.2\ (3600)} = \frac{Q\ V\ G}{1.517 \times 10^6}$$

DETERMINATION OF AERODYNAMIC TORQUES RESULTING FROM THE BENDS

Valve AOV110 (Case 2B)

With this valve installed in the preferred direction it is recommended that the valve be orientated as shown below such that flow assists closing of the valve. 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 9 on Page 28.

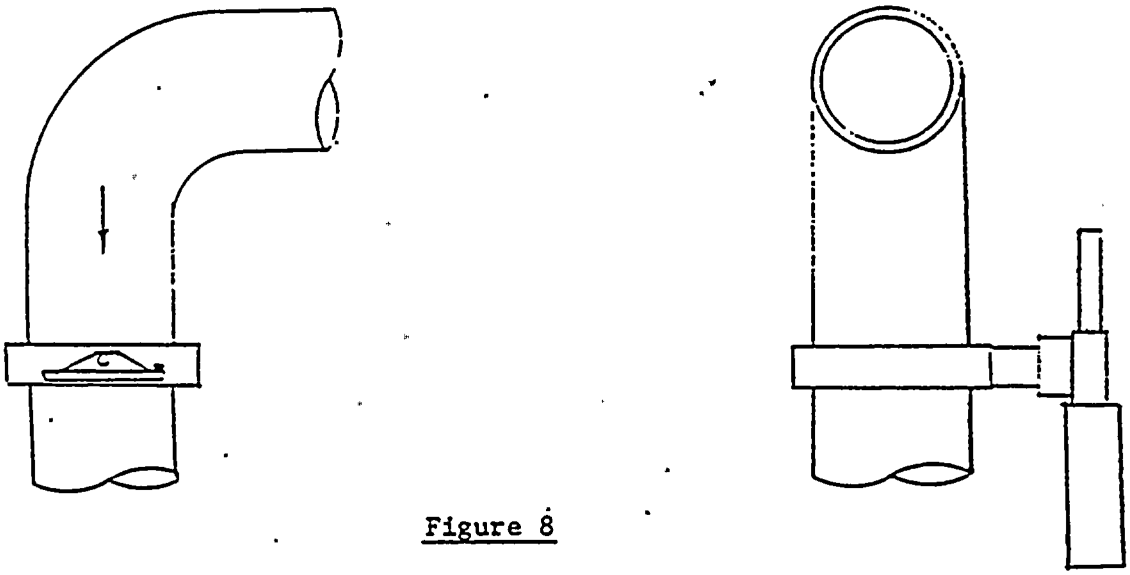


Figure 8

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

Degree	Q	V	E
	(Per Appendix B)		
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

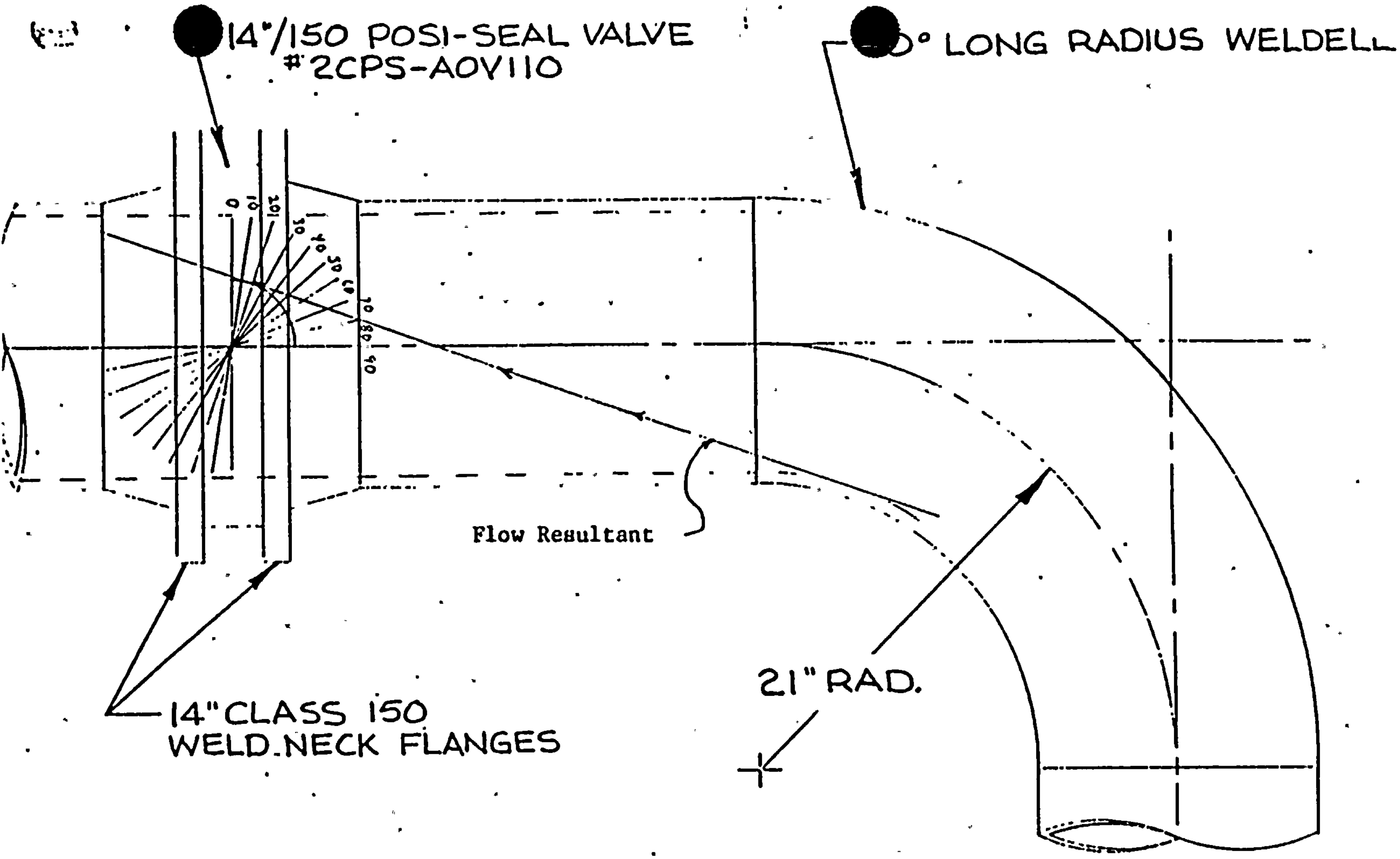


Figure 9

NINE MILE PT. NUCLEAR STA.-UNIT 2

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE 1/8" = 1'

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

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

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

AOV107 (Case 3A)

As with Valve AOV110, this valve should be oriented as shown below such that the flow assists in closing the valve.

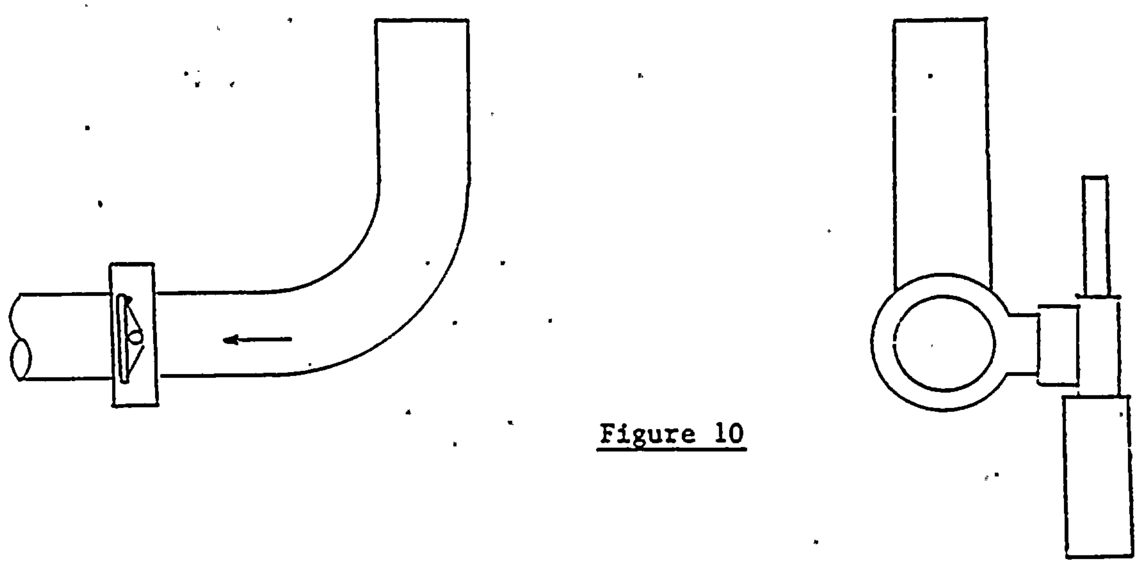
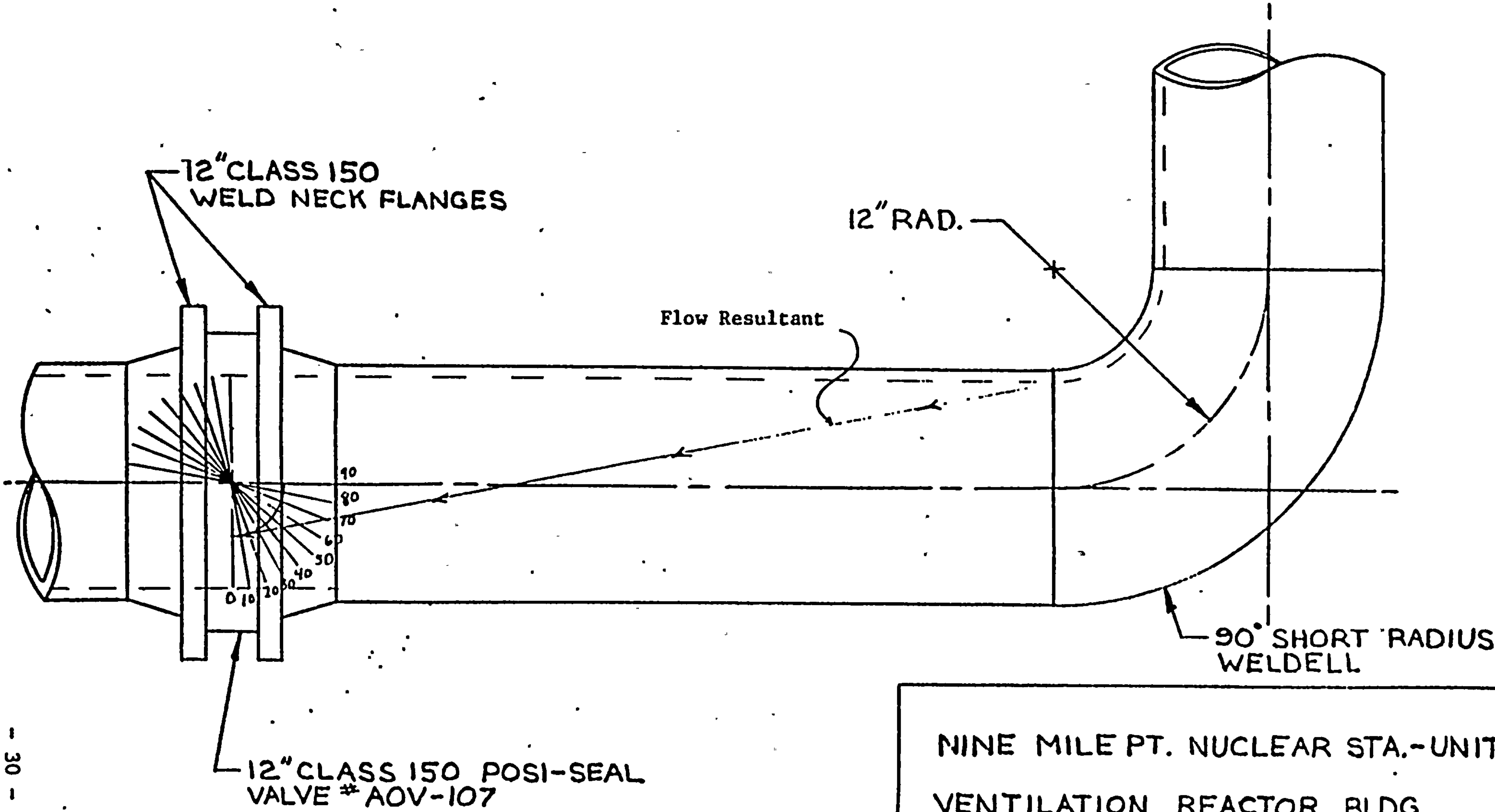


Figure 10

The total torque is calculated in the same manner as for AOV110 with the flow resultant being as shown on Page 30.



NINE MILE PT. NUCLEAR STA.-UNIT 2

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE : 1/8" = 1"

Figure 11

Degree	Q (Per Appendix B)	V	F
90	3,395,000	508	1137
80	3,302,000	549	1195
70	3,080,000	554	1125
60	2,443,000	557	897
50	1,811,000	508	606
40	1,221,000	394	317
30	747,600	260	128
20	378,500	136	34
10	191,400	69.5	9

$$R = \frac{D}{4} \cos (10 - \theta)$$

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	.51	- 580	-2295	-2875
80	1.00	-1195	-2796	-3991
70	1.46	-1643	-1678	-3321
60	1.88	-1686	- 80	-1766
50	2.24	-1357	759	- 598
40	2.53	- 802	1056	254
30	2.75	- 352	1172	820
20	2.88	- 98	1202	1104
10	2.93	- 26	1209	1183

Valve AOV109 (Case 4A)

This valve should be orientated in the same manner as valve AOV107.

The determination of the total torque is based on the flow resultant as shown on Page 32.

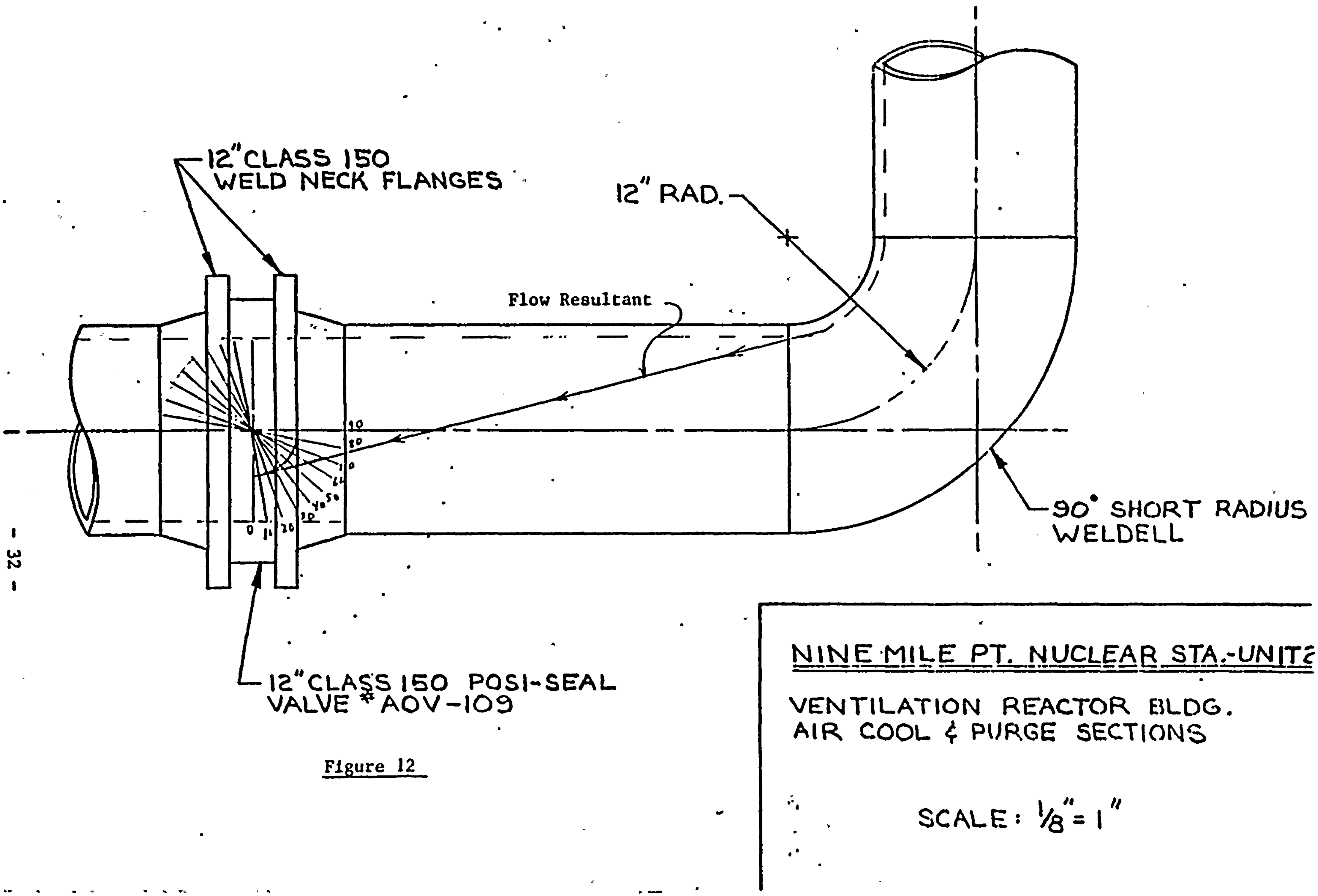

12" CLASS 150
WELD NECK FLANGES
12" RAD.
Flow Resultant
90° SHORT RADIUS
WELDELL
12" CLASS 150 POSI-SEAL
VALVE # AOV-109
NINE MILE PT. NUCLEAR STA.-UNIT 2
VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS
SCALE: 1/8" = 1"

Figure 12

Degree	Q (Per Appendix B)	V	F
90	3,332,000	532	1169
80	3,247,000	535	1145
70	3,039,000	536	1074
60	2,438,000	485	779
50	1,811,000	494	590
40	1,219,000	389	313
30	752,600	260	129
20	378,800	136	34
10	191,500	69.5	9

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

Degree	R	T_R	T_{LOCA} (Per Appendix B)	T_{Total}
90	1.00	-1169	-2127	-3296
80	1.46	-1672	-2647	-4319
70	1.88	-2019	-1571	-3590
60	2.24	-1745	15	-1730
50	2.53	-1492	760	- 732
40	2.75	- 860	1055	195
30	2.88	- 372	117	799
20	2.93	- 100	1202	1102
10	2.88	- 26	1209	1183

Valve AOV111 (Case 4C)

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

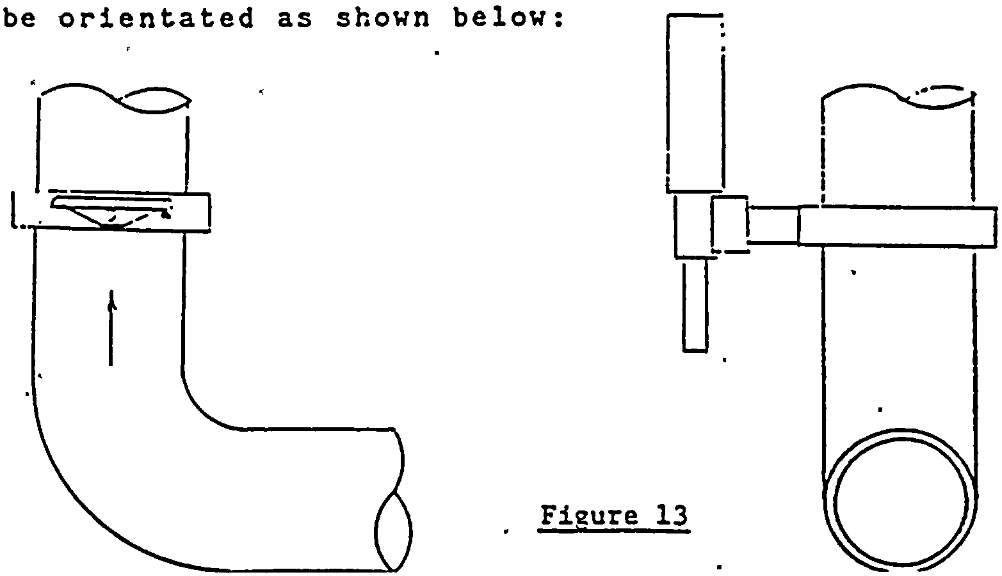


Figure 13

The calculated torques for valve AOV111 are as follows with the resultant flow as shown on Page 35.

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

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

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

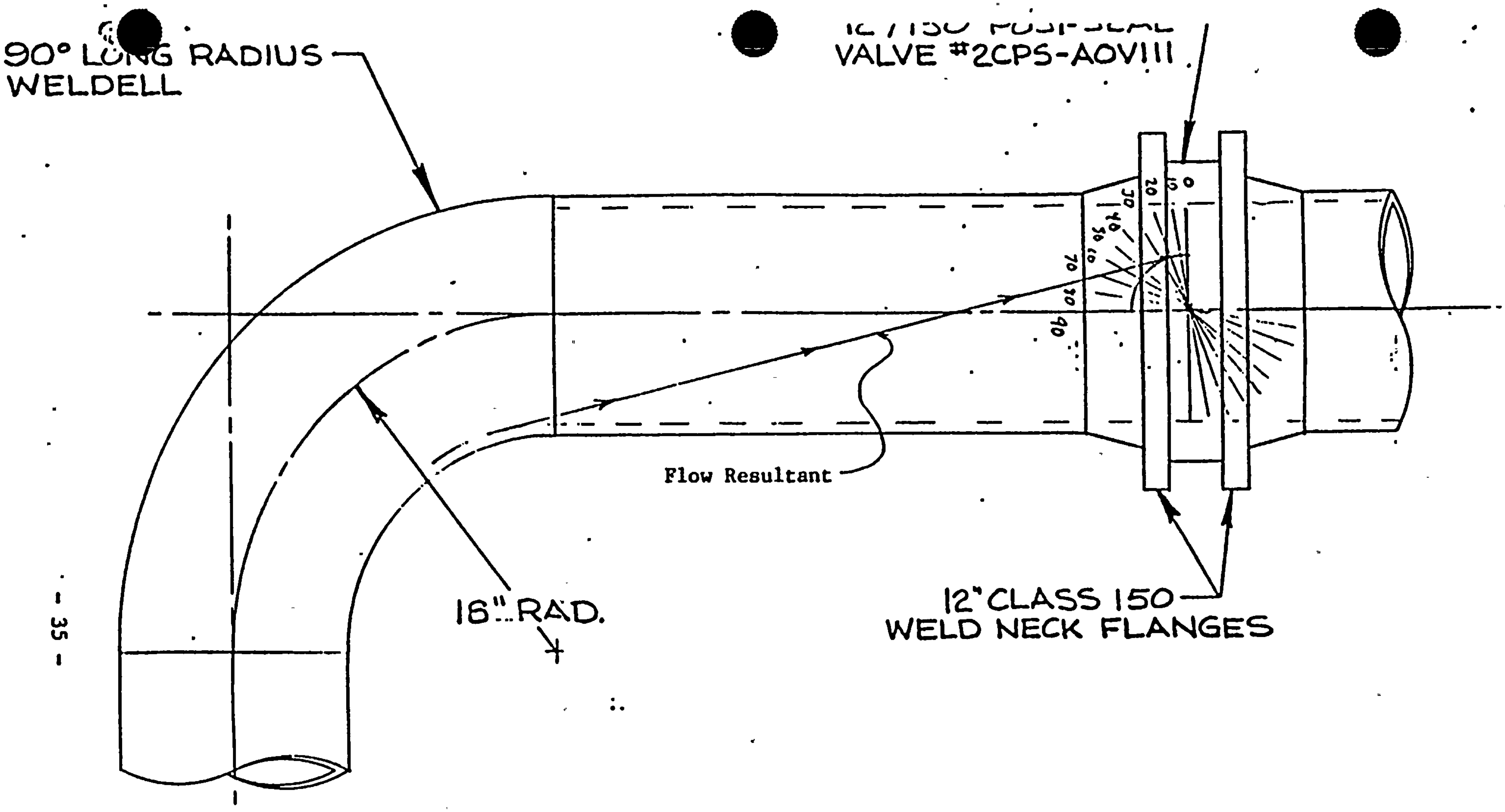


Figure 14

NINE MILE PT. NUCLEAR STA.-UNIT 2

VENTILATION REACTOR BLDG.
AIR COOL & PURGE SECTIONS

SCALE 1/8" = 1'

Seismic Analysis

For the seismic analysis each valve is analyzed based on the maximum torque resulting from a LOCA. The valve angle which results in the largest torque is 80 degrees. If this torque results in overstressing of the valve then the amount of valve angle is restricted to 70 degrees and the stress determined based on the LOCA torque at that angle. If that results in overstressing then the valve angle is restricted to 60 degrees.

The various seismic analyses are given in Appendix C on the pages listed below.

Case	Angle of Max Torque	Page
1A	80°	C-1
1B	80°	C-4
2A	80°	C-7
2B	80°	C-10
	70°	C-13
3A	80°	C-15
	70°	C-18
3C	80°	C-20
	0°	C-23
4A	80°	C-25
	70°	C-28
4C	80°	C-30
	70°	C-33
	60°	C-35

DETERMINATION OF CLOSING TIMES

Shown in Appendix D are the calculated closing times. These closing times are based on the aerodynamic torques determined in Appendix B and the section pertaining to the influence of bends. They are calculated using the computer programs "FLOW-CL" and "FLOW-CL1".

The closing times are determined for all the valves being fully opened. They are also determined for those valves where it is recommended that the amount of valve opening be restricted.

Shown in Appendix E is a comparison of actual closing times to those calculated.

APPENDIX A

SCHEMATIC OF THE PIPING SYSTEM

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

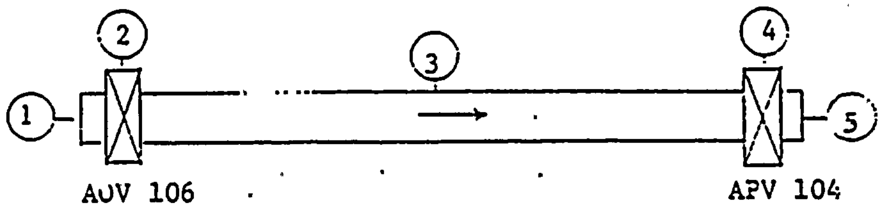
CASE 1

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 Preferred Direction	C_V = 6317
5	Exit (8)	K = 1.0 D_{out} = 14"

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

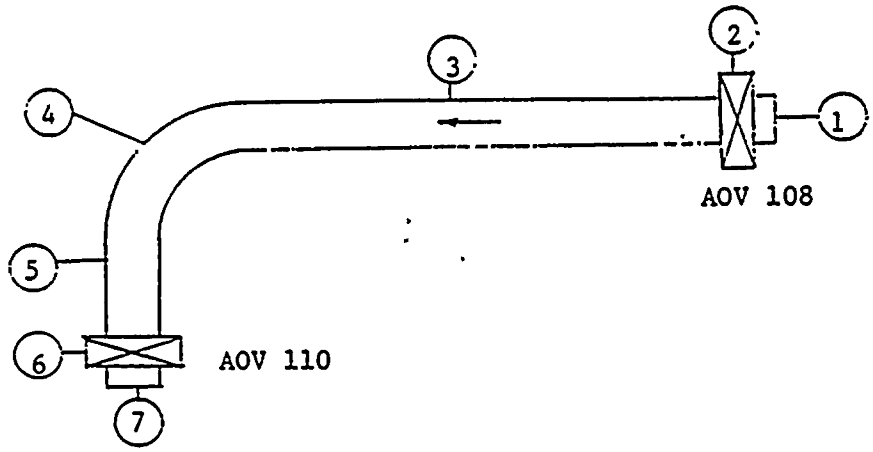
CASE 2

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 Preferred Direction	C_V = 6317
7	Exit (8)	K = 1 D_{out} = 14"

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

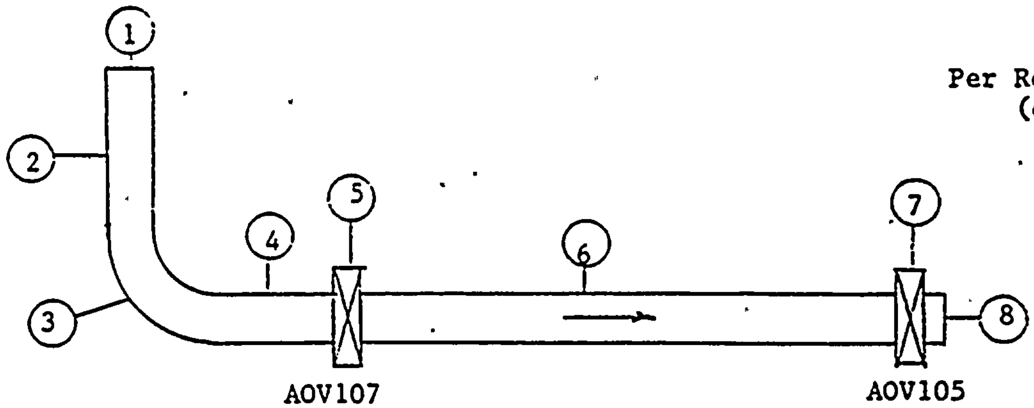
CASE 3

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) & (j)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{in} = 12"
2	Straight Pipe (4)	L = 6.77'
3	Bend 90 Degrees (5)	K = 12 f_t = .16
4	Straight Pipe (4)	L = 4.76
5	Valve (7) Flow in the Nonpreferred Direction	C_V = 4942
6	Straight Pipe (4)	L = 11'
7	Valve (7) Flow in the Nonpreferred Direction	C_V = 4942
8	Exit (8)	K = 1 D_{out} = 12"

Case 3A - Valve AOV107 Cycles
3B - Valve AOV105 Cycles
3C - Valve AOV105 Cycles with piping upstream of Valve AOV107 broken off

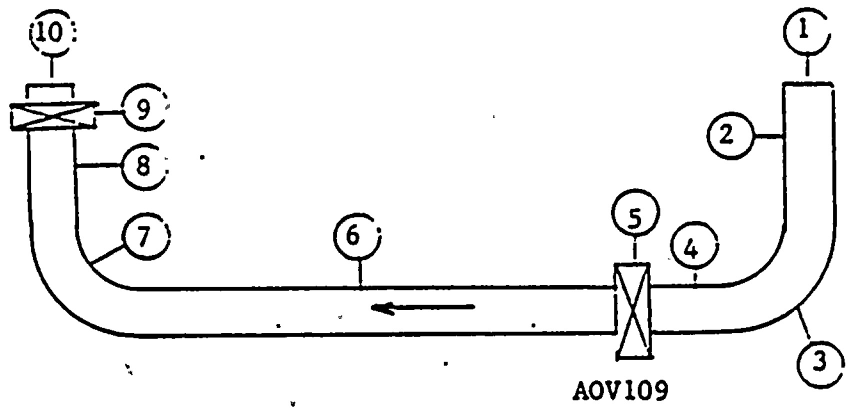
CASE 4

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.



Per References (e),(i) & (k)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{in} = 12"
2	Straight Pipe (4)	L = 9'
3	Bend 90 Degrees (5)	K = 12 f_t = .16
4	Straight Pipe (4)	L = 3.77'
5	Valve (7) Flow in the Preferred Direction	C_V = 4942
6	Straight Pipe (4)	L = 9'
7	Bend 90 Degrees (5)	K = 12 f_t = .16
8	Straight Pipe (4)	L = 4'
9	Valve (7) Flow in the Nonpreferred Direction	C_V = 4942
10	Exit (8)	K = 1 D_{out} = 12"

Case 4A - Valve AOV109 Cycles
4B - Valve AOV111 Cycles
4C - Valve AOV111 Cycles with piping upstream of Valve AOV107 broken off

APPENDIX B

Determination of Flow Conditions

CASE 1A

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 14"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-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 TYPE 14 — VALVE CLASS 150 — FLOW GAS

UPSTREAM PRESSURE	INITIAL DENSITY RATIO	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.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.375	12.774	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	0.860	0.86066
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	48.0	0.2320	126.3	465.[illegible]
4	46.0	0.2252	125.3	478.5
5	39.1	0.2003	119.6	539.6
6	14.7	0.0793	90.4	1085.3

NOTE: THERE IS CHOKED FLOW AT STATION 5

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

1770

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	[illegible]	135.0	[illegible]
2	53.5	0.2506	130.9	430.7
3	48.0	0.2320	126.8	465.1
4	46.0	[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	9.66	- 6,115

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	398.9
2	53.5	0.2506	130.8	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	611.6
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	40.1	0.2042	120.5	468.5
4	38.5	0.1983	119.1	481.5
5	31.6	0.1722	112.6	554.4
6	14.7	0.1012	91.0	938.5

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	0.1566	108.4	469.7
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	739.1

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
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

5	[illegible]	[illegible]	90.4	[illegible]
6	14.7	0.0995	90.4	540.4

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,912,259	42.07	1,216

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	132.7
2	[illegible]	[illegible]	134.7	[illegible]
3	17.2	0.1114	94.6	322.8
4	16.9	0.1104	94.2	325.6
5	16.1	[illegible]	92.9	335.9
6	14.7	0.0995	90.4	361.1

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	561,787	44.66	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	14.9	0.1009	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

1781

CASE 1A

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	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-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 090 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	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.860	0.86038
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	59.7	0.2010	340.0	465.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	46.1	0.1672	315.9	556.4
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

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

1782

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	465.4
2	53.5	0.1860	329.6	501.6
3	48.0	0.1722	319.6	541.9
4	46.1	[illegible]	[illegible]	556.4
5	39.2	0.1489	301.5	628.1
6	14.7	0.0738	227.9	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	329.6	501.6
3	43.8	0.1611	311.2	579.0
4	41.7	0.1557	306.9	597.5
5	33.1	0.1321	287.3	706.0
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..900	332.4	434.7
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	[illegible]	1102.9

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	0.1153	272.2	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]

5	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0738	227.8	[illegible]

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	[illegible]
3	17.2	0.0826	238.2	374.8
4	16.9	0.0819	237.4	378.1
5	16.1	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	15.6	0.0770	231.7	245.8
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	44.67	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	14.9	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

1785

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 .6L

HYDRODYNAMIC FACTOR @ 90 DEG 1182 IN.LBS/PSI

STEM DIA. 1.375 IN.

PACKING.TORQUE 932 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 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 @90 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	0.86066
3	STRAIGHT PIPE	14.0	11.0	0.141	0.14142
4	VALVE	14.0	0.0	0.860	0.86066
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED 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	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 3,101 IN. LBS

DELTA P=45.00 PSI

1702

CONDITIONS AS VALVE CLOSES

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

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	[illegible]	[illegible]	[illegible]
2	53.3	0.1266	284.2	592.9
3	48.3	0.1175	277.7	638.9
4	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	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	[illegible]	257.3	[illegible]
6	14.7	0.0474	209.2	1587.9

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	5,279,451	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	40.8	[illegible]	266.8	650.2
4	39.3	0.1004	264.4	666.3
5	33.3	0.0884	254.1	757.0
6	14.7	0.0489	[illegible]	[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	672.9
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	1092.9

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	274.5
2	58.6	0.1361	290.7	277.5
3	20.6	0.0615	226.9	615.7
4	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	15.2	[illegible]	[illegible]	[illegible]
[illegible]	14.7	0.0474	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	291.7	184.8
3	17.2	0.0534	217.2	476.5
4	17.0	0.0530	216.6	480.5
5	16.2	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	59.8	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	83.6
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

1706

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 Preferred

GAGE DIA. 12.974 IN

SEAL TORQUE 1454 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

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

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(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	0.860	0.86066
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	48.0	0.2320	126.8	465.1
4	46.0	0.2252	125.3	478.5
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

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	5,447,632	6.95	-	5,440

	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	478.5
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	-	6,486

	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	-	3,983

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	340.7
2	55.5	0.2575	132.2	357.6
3	52.0	0.2458	129.8	374.8
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	3,567,082	33.10	-	740

	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	131.8	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	737

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	194.9
2	58.6	0.2675	134.3	197.0
3	57.6	0.2642	133.6	199.5

4	57.3	0.2634	133.4	199.9
5	18.2	0.1160	96.1	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	1,602,844	42.57	1,216

	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	44.16	1,393

	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	81.6
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	1,436

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2710	135.0	41.0
2	59.6	0.2709	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	90.6	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/FT³

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 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 DENSITY-X1000	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
[illegible]	[illegible]	340	14.7	[illegible]

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 370 SEC
AIR	1.4	1	1	1182

STEM DIA.	BALL DIA.	PACKING TORQUE	SEAT 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	[illegible]	14.0	0.0	[illegible]	[illegible]
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW = 4,727,176 SCFH

	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	[illegible]	[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

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	[illegible]	[illegible]	[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	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]	477.0
3	49.3	0.1754	321.9	510.1
4	47.6	0.1710	318.7	522.0
5	36.5	[illegible]	296.4	[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	[illegible]	[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	[illegible]	340.0	[illegible]
2	57.5	0.1956	336.3	311.6
3	55.5	0.1910	333.1	319.3
4	55.0	[illegible]	[illegible]	[illegible]
5	21.9	0.0782	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]	59.[illegible]	[illegible]	[illegible]8.3	231.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	14.7	0.0738	227.8	616.5

NOTE: THERE IS CHOKED FLOW AT STATION [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	14.7	0.0738	227.8	[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	94.5
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]	0.2009	339.9	[illegible]
3	59.6	0.2008	339.8	47.6
4	59.6	0.2008	339.8	47.6
5	[illegible]	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	0.0739	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 DENSITY .138 LBS/FT^3
INITIAL TEMPERATURE 292 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 59.7 PSIA	MEDIA Sat. Steam
RATIO OF SP. HEAT 1.312	SPECIFIC GRAVITY .62
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 DENSIYY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
59.7	13.9	292	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
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)	LENGTH-(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	0.860	0.86066
5	EXIT	14.0	0.0	1.000	1.00000

FLOW IN PREFERRED 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	1587.9

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	5,895,146	6.14	- 5,125

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	545.6
2	53.3	0.1269	294.2	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	5,693,308	10.05	- 6,205

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	526.9
2	53.9	0.1276	284.9	568.1
3	49.4	0.1194	279.1	607.2
4	47.8	0.1165	276.9	620.1
5	37.7	0.0973	261.8	747.2
6	14.7	0.0474	209.2	1533.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	5,113,537	18.79	- 3,817

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	473.3
2	55.4	0.1305	296.9	498.6
3	52.1	0.1244	282.7	522.9
4	51.0	0.1225	281.3	529.3
5	32.2	0.0863	252.2	756.3
6	14.7	0.0474	209.2	1377.4

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	3,923,324	32.66	- 763

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	363.1
2	57.5	0.1341	289.4	372.6
3	55.7	0.1308	287.2	381.7
4	55.2	0.1300	286.6	383.2
5	22.5	0.0657	231.7	761.9
6	14.7	0.0474	209.2	1056.8

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,912,227	39.14	722

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	269.5
2	58.6	0.1361	290.7	272.5
3	57.7	0.1344	289.6	275.9

4	57.5	0.1341	289.4	275.9
5	18.4	0.0562	220.7	660.8
6	14.7	0.0474	209.2	784.4

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,975,299	42.70	1,211

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	182.8
2	59.4	0.1375	291.7	182.8
3	59.0	0.1368	291.2	183.8
4	58.9	0.1366	291.1	183.8
5	16.2	0.0511	214.3	492.8
6	14.7	0.0474	209.2	532.0

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	1,216,772	44.16	1,391

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	112.6
2	59.6	0.1378	291.8	112.6
3	59.4	0.1375	291.7	112.8
4	59.4	0.1375	291.6	112.8
5	15.2	0.0487	211.1	318.5
6	14.7	0.0474	209.2	327.7

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	612,341	44.79	1,436

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.1380	292.0	56.6
2	59.6	0.1379	291.9	56.6
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	163.7
6	14.7	0.0474	209.2	164.9

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	309,559	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	83.2
6	14.7	0.0474	209.2	83.3

NOTE: THERE IS CHOKED FLOW AT STATION 4

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 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	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 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 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	0.86066
3	STRAIGHT PIPE	14.0	9.0	0.115	0.11571
4	PIPE BEND	14.0	0.0	0.180	0.18000
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	491.7
3	48.5	0 1734	320.5	528.9
4	47.2	0.1699	317.9	538.2
5	45.1	0.1645	313.8	554.3
6	44.7	0.1636	313.1	556.2
7	37.8	0.1450	298.4	633.8
8	14.7	0.0738	227.8	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	[illegible]	[illegible]	-	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	457.5
2	53.7	0.1866	330.0	491.7
3	48.5	0.1734	320.5	528.9
4	47.2	[illegible]	[illegible]	[illegible]
5	45.1	0.1645	313.8	554.5
6	44.7	0.1636	313.1	556.2
7	37.8	0.1450	278.4	633.8
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	44.8	0.1633	312.9	561.8
4	43.1	0.1593	309.8	573.9
5	40.8	0.1534	305.1	594.4
6	40.5	0.1524	304.4	578.4
7	31.8	0.1281	284.0	717.3
8	14.7	0.0738	227.8	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	[illegible]
3	40.9	0.1534	305.1	533.4
4	39.6	0.1501	302.5	544.1
5	37.8	0.1452	298.5	560.9
6	37.5	0.1444	297.8	562.8
7	30.7	0.1251	281.1	655.0
8	14.7	0.0738	227.8	1109.8

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
60	3,204,786	28.71	-	587

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	315.5
2	57.2	0.1951	336.0	324.4
3	28.5	0.1187	290.3	534.0
4	27.8	0.1166	275.4	543.7
5	26.7	0.1132	270.2	560.0
6	26.5	0.1128	269.8	562.2
7	22.6	0.1006	257.8	629.9
8	14.7	0.0738	227.8	858.7

NOTE: THERE IS CHOKED FLOW AT STATION [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,339,609	37.40	756

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	230.2
2	58.5	0.1982	339.1	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	501.3
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	DP ACROSS VALVE	Tclosing
40	1,568,865	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	378.6
6	16.9	0.0818	237.3	379.4
7	16.2	0.0791	234.2	392.1
8	14.7	0.0738	227.8	420.3

NOTE: THERE IS CHOKED FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	958,472	43.88	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	15.6	0.0772	231.9	245.3
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	DP 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	ΔP ACROSS VALVE	Tclosing
10	245.337	44.91	1.444

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	24.1
2	[illegible]	[illegible]	[illegible]	[illegible]
3	14.7	0.0741	229.1	65.4
4	14.7	0.0741	229.1	65.4
5	14.7	0.0741	229.1	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

1835

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	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-Y10^2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
[illegible]	[illegible]	340	14.7	[illegible]

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 90 DEG
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	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	0.860	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	[illegible]	0.1866	330.0	471.7
3	48.5	0.1734	320.5	528.9
4	47.2	0.1699	317.9	536.2
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	1244.9

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
1	59.7	[illegible]	[illegible]	[illegible]
2	53.7	0.1966	330.0	491.7
3	48.5	0.1734	320.5	528.9
4	[illegible]	[illegible]	[illegible]	[illegible]
5	45.1	0.1645	313.8	554.5
6	44.7	0.1635	313.1	556.2
7	[illegible]	[illegible]	[illegible]	[illegible]
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	-	6,516

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	440.1
2	54.3	0.1880	331.0	469.3
3	[illegible]	0.1783	[illegible]	[illegible]
4	48.5	0.1733	320.4	507.6
5	46.6	0.1685	316.8	521.2
6	46.4	[illegible]	[illegible]	[illegible]
7	35.1	0.1377	292.1	642.2
8	14.7	0.0738	227.8	1197.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
70	3,982,860	20.51	-	3,954

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	392.1
2	[illegible]	[illegible]	[illegible]	[illegible]
3	52.2	0.1827	327.2	430.7
4	51.4	0.1807	325.8	434.2
5	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]		730

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	57.6	0.1960	336.5	309.0
3	55.7	0.1914	333.4	316.3
4	[illegible]	[illegible]	[illegible]	[illegible]
5	54.8	0.1892	331.8	318.9
6	54.7	0.1890	331.7	318.9
7	[illegible]	[illegible]	[illegible]	[illegible]
8	14.7	0.0738	227.8	822.1

[illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	2,238,[illegible]	39.15	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	225.3
2	58.[illegible]	0.1995	339.[illegible]	227.[illegible]
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	[illegible]	[illegible]	[illegible]
7	18.1	0.0959	242.0	526.8
8	14.7	0.0738	227.8	613.2

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANCLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,551,568	42.55	1,217

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	152.7
2	59.3	0.2001	339.4	153.[illegible]
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	415.7

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	958,471	44.13	1,393

	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	250.3
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	1,436

	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

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

CASE 3A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SK80-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)

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.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.25	11.703	756	1183

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	STRAIGHT PIPE	12.0	6.7	0.101	0.10155
3	PIPE BEND	12.0	0.0	0.160	0.16000
4	STRAIGHT PIPE	12.0	4.7	0.071	0.07140
5	VALVE	12.0	0.0	0.759	0.75903
6	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
7	VALVE	12.0	0.0	0.759	0.75903
8	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 3,394,870 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	455.0
2	53.8	0.1866	330.0	489.0
3	52.6	0.1838	328.0	495.7
4	50.7	0.1790	324.6	508.1
5	50.0	0.1771	323.2	512.4
6	45.1	0.1646	313.9	551.2
7	42.9	0.1587	309.4	570.2
8	36.8	0.1423	296.0	642.4
9	14.7	0.0738	227.8	1238.1

NOTE: THERE IS CHOKED FLOW AT STATION 8

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	3,394,570	4.85	- 2,295

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	455.0
2	53.8	0.1866	330.0	489.0
3	52.6	0.1838	326.0	495.7
4	50.7	0.1790	324.6	508.1
5	50.0	0.1771	323.2	512.4
6	45.1	0.1646	313.9	551.2
7	42.9	0.1587	309.4	570.2
8	36.8	0.1423	296.0	642.4
9	14.7	0.0738	227.8	1238.1

NOTE: THERE IS CHOKED FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,301,609	7.53	- 2,796

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	442.5
2	54.3	0.1880	331.0	471.8
3	53.3	0.1855	329.3	476.9
4	51.6	0.1812	326.2	487.4
5	51.0	0.1797	325.1	490.1
6	43.5	0.1604	310.6	549.3
7	41.4	0.1549	306.3	567.0
8	35.4	0.1385	292.9	641.8
9	14.7	0.0738	227.8	1204.1

NOTE: THERE IS CHOKED FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,079,859	13.44	- 1,678

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	412.7
2	55.2	0.1900	332.4	435.5
3	54.4	0.1881	331.1	439.0
4	53.0	0.1842	328.7	446.1
5	52.5	0.1834	327.7	448.5
6	39.0	0.1485	301.2	554.0
7	37.2	0.1435	297.1	571.3
8	31.3	0.1267	282.7	646.8
9	14.7	0.0732	227.0	1111.7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,443,352	27.43	- 80

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	327.4
2	57.0	0.1946	335.6	337.5
3	56.7	0.1937	335.0	338.4
4	55.9	0.1919	333.8	341.0
5	55.8	0.1915	333.5	341.0
6	28.3	0.1181	274.9	557.1
7	27.0	0.1142	271.2	575.9
8	23.5	0.1032	260.5	637.2
9	14.7	0.0738	227.8	891.1

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,311,021	36.84	759

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	242.7
2	58.4	0.1980	337.9	245.7
3	58.3	0.1977	337.7	245.7
4	58.1	0.1972	337.4	245.7
5	58.0	0.1970	337.2	245.7
6	21.2	0.0959	252.9	508.3
7	20.5	0.0937	250.5	520.4
8	18.8	0.0881	244.5	553.3
9	14.7	0.0738	227.8	660.5

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,220,686	41.65	1,056

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	163.6
2	59.2	0.2000	339.3	164.0
3	59.2	0.1998	339.2	164.0
4	59.1	0.1996	339.0	164.0
5	59.1	0.1995	339.0	164.0
6	17.4	0.0834	239.2	393.8
7	17.1	0.0825	238.1	398.3
8	16.3	0.0798	235.0	411.8
9	14.7	0.0738	227.8	445.2

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	747,551	43.81	1,172

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.1
2	59.5	0.2007	339.8	100.1
3	59.5	0.2006	339.7	100.1
4	59.5	0.2006	339.7	100.1
5	59.5	0.2005	339.7	100.1
6	15.7	0.0774	232.1	260.0
7	15.6	0.0771	231.7	261.1
8	15.3	0.0760	230.4	264.8
9	14.7	0.0738	227.8	272.6

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	378,486	44.63	1,202

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.7
2	59.6	0.2009	339.9	50.7
3	59.6	0.2009	339.9	50.7
4	59.6	0.2008	339.9	50.7
5	59.6	0.2008	339.9	50.7
6	15.0	0.0750	229.2	135.9
7	14.9	0.0749	229.1	136.0
8	14.8	0.0744	228.4	137.0

9	14.7	0.0738	227.8	138.0

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191.3e-	44.90	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	59.6	0.2009	339.9	25.6
6	14.7	0.0741	228.1	69.5
7	14.7	0.0741	228.1	69.5
8	14.7	0.0740	227.9	69.6
9	14.7	0.0738	227.8	69.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

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)

CONTROL SYSTEM ANALYSIS

Case 3B

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 DEC
AIR	1.4	1	1	761

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

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	STRAIGHT PIPE	12.0	6.7	0.101	0.10155
3	PIPE BEND	12.0	0.0	0.160	0.16000
4	STRAIGHT PIPE	12.0	4.7	0.071	0.07140
5	VALVE	12.0	0.0	0.759	0.75903
6	STRAIGHT PIPE	12.0	11.0	0.165	0.16500
7	VALVE	12.0	0.0	0.759	0.75903
8	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,394,870 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	455.0
2	53.8	0.1866	330.0	489.0
3	52.6	0.1838	328.0	495.7
4	50.7	0.1790	324.6	508.1
5	50.0	0.1771	323.2	512.4
6	45.1	0.1646	313.9	551.2
7	42.9	0.1587	309.4	570.2
8	36.8	0.1423	296.0	642.4
9	14.7	0.0738	227.8	1238.1

NOTE: THERE IS CHOKED FLOW AT STATION 8

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	3,394,870	6.09	-	2,823

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	455.0
2	53.8	0.1866	330.0	489.2
3	52.6	0.1838	328.0	495.7
4	50.7	0.1790	324.6	508.1
5	50.0	0.1771	323.2	512.4
6	45.1	0.1646	313.9	551.2
7	42.9	0.1587	309.4	570.2
8	36.8	0.1423	296.0	642.4
9	14.7	0.0738	227.8	1238.1

NOTE: THERE IS CHOKED FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
80	3,285,444	9.64	-	3,408

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	440.3
2	54.3	0.1880	331.0	469.5
3	53.4	0.1856	329.3	474.6
4	51.6	0.1813	326.2	485.0
5	51.1	0.1798	325.2	487.7
6	46.7	0.1687	317.0	519.7
7	44.8	0.1638	313.3	534.0
8	35.1	0.1378	292.2	642.2
9	14.7	0.0738	227.8	1198.2

NOTE: THERE IS CHOKED FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
70	3,001,555	17.31	-	2,004

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	402.3
2	55.4	0.1906	332.8	423.3
3	54.6	0.1887	331.5	426.7
4	53.3	0.1854	329.2	433.6
5	52.9	0.1845	328.5	434.7
6	49.5	0.1760	322.4	455.6
7	48.2	0.1725	319.8	463.5
8	30.9	0.1255	281.6	643.9
9	14.7	0.0738	227.8	1094.7

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE		Tclosing
60	2,354,692	30.96	-	144

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	315.6
2	57.2	0.1951	336.0	324.4
3	56.9	0.1943	335.4	325.3
4	56.3	0.1929	334.4	326.9
5	56.2	0.1925	334.1	326.9
6	54.3	0.1880	331.0	334.8
7	53.6	0.1862	329.7	337.5
8	22.6	0.1006	257.8	630.0

9	14.7	0.0738	227.8	858.8

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,774,2[illegible]	38.14	753

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	237.8
2	58.5	0.1981	338.0	240.8
3	58.3	0.1978	337.8	240.8
4	58.1	0.1973	337.5	240.8
5	58.0	0.1971	337.3	240.8
6	57.1	0.1947	335.7	243.7
7	56.7	0.1939	335.1	244.3
8	18.6	0.0875	243.8	546.0
9	14.7	0.0738	227.8	647.1

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,212,566	42.19	1,057

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.5
2	59.2	0.2000	339.3	162.9
3	59.2	0.1998	339.2	162.9
4	59.1	0.1996	339.1	162.9
5	59.1	0.1995	339.0	162.9
6	58.6	0.1984	338.3	163.8
7	58.5	0.1982	338.1	163.8
8	16.3	0.0797	234.9	409.4
9	14.7	0.0738	227.8	442.2

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	748,860	44.00	1,173

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.3
2	59.5	0.2007	339.8	100.3
3	59.5	0.2006	339.7	100.3
4	59.5	0.2006	339.7	100.3
5	59.5	0.2005	339.7	100.3
6	59.3	0.2001	339.4	100.5
7	59.3	0.2000	339.3	100.5
8	15.3	0.0760	230.4	265.3
9	14.7	0.0738	227.8	273.1

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	377,022	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	59.6	0.2009	339.9	50.5
4	59.6	0.2008	339.9	50.5
5	59.6	0.2008	339.9	50.5
6	59.6	0.2007	339.8	50.5

7	59.6	0.2007	339.8	50.5
8	14.8	0.0744	228.4	136.5
9	14.7	0.0738	227.8	137.5

NOTE: THERE IS CHOKED FLOW AT STATION 7

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	190.006	44.93	1.209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.5
2	59.6	0.2009	339.9	25.5
3	59.6	0.2009	339.9	25.5
4	59.6	0.2009	339.9	25.5
5	59.6	0.2009	339.9	25.5
6	59.6	0.2009	339.9	25.5
7	59.6	0.2009	339.9	25.5
8	14.7	0.0740	227.9	69.3
9	14.7	0.0738	227.8	69.5

NOTE: THERE IS CHOKED FLOW AT STATION 7

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

CASE 3C

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 12"

VALVE CLASS: 150

ACTUATOR: Bettis N721C-SR80-M3HW

UPSTREAM PRESSURE	57.7 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	[illegible]	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR [illegible]
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	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= [illegible] 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	[illegible]	[illegible]	[illegible]
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]	3,51[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	[illegible]	[illegible]	340.[illegible]	[illegible]
2	53.3	0.1855	329.2	509.4
3	48.5	0.1732	320.4	545.4
4	[illegible]	[illegible]	[illegible]	[illegible]
5	40.2	0.1516	303.[illegible]	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
90	3,517,149	11.89	- 4,100

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	471.4
2	[illegible]	[illegible]	[illegible]	[illegible]
3	48.5	0.1732	320.4	545.4
4	46.1	0.1673	315.9	563.2
5	34.2	[illegible]	[illegible]	700.5
6	14.7	0.0738	227.8	1282.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,099,067	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
3	[illegible]	[illegible]	[illegible]	460.0
4	50.0	0.1773	323.3	469.0
5	31.6	0.1276	283.4	653.9
6	14.7	[illegible]	227.8	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,[illegible]	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	57.2	0.1950	335.9	330.1
3	55.3	0.1904	332.7	338.1
4	54.[illegible]	[illegible]	331.4	340.8
5	23.0	0.1018	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	751

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.6

[illegible]	[illegible]	0.1940	335.8	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	14.7	0.0739	227.9	652.1

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,214,165	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	0.0738	[illegible]	[illegible]

NOTE: THERE IS CHOKED FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	750,798	[illegible]	[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	[illegible]
2	59.5	0.2007	339.8	100.6
3	59.4	0.2003	339.5	100.8
4	59.3	[illegible]	[illegible]	[illegible]
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	1,203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.6
2	[illegible]	0.2009	[illegible]	[illegible]
3	59.6	0.2008	339.8	50.6
4	59.6	0.2008	339.8	50.6
5	[illegible]	0.0744	[illegible]	[illegible]
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	227.9	69.6

NOTE: THERE IS CHOKED FLOW AT STATION 4

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

CASE 4A

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)

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 090 DEG
AIR	1.4	1	1	761

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

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
3	PIPE BEND	12.0	0.0	0.160	0.16000
4	STRAIGHT PIPE	12.0	3.7	0.056	0.05655
5	VALVE	12.0	0.0	0.759	0.75903
6	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
7	PIPE BEND	12.0	0.0	0.160	0.16000
8	STRAIGHT PIPE	12.0	4.0	0.060	0.06000
9	VALVE	12.0	0.0	0.759	0.75903
10	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 3,331,783 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.5
2	54.1	0.1875	330.7	477.4
3	52.7	0.1841	328.2	485.2
4	51.0	0.1796	325.0	495.9
5	50.6	0.1786	324.3	497.3
6	46.0	0.1670	315.7	532.0
7	44.4	0.1626	312.4	545.1
8	42.3	0.1573	308.2	562.3
9	41.7	0.1558	307.0	565.9
10	35.7	0.1394	293.5	643.7
11	14.7	0.0738	227.8	1215.1

NOTE: THERE IS CHOKED FLOW AT STATION 10

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	3,331,763	4.56	- 2,127

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.5
2	54.1	0.1875	330.2	477.4
3	52.7	0.1841	328.2	485.2
4	51.0	0.1796	325.0	495.9
5	50.6	0.1786	324.3	497.3
6	46.0	0.1670	315.7	532.0
7	44.4	0.1626	312.4	545.1
8	42.3	0.1573	308.2	562.3
9	41.7	0.1558	307.0	565.9
10	35.7	0.1394	293.5	643.7
11	14.7	0.0738	227.8	1215.1

NOTE: THERE IS CHOKED FLOW AT STATION 10

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,247,125	7.13	- 2,647

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	435.2
2	54.5	0.1885	331.3	462.8
3	53.2	0.1851	329.0	470.3
4	51.6	0.1812	326.1	479.3
5	51.2	0.1802	325.5	480.7
6	44.1	0.1619	311.8	535.0
7	42.6	0.1579	308.7	546.9
8	40.6	0.1526	304.5	564.7
9	40.0	0.1511	303.3	568.5
10	33.9	0.1343	289.3	651.1
11	14.7	0.0738	227.8	1184.2

NOTE: THERE IS CHOKED FLOW AT STATION 10

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	3,039,219	12.58	- 1,571

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	407.3
2	55.3	0.1905	332.7	428.6
3	54.3	0.1880	331.0	433.2
4	53.0	0.1846	328.6	440.2
5	52.6	0.1838	328.0	441.4
6	40.0	0.1512	303.4	536.4
7	38.6	0.1473	300.3	549.1
8	36.8	0.1425	296.3	566.4
9	36.3	0.1410	295.1	570.4
10	30.4	0.1241	280.3	648.4
11	14.7	0.0741	228.1	1078.5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,438,258	21.77	15

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	326.8
2	57.0	0.1946	335.6	336.8
3	56.5	0.1933	334.7	338.5
4	55.7	0.1915	333.4	341.2

5	55.6	0.1911	333.2	341.2
6	33.5	0.1341	289.1	485.6
7	28.3	0.1180	[illegible]	556.5
8	27.6	0.1161	272.9	565.7
9	27.2	0.1148	271.7	572.0
10	23.4	0.1031	260.4	636.6
11	14.7	0.0738	227.8	889.2

NOTE THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,811,625	35.91	760

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	242.8
2	58.4	0.1980	337.9	245.8
3	58.3	0.1976	337.7	245.8
4	58.0	0.1971	337.3	245.8
5	58.0	0.1969	337.2	245.8
6	22.1	0.0988	255.9	493.7
7	21.5	0.0971	254.1	502.5
8	20.8	0.0949	251.8	513.9
9	20.6	0.0942	251.1	517.9
10	18.8	0.0881	244.5	553.4
11	14.7	0.0738	227.8	660.7

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,219,632	41.37	1,055

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	163.4
2	59.2	0.2000	339.3	163.8
3	59.2	0.1998	339.2	163.8
4	59.1	0.1996	339.0	163.8
5	59.0	0.1995	339.0	163.8
6	17.7	0.0844	240.3	389.2
7	17.4	0.0836	239.4	392.7
8	17.2	0.0827	238.4	397.0
9	17.1	0.0824	238.0	398.4
10	16.3	0.0798	235.0	411.4
11	14.7	0.0738	227.8	444.8

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	752,648	43.67	1,171

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.8
2	59.5	0.2007	339.8	100.8
3	59.5	0.2006	339.7	100.8
4	59.5	0.2005	339.7	100.8
5	59.5	0.2005	339.6	100.8
6	15.8	0.0778	232.6	260.3
7	15.7	0.0776	232.3	261.2
8	15.6	0.0772	231.9	262.3
9	15.6	0.0771	231.8	262.7
10	15.3	0.0760	230.5	266.5
11	14.7	0.0738	227.8	274.5

NOTE: THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	378,545	44.60	1,202

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.7
2	59.6	0.2009	339.9	50.7
3	59.6	0.2009	339.9	50.7
4	59.6	0.2008	339.9	50.7
5	59.6	0.2008	339.9	50.7
6	15.0	0.0751	229.3	135.8
7	15.0	0.0750	229.2	136.0
8	15.0	0.0749	229.1	136.1
9	14.9	0.0749	229.1	136.2
10	14.8	0.0744	228.4	137.1
11	14.7	0.0738	227.8	138.1

NOTE; THERE IS CHOKED FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	191,512	44.89	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	59.6	0.2009	339.9	25.6
6	14.7	0.0741	228.2	69.5
7	14.7	0.0741	228.1	69.5
8	14.7	0.0741	228.1	69.5
9	14.7	0.0741	228.1	69.5
10	14.7	0.0740	227.9	69.7
11	14.7	0.0738	227.8	69.8

NOTE: THERE IS CHOKED FLOW AT STATION 5

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

Case 2B

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	.261

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

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	12.0	0.0	0.500	0.50000
2	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
3	PIPE BEND	12.0	0.0	0.160	0.16000
4	STRAIGHT PIPE	12.0	3.7	0.056	0.05655
5	VALVE	12.0	0.0	0.759	0.75903
6	STRAIGHT PIPE	12.0	9.0	0.135	0.13500
7	PIPE BEND	12.0	0.0	0.160	0.16000
8	STRAIGHT PIPE	12.0	4.0	0.060	0.06000
9	VALVE	12.0	0.0	0.759	0.75903
10	EXIT	12.0	0.0	1.000	1.00000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW= 3,331,783 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.5
2	54.1	0.1875	330.7	477.4
3	52.7	0.1841	328.2	485.2
4	51.0	0.1796	325.0	495.9
5	50.6	0.1786	324.3	497.3
6	46.0	0.1670	315.7	532.0
7	44.4	0.1626	312.4	545.1
8	42.3	0.1573	308.2	562.3
9	41.7	0.1558	307.0	565.9
10	35.7	0.1394	293.5	643.7
11	14.7	0.0738	227.8	1215.1

NOTE: THERE IS CHOKED FLOW AT STATION 10

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	3,331,763	6.01	- 2,763

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	446.5
2	54.1	0.1875	330.2	477.4
3	52.7	0.1641	328.2	485.2
4	51.0	0.1796	325.0	495.9
5	50.6	0.1786	324.3	497.3
6	46.0	0.1670	315.7	532.0
7	44.4	0.1626	312.4	545.1
8	42.3	0.1573	308.2	562.3
9	41.7	0.1558	307.0	565.9
10	35.7	0.1394	293.5	643.7
11	14.7	0.0738	227.8	1215.1

NOTE: THERE IS CHOKED FLOW AT STATION 10

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
80	3,216,287	9.75	- 3,367

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	431.0
2	54.6	0.1886	331.4	458.4
3	53.2	0.1853	329.1	465.8
4	51.7	0.1813	326.3	474.8
5	51.3	0.1804	325.6	476.1
6	47.2	0.1699	317.9	505.4
7	45.7	0.1661	315.0	516.0
8	43.8	0.1613	311.3	530.4
9	43.3	0.1599	310.3	533.7
10	33.5	0.1333	288.4	649.9
11	14.7	0.0738	227.8	1173.0

NOTE: THERE IS CHOKED FLOW AT STATION 10

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
70	2,938,239	17.40	- 1,955

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	393.8
2	55.6	0.1911	333.2	413.3
3	54.6	0.1887	331.5	417.7
4	53.4	0.1858	329.4	423.3
5	53.1	0.1850	328.9	424.4
6	49.9	0.1770	323.1	443.6
7	48.8	0.1741	321.0	450.0
8	47.5	0.1708	318.5	457.9
9	47.1	0.1699	317.9	459.2
10	29.7	0.1223	278.7	647.0
11	14.7	0.0738	227.8	1071.6

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,334,619	30.62	- 133

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	312.9
2	57.4	0.1955	336.2	320.8

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
3	56.9	0.1942	335.3	322.5
4	56.3	0.1929	334.3	324.2
5	56.1	0.1925	334.1	32[illegible]
6	54.3	0.1880	331.0	331.8
7	53.8	0.1867	330.1	333.6
8	53.2	0.1852	329.1	335.4
9	53.1	0.1849	328.9	335.4
10	22.5	0.1001	257.2	628.1
11	14.7	0.0228	227.8	851.4

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,771,908	38.01	752

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	237.4
2	58.5	0.1981	338.0	240.4
3	58.3	0.1977	337.7	240.4
4	58.1	0.1972	337.4	240.4
5	58.0	0.1970	337.3	240.4
6	57.0	0.1946	335.6	243.4
7	56.9	0.1942	335.4	243.4
8	56.7	0.1937	335.0	243.4
9	56.6	0.1936	334.9	243.4
10	18.6	0.0875	243.7	545.5
11	14.7	0.0738	227.8	646.2

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
40	1,210,253	42.08	1,057

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	162.2
2	59.3	0.2000	339.3	162.6
3	59.2	0.1998	339.2	162.6
4	59.1	0.1996	339.0	162.6
5	59.1	0.1995	339.0	162.6
6	58.6	0.1984	338.2	163.4
7	58.5	0.1982	338.1	163.4
8	58.4	0.1980	338.0	163.4
9	58.4	0.1979	337.9	163.4
10	16.3	0.0797	234.9	408.7
11	14.7	0.0738	227.8	441.4

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	747,428	43.96	1,173

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.1
2	59.5	0.2007	339.8	100.1
3	59.5	0.2006	339.7	100.1
4	59.5	0.2005	339.7	100.1
5	59.5	0.2005	339.6	100.1
6	59.3	0.2001	339.4	100.3
7	59.3	0.2000	339.3	100.3
8	59.2	0.1999	339.3	100.3
9	59.2	0.1999	339.2	100.3
10	15.3	0.0760	230.4	264.8
11	14.7	0.0738	227.8	272.6

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
20	376.307	44.34	1.203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	50.4
2	59.6	0.2009	339.9	50.4
3	59.6	0.2009	339.9	50.4
4	59.6	0.2008	339.9	50.4
5	59.6	0.2008	339.9	50.4
6	59.6	0.2007	339.8	50.4
7	59.6	0.2007	339.8	50.4
8	59.5	0.2007	339.8	50.4
9	59.5	0.2007	339.8	50.4
10	14.8	0.0744	228.4	136.2
11	14.7	0.0738	227.8	137.2

NOTE: THERE IS CHOKED FLOW AT STATION 9

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
10	190,249	44.93	1,209

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	25.4
2	59.6	0.2009	339.9	25.4
3	59.6	0.2009	339.9	25.4
4	59.6	0.2009	339.9	25.4
5	59.6	0.2009	339.9	25.4
6	59.6	0.2009	339.9	25.5
7	59.6	0.2009	339.9	25.5
8	59.6	0.2009	339.9	25.5
9	59.6	0.2009	339.9	25.5
10	14.7	0.0740	227.9	69.2
11	14.7	0.0738	227.8	69.3

NOTE: THERE IS CHOKED FLOW AT STATION 9

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

CASE 4C
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/FT³
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	20.1	340	14.7	59.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 270 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	0.120	0.12000
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	53.6	0.1861	329.7	497.4
3	49.0	0.174[illegible]	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	0.1469	299.8	631.5
8	14.7	0.0738	227.3	1238.0

NOTE: THERE IS CHOKED FLOW AT STATION 7

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	[illegible]	5.07	[illegible]

	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	0.1629	312.5	564.2
7	38.4	0.1469	299.5	631.5
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	0.1861	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	0.1629	312.5	564.2
7	32.0	0.1288	234.5	720.1
8	14.7	0.0739	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	55.2	0.1901	332.5	421.2
3	51.9	0.1819	326.6	450.7
4	50.7	0.1790	324.6	457.0
5	49.3	0.1755	322.0	464.8
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	1112.1

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
60	2,375,062	31.29	156

	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	336.8
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	832.0
8	14.7	0.0738	227.8	866.6

2A72 [illegible]

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
50	1,[illegible]	38.35	751

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	239.2
2	58.[illegible]	0.1980	338.0	242.2
3	57.5	0.1953	333.3	245.2
4	57.3	0.1952	336.0	245.2
5	57.1	0.1947	335.7	245.2
6	57.0	0.1948	335.3	245.2
7	18.6	0.0876	243.9	548.3
8	14.7	0.0738	227.9	650.9

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	0.2000	339.3	162.8
3	58.9	0.1939	338.6	163.7
4	58.7	0.1987	338.4	163.7
5	58.6	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	0.0738	227.8	442.0

NOTE: THERE IS CHOKED FLOW AT STATION 6

ANGLE	FLOW	DP ACROSS VALVE	Tclosing
30	749,432	44.03	1,174

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	59.7	0.2010	340.0	100.4
2	59.5	0.2007	339.8	100.4
3	59.4	0.2003	339.5	100.6
4	59.3	0.2002	339.5	100.6
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	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	1,203

	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	59.3	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

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	40.93	1.209

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

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- P304 D / 12177
SPEC. NO.: NMP2- P304 D 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	SA 351 GR CF8M	23400	PSI
B.	STEM	SA 564 GR 630 Cond H1075	52800	PSI
C.	PIN	SA 564 GR 630 Cond H1075	35200	PSI 1A
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-SR80-

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUT. 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	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

NUCLEAR SEISMIC ANALYSIS

Case 1A

14" CLASS 150 VALVE ASSEMBLY
WITH [illegible] ACTUATOR

[illegible]
[illegible] 12127
[illegible]
SER.NO.:19157
[illegible] 10.13

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.[illegible] DWG.NO. 19157-3 REV.B	A.BODY: 23400
B.[illegible] REV.A	B.STEM: 52800
C.[illegible] DWG.NO..211-301 REV.B	C.PIN: 35200
D.STEM DWG.NO.:2510-015 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. :2400-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.2000-197 REV.-	

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

	G LOADINGS
LOCA TORQUE= 6170	TRANSVERSE= 4
MEDIA=AIR	VERTICAL= 3
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.628	X3= 3.688	X4= 6	X5= 1.375	W1= 219	W2= 27
W4= 61	T1= .275	T2= 5	T3= 7	T4= 3	T9= .75	T0= .625
d3= 0	D1= 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= 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= 65 VS. 33HZ.	SHEAR= 9901 PSI
VERTICAL(Y) ACT./VALVE= 576 VS. 33HZ.	TENSILE= 8491 PSI
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 15019 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8315 PSI	SHEAR= 638 PSI
TENSILE= 17010 PSI	TENSILE= 3657 PSI
COMBINED= 20400 PSI VS.ALLOW= 37500	COMBINED= 3765 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 917 PSI	SHEAR= 12087 PSI
TENSILE= 1234 PSI	TENSILE= 4460 PSI
COMBINED= 1722 PSI VS.ALLOW= 23400	COMBINED= 14522 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 14008 PSI VS.ALLOW= 21120	VALVE= 762.38 IN↑3
	PIPING= 61.22 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 3.63100000E-03 INCHES	NOT APPLICABLE
VERTICAL= 8.30000000E-05 INCHES	
TRANSVERSE= 2.10000000E-03 INCHES	

SIGNED.......[signature].......DATED....12/13/85..

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C-SR80-M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D/12177
SPEC. NO.: NMP2-P304D 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	SA 351 GR CF8M	23400	PSI	
B.	STEM	SA 564 GR 630 Cond H1075	52800	PSI	
C.	PIN	SA 564 GR 630 Cond H1075	35200	PSI	1A
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: 6519 Case 1B. IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred 1A

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 14" CLASS 150

ACTUATOR N721C-SR80-

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTE 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	13.974	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	〃	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

NUCLEAR INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

Case 16

14 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR60 ACTUATOR

CUSTOMER NIAGARA MOHAWK
P.O. [illegible] 12177
SPEC.NO. [illegible]
REF.NO. 1915[illegible]
ITEM NO.13

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS Y DWG.NO.119137-3 REV.G	A.BODY: 23400
B.BODY DWG.NO.1114-302 REV.A	B.STEM: 52800
C.DISC DWG.NO.12114-301 REV.B	C.PIN: 35200
D.STEM DWG.NO.12510-015 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. 12600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.2000-197 REV.-	

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

	G LOADINGS
LOCA TORQUE= 6519	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= 1.375	W1= 219	W2= 27
W4= 61	T1= .875	T2= 5	T3= 7	T4= 3	T9= .75	T0= .625
d3= 0	D2= 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= 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= 9735 PSI
VERTICAL(Y) ACT./VALVE= 576 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 16457 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 7636 PSI	SHEAR= 598 PSI
TENSILE= 18314 PSI	TENSILE= 3725 PSI
COMBINED= 21209 PSI VS.ALLOW= 37500	COMBINED= 3819 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 916 PSI	SHEAR= 12771 PSI
TENSILE= 1284 PSI	TENSILE= 4427 PSI
COMBINED= 1761 PSI VS.ALLOW= 23400	COMBINED= 15175 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 15646 PSI VS.ALLOW= 21120	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= 1.60000000E-03 INCHES	

SIGNED... [signature] ......DATED....12/13/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C-SR80-M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2-P304D/12177
SPEC. NO.: NMP2-P304D 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.	2600-560	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	35200	PSI 1A
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	BS
STEM DIA.	1.375	D1	D1
GAGE DIA. OF DISC	13.974	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	1	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. [illegible]
SPEC. NO. NMP2-P304D
REF. NO. 19157
ITEM NO.:3

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-I 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: 35200
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.0000-197 REV.-	

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

	G LOADINGS
LOCA TORQUE= 5848	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= 61	T1= .875	T2= 5	T3= 7	T4= 3	T5= .75	T0= .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= 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.)
LONGITUDINAL(Z) ACT./VALVE= 85 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 574 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.
LATERAL DISC/STEM= 604 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 9650 PSI
TENSILE= 8491 PSI
COMBINED= 14788 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 8107 PSI
TENSILE= 17010 PSI
COMBINED= 20255 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 629 PSI
TENSILE= 3594 PSI
COMBINED= 3701 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 896 PSI
TENSILE= 1234 PSI
COMBINED= 1705 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 11456 PSI
TENSILE= 4460 PSI
COMBINED= 13902 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 14035 PSI VS.ALLOW= 21120

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

ACTUATOR DEFLECTIONS
LONGITUDINAL= 3.83100000E-03 INCHES
VERTICAL= 8.30000000E-05 INCHES
TRANSVERSE= 2.10000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED............................DATED...12/13/85.....

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	35200	PSI 1A
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 @80° 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-1180-

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTE 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	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

NUCLEAR SEISMIC ANALYSIS

Case 2
80°

14 CLASS 150 VALVE ASSEMBLY
WITH N7212-SR83 ACTUATOR

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.[illegible] REV.B	A.BODY: 23400
B.[illegible] DWG.NO. [illegible]-302 REV.A	B.STEM: 52800
C.[illegible] DWG.NO. 2114-301 REV.3	C.PIN: 35200
C.STEM DWG.NO.12510-015 REV.A	D.BRACKET: 18900
E.PIN DWG.NO. 12600-060 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.0000-177 REV.-	

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

	G LOADINGS
LOCA TORQUE= 9584	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 3
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 4

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.682	X4= 6	X5= 1.375	W1= 219	W2= 27
W4= 61	T1= .875	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= .913	
L2= .316	Y2= 1.504	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 5	X8= 2	T5= 9.75	R5= 0	R6= 0	
Z= .65	do= .493	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= 576 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.
LATERAL DISC/STEM= 604 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 13259 PSI
TENSILE= 8491 PSI
COMBINED= 18168 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 10333 PSI
TENSILE= 19836 PSI
COMBINED= 24240 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 782 PSI
TENSILE= 4986 PSI
COMBINED= 5105 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 1261 PSI
TENSILE= 1431 PSI
COMBINED= 2166 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 12776 PSI
TENSILE= 4460 PSI
COMBINED= 21138 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 23002 PSI VS.ALLOW= 21120

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

ACTUATOR DEFLECTIONS
LONGITUDINAL= 5.10800000E-03 INCHES
VERTICAL= 8.30000000E-05 INCHES
TRANSVERSE= 1.60000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED... [signature] ...DATED...12/13/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 14"
VALVE CLASS: 150
ACTUATOR: N721C - SR80 - M3HW
CUSTOMER: Niagara Mohawk
P.O. NO.: NMP2 - P304D / 12177
SPEC. NO.: NMP2 - P304D 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	35200	PSI
D.	BRACKET	CS	18900	PSI
E.	BOLTING	A193 GR B7	37500	PSI

/A

DESIGN CONDITIONS

PRESSURE: 45 PSI
TEMPERATURE: 340 DEG. F.

VALVE TORQUES

LOCA TORQUE: 7496 @ 70° Case 2B IN-LBS /A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 3
LONGITUDINAL: 4

NUCLEAR SEISMIC ANALYSIS

Case 2

14 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

70°

[illegible]
[illegible] 10177
SPEC.NO.[illegible]
REF.NO.:19157
ITEM NO.:3

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASSY DWG.NO.:19157-3 REV.3	A.BODY: 23400
B.BODY DWG.NO.:[illegible]-302 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2114-301 REV.B	C.PIN: 35200
D.STEM DWG.NO.:2510-015 REV.A	D.BRACKET: 18900
E.PIN DWG.NO.:2600-080 REV.A	E.BOLTING: 37500
F.BRACKET DWG.NO.8000-197 REV.-	

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

	G LOADINGS
LOCA TORQUE= 7496	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 3
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 4

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.686	X4= 6	X5= 1.375	W1= 219	W2= 27
W4= 61	T1= .875	T2= 5	T3= 7	T4= 3	T9= .75	TO= .625
d3= 0	Oi= 2.125	O1= 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= 9.75	R5= 0	R6= 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= 11654 PSI
VERTICAL(Y) ACT./VALVE= 576 VS. 33HZ.	TENSILE= 8491 PSI
TRANSVERSE(X) ACT./VALVE= 130 VS.33HZ.	COMBINED= 16649 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 604 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 9013 PSI	SHEAR= 724 PSI
TENSILE= 19836 PSI	TENSILE= 4574 PSI
COMBINED= 23319 PSI VS.ALLOW= 37500	COMBINED= 4687 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 1125 PSI	SHEAR= 14685 PSI
TENSILE= 1431 PSI	TENSILE= 4460 PSI
COMBINED= 2049 PSI VS.ALLOW= 23400	COMBINED= 17084 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 17990 PSI VS.ALLOW= 21120	VALVE= 762.38 IN↑3
	PIPING= 61.22 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 5.10800000E-03 INCHES	NOT APPLICABLE
VERTICAL= 8.30000000E-05 INCHES	
TRANSVERSE= 1.60000000E-03 INCHES	

SIGNED..[signature]......DATED....12/13/85..

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N711C - 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.	1113-301	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	35200	PSI	1A
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: 3991 @80° Case 3A IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred 1A

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

DIMENSIONAL DATA

ACTUATOR U721C-4R80-M3

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
..GE DIA. OF DISC	11.703	D	D
..TH SMALL DIA. BACK OF DISC	1.625	E1	E1
..DTH LARGE DIA. OF DISC	.938	E2	E2
..RUST 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
..OT AREA OF BODY BOLTS		A4	A4
..GTH ACROSS GUSSETS	0	L	L
..CKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	1	B	B
..ULUS OF ELASTICITY	30,000,000	E	E

FUSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

Case 3A
80°

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

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

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-4 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: 35200
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)= 300

VALVE TORQUE(IN-LBS)	G LOADINGS
LOCA TORQUE= 3991	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 3.182	T4= 0	T9= .75	TO= .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= 9.75	R5= 0	R6= 0	
X= .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= 7781 PSI
VERTICAL(Y) ACT./VALVE= 456 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.	COMBINED= 14791 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8363 PSI	SHEAR= 529 PSI
TENSILE= 17852 PSI	TENSILE= 3227 PSI
COMBINED= 21158 PSI VS.ALLOW= 37500	COMBINED= 3312 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 2874 PSI	SHEAR= 10482 PSI
TENSILE= 8782 PSI	TENSILE= 4526 PSI
COMBINED= 9639 PSI VS.ALLOW= 23400	COMBINED= 12987 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 22937 PSI VS.ALLOW= 21120	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....1/5/84....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7UC-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.	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	35200	PSI	1A
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: 3321 @70° Case 3A IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred 1A

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

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

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-4 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: 35200
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)= 300

VALVE TORQUE(IN-LBS)	G LOADINGS
LOCA TORQUE= 3321	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 3.182	T4= 0	T9= .75	TO= .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= 9.75	R5= 0	R6= 0	
Z=.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= 7266 PSI
VERTICAL(Y) ACT./VALVE= 456 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.	COMBINED= 14371 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 7848 PSI	SHEAR= 511 PSI
TENSILE= 17852 PSI	TENSILE= 3095 PSI
COMBINED= 20812 PSI VS.ALLOW= 37500	COMBINED= 3178 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 2707 PSI	SHEAR= 8722 PSI
TENSILE= 8782 PSI	TENSILE= 4526 PSI
COMBINED= 9550 PSI VS.ALLOW= 23400	COMBINED= 11274 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 19086 PSI VS.ALLOW= 21120	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...1/9/85.....

C-19

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7UC - 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.	1113-301	REV.	A
C.	DISC DWG. NO.	2113-301	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	35200	PSI	1A
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: 4100 @80 Case 3E IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred 1A

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

DIMENSIONAL DATA

ACTUATOR U721C-3R80-M3H

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	8	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
W[illegible] LARGE DIA. OF DISC	.938	E2	E2
[illegible]ST WASHER THICKNESS	.305	L2	L2
[illegible] ℄ 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
[illegible]KNESS OF GUSSETS	0	T	T
[illegible] OF FLANGE BOSSES	1	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

NUCLEAR SEISMIC ANALYSIS

Case 3C
80°

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

CUSTOMER.NIAGARA MOHAWK
P.O.NO.NMP2-P304C 12177
SPEC.NO. NMP2-P731D
REF.NO..19157
ITEM NO.:5

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASSY DWG.NO.:19157-5 REV.C	A.BODY: 23400
B.BODY DWG.NO. 1112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 35200
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.SC00-199 REV.-	

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

	G LOADINGS
LOCA TORQUE= 4100	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.682	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 6.5	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	R5= 3.4	R6= 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.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 78 VS. 33HZ.	SHEAR= 7865 PSI
VERTICAL(Y) ACT./VALVE= 563 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.	COMBINED= 14860 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8084 PSI	SHEAR= 532 PSI
TENSILE= 22769 PSI	TENSILE= 3282 PSI
COMBINED= 25347 PSI VS.ALLOW= 37500	COMBINED= 3366 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 1336 PSI	SHEAR= 10768 PSI
TENSILE= 2578 PSI	TENSILE= 4526 PSI
COMBINED= 3146 PSI VS.ALLOW= 23400	COMBINED= 13267 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 23563 PSI VS.ALLOW= 21120	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= 1.80000000E-03 INCHES	

SIGNED.....[signature].....DATED...12/13/85...

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.	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	35200	PSI 1A
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: 2542 Unseat Case 3C IN-LBS
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

Case 3C

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

Unseat Torque

CUSTOMER:NIAGARA MOHAWK
P.O.NO.NMP2-P3040-12177
SPEC.NO.:NMP2-P3040
REF.NO.:19157
ITEM NO.:5

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-5 REV.C	A.BODY: 23400
B.BODY DWG.NO.:1112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 35200
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)= 300

VALVE TORQUE(IN-LBS)	G LOADINGS
LOCA TORQUE= 2542	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.688	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .825	T2= 5	T3= 6.5	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	R5= 3.4	R6= 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= 563 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.
LATERAL DISC/STEM= 906 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 6669 PSI
TENSILE= 10497 PSI
COMBINED= 13897 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 7063 PSI
TENSILE= 22769 PSI
COMBINED= 24782 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 489 PSI
TENSILE= 2975 PSI
COMBINED= 3054 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 1160 PSI
TENSILE= 2578 PSI
COMBINED= 3023 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 6676 PSI
TENSILE= 4526 PSI
COMBINED= 9313 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 14609 PSI VS.ALLOW= 21120

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= 1.80000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED...[signature]...DATED....12/23/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N741C-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.	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	35200	PSI	A
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: 4319 @ 80° Case 4A IN-LBS A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

SIZE 12" CLASS 150

DIMENSIONAL DATA

ACTUATOR N721C-5K50-A

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTE 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	2.938	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

NUCLEAR SEISMIC ANALYSIS

Case 4E

90°

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

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

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-4 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: 35200
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.6000-199 REV.-	

DESIGN CONDITIONS
PRESSURE(PSIG)= 45
TEMPERATURE('F)= 300

VALVE TORQUE(IN-LBS)	G LOADINGS
LOCA TORQUE= 4319	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 3.182	T4= 0	T9= .75	T0= .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= 9.75	R5= 0	R6= 0	
Z= .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= 8034 PSI
VERTICAL(Y) ACT./VALVE= 456 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.	COMBINED= 15000 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8615 PSI	SHEAR= 538 PSI
TENSILE= 17852 PSI	TENSILE= 3292 PSI
COMBINED= 21332 PSI VS.ALLOW= 37500	COMBINED= 3378 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 2956 PSI	SHEAR= 11343 PSI
TENSILE= 8782 PSI	TENSILE= 4526 PSI
COMBINED= 9684 PSI VS.ALLOW= 23400	COMBINED= 13830 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 24822 PSI VS.ALLOW= 21120	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........................DATED..1/8/82........

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7UC - 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.	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	35200	PSI	1A
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: 3590 @ 70° Case 4A IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

POSI-SEAL INTERNATIONAL INC.
NUCLEAR SEISMIC ANALYSIS

Case 4A
70°

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

CUSTOMER:NIAGARA MOHAWK
P.O.NO.NMP2-P3040-12177
SPEC.NO.:NMP2-F3040
REF.NO.:19157
ITEM NO.:4

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-4 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: 35200
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)= 300

VALVE TORQUE(IN-LBS)	G LOADINGS
LOCA TORQUE= 3590	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 8.438	X2= 2.688	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 3.182	T4= 0	T9= .75	TO= .625
d3= 2.875	Di= 1.255	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	TS= 9.75	RS= 0	R6= 0	
Z= .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= 7472 PSI
VERTICAL(Y) ACT./VALVE= 456 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 70 VS.33HZ.	COMBINED= 14538 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8055 PSI	SHEAR= 518 PSI
TENSILE= 17852 PSI	TENSILE= 3148 PSI
COMBINED= 20950 PSI VS.ALLOW= 37500	COMBINED= 3231 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 2774 PSI	SHEAR= 9428 PSI
TENSILE= 8782 PSI	TENSILE= 4626 PSI
COMBINED= 9585 PSI VS.ALLOW= 23400	COMBINED= 11960 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 20632 PSI VS.ALLOW= 21120	VALUE= 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....[illegible]....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N741C - 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	35200	PSI	/A
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: 6776 @ 80° Case 4C IN-LBS /A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 7
LONGITUDINAL: 3

SIZE 12" CLASS 150

ACTUATOR N721C-SR50-A

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTE 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	2.938	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

FLOW-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC ANALYSIS

Case 4C
80°

12 CLASS 150 VALVE ASSEMBLY
WITH N7212-SR30 ACTUATOR

CUSTOMER: NIAGARA MOHAWK
P.O.NO.NMP2-P304C.12177
SPEC.NO..NMP2-P304C
REF.NO..19157
ITEM NO.:5

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-5 REV.C	A.BODY: 23400
B.BODY DWG.NO.:1112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 35200
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.S000-199 REV.-	

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

	G LOADINGS
LOCA TORQUE= 6776	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.688	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 6.5	T4= 2.938	T9= .75	T0= .625
d3= 0	D1= 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	R5= 3.4	R6= 1	
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= 563 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= 22769 PSI	TENSILE= 3609 PSI
COMBINED= 26431 PSI VS.ALLOW= 37500	COMBINED= 3903 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 1640 PSI	SHEAR= 17794 PSI
TENSILE= 2578 PSI	TENSILE= 4526 PSI
COMBINED= 3376 PSI VS.ALLOW= 23400	COMBINED= 20203 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 38943 PSI VS.ALLOW= 21120	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= 1.80000000E-03 INCHES	

SIGNED.....John [signature].....DATED...12/13/85...

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N7UC - 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.	2630-060	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	35200	PSI	1A
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: 4729 @ 70° Case 4C IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

NUCLEAR SEISMIC ANALYSIS

Case 4
70°

12 CLASS 150 VALVE ASSEMBLY
WITH N?210-SR8? ACTUATOR

CUSTOMER: NIAGARA MOHAWK
P.O.NO.NM-2-F30-0 10177
SPEC.NO.:NMP2-57?NO.
REF.NO.:19157
ITEM NO.:5

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:19157-5 REV.C	A.BODY: 23400
B.BODY DWG.NO.:2112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 35200
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)= 340

	G LOADINGS
LOCA TORQUE= 4729	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.622	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 6.5	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	R5= 3.4	R6= 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.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 78 VS. 33HZ.	SHEAR= 8350 PSI ,
VERTICAL(Y) ACT./VALVE= 563 VS. 33HZ.	TENSILE= 10697 PSI
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.	COMBINED= 15265 PSI VS.ALLOW.= 37500
LATERAL DISC/STEM= 906 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 8497 PSI	SHEAR= 549 PSI
TENSILE= 22769 PSI	TENSILE= 3406 PSI
COMBINED= 25590 PSI VS.ALLOW= 37500	COMBINED= 3492 PSI VS.ALLOW= 18900

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 1408 PSI	SHEAR= 12420 PSI
TENSILE= 2578 PSI	TENSILE= 4526 PSI
COMBINED= 3198 PSI VS.ALLOW= 23400	COMBINED= 14888 PSI VS.ALLOW= 52800

DISC PIN STRESS	SECTION MODULUS
SHEAR= 27178 PSI VS.ALLOW= 21120	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= 1.80000000E-03 INCHES	

SIGNED... [signature] ....DATED..12/13/85....

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 12"
VALVE CLASS: 150
ACTUATOR: N711C-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.	1113-301	REV.	A
C.	DISC DWG. NO.	2113-301	REV.	A
D.	STEM DWG. NO.	2510-012	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	35200	PSI	1A
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: 2611 @ 60° Case 4C IN-LBS 1A
MEDIA: Air
FLOW DIRECTION: Preferred

G-LOADINGS

TRANSVERSE: 3
VERTICAL: 4
LONGITUDINAL: 3

Case 4:
60°

NUCLEAR SEISMIC ANALYSIS

12 CLASS 150 VALVE ASSEMBLY
WITH N721C-SR80 ACTUATOR

CUSTOMER: [illegible]
P.O.NO. [illegible]
SPEC. NO. [illegible]
REF.NO.:19157
ITEM NO..5

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS Y DWG.NO.:19157-5 REV.C	A.BODY: 23400
B.BODY DWG.NO. 1112-301 REV.A	B.STEM: 52800
C.DISC DWG.NO.:2112-301 REV.A	C.PIN: 35200
C.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.8003-199 REV.-	

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

	G LOADINGS
LOCA TORQUE= 2611	TRANSVERSE= 3
MEDIA=AIR	VERTICAL= 4
FLOW DIRECTION=PREFERRED	LONGITUDINAL= 3

DIMENSIONAL DATA

X1= 2.698	X2= 8.438	X3= 3.688	X4= 6	X5= 2.665	W1= 219	W2= 27
W4= 26	T1= .875	T2= 5	T3= 6.5	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	R5= 3.4	R6= 1	
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= 563 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 123 VS.33HZ.
LATERAL DISC/STEM= 906 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 6721 PSI
TENSILE= 10697 PSI
COMBINED= 13938 PSI VS.ALLOW.= 37500

BRACKET BOLT STRESSES
SHEAR= 7109 PSI
TENSILE= 22769 PSI
COMBINED= 24806 PSI VS.ALLOW= 37500

BRACKET STRESSES
SHEAR= 491 PSI
TENSILE= 2989 PSI
COMBINED= 3068 PSI VS.ALLOW= 18900

VALVE NECK STRESSES
SHEAR= 1167 PSI
TENSILE= 2578 PSI
COMBINED= 3029 PSI VS.ALLOW= 23400

STEM STRESSES
SHEAR= 6857 PSI
TENSILE= 4526 PSI
COMBINED= 9484 PSI VS.ALLOW= 52800

DISC PIN STRESS
SHEAR= 15005 PSI VS.ALLOW= 21120

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= 1.80000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED........ DATED..12/13/85....

APPENDIX D

Determination of Closing Times

NOTE: Positive torques are tending to open the valve, negative torques are tending to close the valve.

CASE 1A

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 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 1457 IN.LBS.

GAGE DIA. 12.977 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	245.8	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

Case 1E

14 - 150 CLASS VALVE WITH A N[illegible]C-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible]	[illegible]		
ACT. [illegible]	ACT. [illegible] RADIUS= 2.3	ACT. [illegible]= 80	SOL. VALVE Cv= 2.2[illegible]
MEDIA=AIR	VALVE C.T [illegible]	HYDRO. TORQUE @ 90= 1182	SHUT-OFF PRES. DROP= 45
[illegible] TORQUE= [illegible]	[illegible] TORQUE= [illegible]	[illegible]	[illegible]
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.07[illegible]	.0770	.0826	.0939	.1150	.1510	.1610	.1720
VELOCITY	65.[illegible]	12[illegible]	245.9	374.[illegible]	492.8	549.5	549.9	579.0	541.9
PRES DROP	44.90	44.70	44.00	42.10	37.90	29.90	15.20	9.74	5.48

LOCA CLOSES THE VALVE TO 62 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -6514 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	4634	-3098	-2312	499	368	62.00	26.96
0.05	0	2530	-2825	-708	499	504	51.17	36.95
0.10	0	2059	-2764	-342	499	547	44.70	40.12
0.15	0	1799	-2697	-177	499	576	39.44	42.20
0.20	0	1693	-2675	-95	499	588	34.91	43.06
0.25	0	1633	-2683	-47	499	598	30.82	43.84
0.30	0	1637	-2713	-26	499	603	27.06	44.20
0.35	0	1670	-2761	-14	499	606	23.55	44.45
0.40	0	1724	-2826	-7	499	610	20.24	44.68
0.45	0	1800	-2906	-4	499	611	17.13	44.75
0.50	0	1890	-2999	-2	499	611	14.19	44.81
0.55	0	1994	-3105	-1	499	612	11.42	44.87
0.60	0	2107	-3221	-0	499	613	8.81	44.91
0.65	0	2235	-3348	-0	499	613	6.36	44.93
0.70	0	2369	-3483	-0	499	613	4.06	44.95
0.75	0	1640	-3625	-0	1370	614	1.92	44.98
0.80	0	1306	-3721	-0	1800	614	0.59	44.99

CASE 1B

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 PRESSURE 40 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 .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	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

14 - 150 CLASS VALVE WITH A [illegible] ACTUATOR

Case 18

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible]	[illegible]= 3770		
ACT. [illegible]	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= 0.26
[illegible]	VALVE Cv= .317	HYDRO. TORQUE @ 90= 1192	SHUT-OFF PRES. DROP= 45
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	.0743	.0757	.0790	.08[illegible]	.09[illegible]	.1[illegible]	.1420	.1490
VELOCITY	65.3	125.7	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	1563	12993	-5924	-6431	832	94	90.00	6.92
0.05	99	11528	-5924	-6431	832	94	90.00	6.92
0.10	0	10275	-5924	-6431	832	94	90.00	6.92
0.15	0	11254	-4492	-7404	499	144	81.32	10.54
0.20	0	5979	-3248	-3588	499	358	65.55	26.21
0.25	0	2704	-2643	-877	499	517	52.31	37.86
0.30	0	2103	-2771	-388	499	557	45.42	40.81
0.35	0	1818	-2702	-196	499	581	40.04	42.58
0.40	0	1692	-2676	-106	499	591	35.44	43.32
0.45	0	1634	-2681	-53	499	600	31.31	43.98
0.50	0	1632	-2708	-29	499	605	27.52	44.34
0.55	0	1663	-2754	-15	499	608	23.98	44.56
0.60	0	1715	-2817	-7	499	611	20.66	44.76
0.65	0	1788	-2895	-4	499	612	17.52	44.82
0.70	0	1877	-2986	-2	499	612	14.56	44.85
0.75	0	1980	-3090	-1	499	612	11.77	44.88
0.80	0	2094	-3206	-0	499	613	9.14	44.90
0.85	0	2218	-3331	-0	499	613	6.67	44.93
0.90	0	2352	-3465	-0	499	613	4.35	44.95
0.95	0	1738	-3606	-0	1253	614	2.19	44.97
1.00	0	1340	-3708	-0	1753	614	0.76	44.99

CASE 2A

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" VALVE CLASS 150

ACTUATOR Bettis N721C-SR80

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 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	244.8	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

14 - 150 CLASS VALVE WITH A [illegible] ACTUATOR

Case 2A

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible] 3730	Tipping [illegible] 3770		
ACT. VOL. [illegible]	ACT. YOKE RADIUS= 2.5	ACT. PRESS= 80	SOL. VALVE Cv= [illegible]
[illegible]	VALVE [illegible]	HYSCO. TORQUE @ 90= 1182	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 832	SEAL TORQUE= 1454	Dstem= 1.375	Dgage= 12.97-
BUILDING PRESSURE= 45			

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	[illegible]	.0750	.0774	.0833	.0957	.1190	.1530	.1630	.1730
VELOCITY	65.4	125.0	244.8	372.8	483.3	534.0	533.4	561.6	528.9
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 62 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -6183 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	4634	-3098	-2251	499	352	62.00	25.84
0.05	0	2524	-2825	-694	499	496	51.17	36.37
0.10	0	2061	-2764	-339	499	543	44.72	39.77
0.15	0	1802	-2697	-177	499	573	39.46	42.00
0.20	0	1685	-2675	-95	499	586	34.91	42.91
0.25	0	1634	-2683	-47	499	597	30.82	43.73
0.30	0	1637	-2713	-26	499	602	27.06	44.13
0.35	0	1670	-2761	-14	499	606	23.54	44.41
0.40	0	1724	-2827	-7	499	610	20.24	44.68
0.45	0	1800	-2906	-4	499	611	17.12	44.75
0.50	0	1890	-2999	-2	499	611	14.18	44.81
0.55	0	1994	-3105	-1	499	612	11.41	44.87
0.60	0	2109	-3221	-0	499	613	8.80	44.91
0.65	0	2235	-3348	-0	499	613	6.36	44.93
0.70	0	2370	-3483	-0	499	613	4.06	44.95
0.75	0	1639	-3625	-0	1371	614	1.91	44.98
0.80	0	1306	-3721	-0	1800	614	0.59	44.99

CASE 2B

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 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.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1413	44.94
20	1303	44.78
30	888	44.13
40	7	42.55
50	-1492	39.15
60	-3113	32.93
70	-7496	20.51
80	-9584	11.29
90	-7586	6.95

DETERMINATION OF CLOSING TIME

14 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 2B

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930 Tspring ending= 3720
ACT. VOL.= .72 ACT. YOKE RADIUS= 2.5 ACT. PRESS= 80 SOL. VALVE Cv= 2.26
MEDIA=AIR VALVE Cv= 6317 HYDRO. TORQUE @ 90= 1182 SHUT-OFF PRES. DROP= 45
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
AERO TORQUE	1413	1303	888	7	-1492	-3113	-7496	-9584	-7586
PRES DROP	44.94	44.78	44.13	42.55	39.15	32.93	20.51	11.29	6.95

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

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -9584 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 sec
0.00	0	10309	-3428	-8186	832	297	69.00	21.752
0.05	0	4171	-2781	-2437	499	548	47.10	40.135
0.10	0	2693	-2679	-1101	499	588	36.45	43.109
0.15	0	2128	-2688	-541	499	602	29.87	44.138
0.20	0	1979	-2738	-347	499	606	25.08	44.449
0.25	0	1882	-2809	-182	499	610	21.03	44.712
0.30	0	1897	-2894	-114	499	612	17.56	44.818
0.35	0	1960	-2991	-80	499	612	14.42	44.869
0.40	0	2037	-3100	-49	499	613	11.53	44.915
0.45	0	2135	-3219	-28	499	613	8.85	44.946
0.50	0	2255	-3347	-20	499	613	6.37	44.961
0.55	0	2383	-3483	-13	499	614	4.06	44.975
0.60	0	1307	-3626	-6	1711	614	1.90	44.988
0.65	0	1026	-3702	-2	2064	614	0.84	44.994
0.70	0	876	-3761	-0	2270	614	0.06	44.999

CASE 2B

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" 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 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.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1413	44.94
20	1303	44.78
30	888	44.13
40	7	42.55
50	-1492	39.15
60	-3113	32.93
70	-7496	20.51
80	-9584	11.29
90	-7586	6.95

DETERMINATION OF CLOSING TIME

14 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 22

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

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= 6317	HYDRO. TORQUE @ 90= 1182	SHUT-OFF PRES. DROP= 45
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
AERO TORQUE	1413	1303	888	7	-1492	-3113	-7496	-9584	-7586
PRES DROP	44.94	44.78	44.13	42.55	39.15	32.93	20.51	11.29	6.95

LOCA CLOSES THE VALVE TO 64 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -7496 IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	0	8258	-3178	-6080	832	381	64.00	27.962
0.05	0	3830	-2767	-2120	499	558	44.91	40.878
0.10	0	2580	-2676	-994	499	591	35.21	43.306
0.15	0	2097	-2695	-505	499	603	28.98	44.196
0.20	0	1959	-2749	-316	499	607	24.33	44.498
0.25	0	1869	-2823	-156	499	611	20.39	44.754
0.30	0	1906	-2909	-108	499	612	17.01	44.827
0.35	0	1972	-3009	-74	499	612	13.91	44.877
0.40	0	2051	-3120	-44	499	613	11.06	44.923
0.45	0	2155	-3240	-27	499	613	8.42	44.949
0.50	0	2276	-3370	-19	499	614	5.96	44.964
0.55	0	2406	-3507	-12	499	614	3.68	44.977
0.60	0	1199	-3651	-5	1842	614	1.55	44.990
0.65	0	975	-3721	-1	2132	614	0.59	44.996

CASE 3A

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 .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1183	44.90
20	1104	44.63
30	820	43.81
40	254	41.65
50	-598	36.84
60	-1766	27.43
70	-3321	13.44
80	-3991	7.53
90	-2875	4.85

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 3A

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930	Tspring ending= 3770		
ACT. VOL.= .72	ACT. YOKE RADIUS= 2.5	ACT. PRES= 80	SOL. VALVE Cv= 2.26
MEDIA=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 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
AERO TORQUE	1183	1604	820	254	-598	-1766	-3321	-3991	-2875
PRES DROP	44.90	44.63	43.81	41.65	36.84	27.43	13.44	7.53	4.85

LOCA CLOSES THE VALVE TO 59 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -3991 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 sec
0.00	0	4654	-2997	-2691	756	286	59.00	28.371
0.05	0	3488	-2785	-1539	453	383	47.67	37.957
0.10	0	2669	-2692	-854	453	423	38.74	41.921
0.15	0	2278	-2678	-492	453	437	32.08	43.358
0.20	0	1946	-2716	-129	453	445	26.78	44.073
0.25	0	1683	-2777	191	453	448	22.65	44.412
0.30	0	1570	-2846	371	453	450	19.39	44.646
0.35	0	1761	-2921	254	453	451	16.62	44.721
0.40	0	1973	-3013	134	453	452	13.79	44.797
0.45	0	2204	-3124	13	453	453	10.95	44.874
0.50	0	2369	-3255	-21	453	453	8.13	44.918
0.55	0	2504	-3397	-14	453	453	5.48	44.945
0.60	0	2647	-3549	-8	453	454	3.03	44.969
0.65	0	1482	-3707	-2	1772	454	0.78	44.992

CASE 3A

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. 1.25 IN.

GAGE DIA. 11.703 IN.

BUILDING PRESSURE 45 PSIG

dt .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1183	44.90
20	1104	44.63
30	820	43.81
40	254	41.65
50	-598	36.84
60	-1766	27.43
70	-3321	13.44
80	-3991	7.53
90	-2875	4.85

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 3A

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930
ACT. VOL.= .72
MEDIA=AIR
PACKING TORQUE= 756
GUILDING PRESSURE= 45

Tspring ending= 3770
ACT. YOKE RADIUS= 2.5
VALVE Cv= 4942
SEAL TORQUE= 1163

ACT. PRESS= 80
HYDRO. TORQUE @ 90= 761
Dstem= 1.25

SOL. VALVE Cv= 2.26
SHUT-OFF PRES. DROP= 45
Dgage= 11.703

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	1183	1604	820	254	-598	-1766	-3321	-3991	-2875
PRES DROP	44.90	44.63	43.81	41.65	36.84	27.43	13.44	7.53	4.85

LOCA CLOSES THE VALVE TO 53 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -3321 IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	0	3799	-2855	-2047	755	343	53.00	34.017
0.05	0	3074	-2742	-1190	453	404	43.33	40.047
0.10	0	2472	-2676	-679	453	430	35.52	42.615
0.15	0	2136	-2691	-342	453	442	29.53	43.848
0.20	0	1814	-2743	28	453	446	24.75	44.240
0.25	0	1590	-2809	314	453	449	21.06	44.542
0.30	0	1657	-2879	317	453	451	18.11	44.680
0.35	0	1857	-2962	198	453	452	15.31	44.756
0.40	0	2078	-3063	78	453	452	12.47	44.833
0.45	0	2301	-3183	-25	453	453	9.63	44.903
0.50	0	2431	-3320	-18	453	453	6.86	44.931
0.55	0	2571	-3467	-11	453	454	4.31	44.956
0.60	0	1720	-3622	-5	1452	454	1.96	44.980
0.65	0	1449	-3723	-1	1820	454	0.56	44.994

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR B.f.L.s N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 90°

DIRECTION OF FLOW P...l

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 .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

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 3B

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible] SPEC	[illegible] ENGINE= 3770		
ACT. [illegible]	ACT. [illegible] FACTOR= 2.5	ACT. PRESS= 60	SOL. VALVE Cv= 2.26
[illegible]	VALVE [illegible]	HYDRC. TORQUE @ 90= [illegible]	SHUT-OFF PRES. DROP= 45
[illegible]	SEA. TORQUE= 1103	D[illegible] 1.25	Dcase= 11.707
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	79.5	136.2	265.7	409.9	549.0	633.3	653.9	700.5	624.9
PRES DROP	44.70	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	4197	12993	-5924	-3687	756	60	90.00	5.95
0.05	2732	11528	-5924	-3687	756	60	90.00	5.95
0.10	1579	10375	-5924	-3687	756	60	90.00	5.95
0.15	645	9442	-5924	-3687	756	60	90.00	5.95
0.20	0	8668	-5924	-3687	756	60	90.00	5.95
0.25	0	8739	-4497	-4598	453	102	82.91	10.16
0.30	0	6416	-3618	-3425	453	173	71.97	17.19
0.35	0	3478	-3023	-1228	453	320	59.83	31.71
0.40	0	2488	-2830	-489	453	378	51.51	37.45
0.45	0	2145	-2769	-237	453	407	45.16	40.38
0.50	0	1937	-2699	-120	453	428	39.68	42.45
0.55	0	1846	-2675	-61	453	437	34.80	43.28
0.60	0	1816	-2626	-28	453	444	30.32	44.04
0.65	0	1836	-2723	-15	453	448	26.19	44.36
0.70	0	1886	-2783	-7	453	450	22.33	44.63
0.75	0	1960	-2863	-3	453	452	18.72	44.81
0.80	0	2055	-2960	-1	453	452	15.36	44.84
0.85	0	2166	-3072	-0	453	453	12.22	44.87
0.90	0	2291	-3198	-0	453	453	9.29	44.90
0.95	0	2428	-3335	-0	453	453	6.58	44.93
1.00	0	2575	-3482	-0	453	454	4.07	44.95
1.05	0	1964	-3637	-0	1216	454	1.74	44.98
1.10	0	1698	-3752	-0	1600	454	0.18	44.99

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR B. Lli. N721C-SR80-M3HW

AMOUNT OF VALVE OPENING 70°

DIRECTION OF FLOW P. A. [illegible]

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 .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

Gas. 3B

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

[illegible]	[illegible]		
ACT. [illegible]	ACT. YOKE RADIUS= 2.0	ACT. PRESS= 80	SOL. VALVE Cv= 2.26
MEDIUM=AIR	VALVE Cv= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 756	SEAL TORQUE= 1193	Dstem= 1.25	Dpaco= 11.703
BUILDING PRESSURE= [illegible]			

DEG.	1.	[illegible]	[illegible]	[illegible]	50	60	70	80	90
DENSITY	.0740	.0744	.0760	.0797	.0877	.1020	.1280	.1350	.1520
VELOCITY	[illegible]	136.8	265.9	409.9	549.0	633.3	653.9	700.5	624.9
PRES DROP	[illegible]	44.80	44.10	42.40	38.50	31.00	18.50	11.90	5.70

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P psi
0.00	2634	8475	-3428	-3094	756	186	70.00	18.50
0.05	1879	7520	-3408	-3094	756	186	70.00	18.50
0.10	1127	[illegible]	-3428	-3094	756	186	70.00	18.50
0.15	518	6158	-3488	-3094	756	186	70.00	18.50
0.20	14	5654	-3488	-3094	756	186	70.00	18.50
0.25	0	5228	-3488	-3094	756	186	70.00	18.50
0.30	0	3453	-3018	-1209	453	321	59.66	31.82
0.35	0	2477	-2828	-481	453	379	51.39	37.53
0.40	0	2142	-2749	-234	453	408	45.06	40.42
0.45	0	1935	-2698	-118	453	428	39.59	42.46
0.50	0	1845	-2675	-60	453	437	34.72	43.29
0.55	0	1816	-2686	-28	453	445	30.25	44.05
0.60	0	1837	-2724	-14	453	446	26.12	44.37
0.65	0	1887	-2784	-7	453	450	22.27	44.64
0.70	0	1962	-2864	-3	453	452	18.67	44.81
0.75	0	2057	-2962	-1	453	452	15.30	44.84
0.80	0	2168	-3074	-0	453	453	12.17	44.87
0.85	0	2294	-3200	-0	453	453	9.25	44.90
0.90	0	2431	-3338	-0	453	453	6.54	44.93
0.95	0	2577	-3485	-0	453	454	4.03	44.95
1.00	0	1955	-3640	-0	1230	454	1.70	44.98
1.05	0	1694	-3754	-0	1605	454	0.15	44.99

CASE 4A

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 .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1183	44.89
20	1102	44.60
30	799	43.67
40	195	41.37
50	-732	35.91
60	-1730	21.77
70	-3590	12.58
80	-4319	7.13
90	-3296	4.56

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR60 ACTUATOR

Case 4 A

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= 4942   HYDRO. TORQUE @ 90= 761   SHUT-OFF PRES. DROP= 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
AERO TORQUE	1183	1102	799	195	-732	-1730	-3590	-4319	-3296
PRES DROP	44.89	44.60	43.67	41.37	35.91	21.77	12.58	7.13	4.56

LOCA CLOSES THE VALVE TO 59 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -4319 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 sec
0.00	0	4654	-2997	-2620	756	234	59.00	23.184
0.05	0	3604	-2785	-1648	453	375	47.67	37.178
0.10	0	2703	-2689	-888	453	421	38.44	41.727
0.15	0	2287	-2679	-498	453	437	31.72	43.273
0.20	0	2115	-2720	-293	453	444	26.43	44.001
0.25	0	2050	-2790	-162	453	448	21.98	44.415
0.30	0	2064	-2879	-89	453	451	18.11	44.654
0.35	0	2141	-2984	-62	453	452	14.64	44.755
0.40	0	2234	-3103	-37	453	452	11.46	44.847
0.45	0	2350	-3234	-22	453	453	8.54	44.906
0.50	0	2484	-3376	-15	453	453	5.86	44.935
0.55	0	2627	-3526	-8	453	454	3.38	44.962
0.60	0	1535	-3683	-2	1396	454	1.10	44.987

CASE 4A

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 2.20

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 .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1183	44.89
20	1102	44.60
30	799	43.67
40	195	41.37
50	-732	35.91
60	-1730	21.77
70	-3590	12.58
80	-4319	7.13
90	-3296	4.56

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Cont YS

THE VALVE OPENING IS RESTRICTED TO 70 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930
ACT. VOL.= .72
MEDIA=AIR
PACKING TORQUE= 756
BUILDING PRESSURE= 45

Tspring ending= 3770
ACT. YOKE RADIUS= 2.5
VALVE Cv= 4942
SEAL TORQUE= 1183

ACT. PRESS= 80
HYDRO. TORQUE @ 90= 761
Dstem= 1.25

SOL. VALVE Cv= 2.26
SHUT-OFF PRES. DROP= 45
Dgage= 11.703

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	1183	1102	799	195	-732	-1730	-3590	-4319	-3296
PRES DROP	44.89	44.60	43.67	41.37	35.91	21.77	12.58	7.13	4.56

LOCA CLOSES THE VALVE TO 52 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM LOCA TORQUE AS VALVE CLOSES IS -3590 IN.LBS. @ 70 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	0	3817	-2838	-2021	756	334	52.00	33.082
0.05	0	3043	-2727	-1175	453	405	42.25	40.141
0.10	0	2453	-2675	-662	453	430	34.54	42.624
0.15	0	2160	-2697	-358	453	442	28.65	43.794
0.20	0	2074	-2756	-219	453	446	23.90	44.236
0.25	0	2036	-2837	-102	453	450	19.78	44.606
0.30	0	2104	-2934	-74	453	451	16.18	44.710
0.35	0	2190	-3047	-48	453	452	12.87	44.806
0.40	0	2292	-3173	-26	453	453	9.83	44.891
0.45	0	2421	-3310	-18	453	453	7.05	44.922
0.50	0	2561	-3457	-11	453	454	4.48	44.950
0.55	0	1766	-3611	-5	1396	454	2.12	44.976
0.60	0	1466	-3715	-1	1796	454	0.67	44.992

CASE 4B

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis 11721 C-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 2.25

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 .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1180	44.93
20	1093	44.75
30	756	44.03
40	61	42.27
50	-1061	38.36
60	-2611	31.28
70	-4729	17.33
80	-6776	12.44
90	-4404	5.97

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 4B

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= 4942	HYDRO. TORQUE @ 90= 761	SHUT-OFF PRES. DROP= 45
PACKING TORQUE= 75c	SEAL TORQUE= 1183	Dstem= 1.25	Dgage= 11.703
BUILDING PRESSURE= 3.1			

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	1180	1093	756	61	-1061	-2611	-4729	-6776	-4404
PRES DROP	44.93	44.75	44.03	42.27	38.36	31.28	17.33	12.44	5.97

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	2664	12993	-5924	-5220	756	60	90.00	5.970
0.05	1200	11529	-5924	-5220	756	60	90.00	5.970
0.10	47	10376	-5924	-5220	756	60	90.00	5.970
0.15	0	9442	-5924	-5220	756	60	90.00	5.970
0.20	0	11159	-4603	-7120	453	111	82.20	11.014
0.25	0	7777	-3331	-5113	453	214	67.23	21.187
0.30	0	4234	-2814	-2258	453	384	50.36	38.099
0.35	0	2906	-2698	-1089	453	427	39.52	42.354
0.40	0	2380	-2677	-597	453	440	32.25	43.633
0.45	0	2152	-2717	-336	453	447	26.70	44.267
0.50	0	2069	-2787	-186	453	450	22.15	44.594
0.55	0	2070	-2876	-99	453	452	18.22	44.781
0.60	0	2144	-2981	-70	453	452	14.73	44.844
0.65	0	2236	-3100	-42	453	453	11.54	44.902
0.70	0	2349	-3231	-25	453	453	8.61	44.939
0.75	0	2482	-3372	-17	453	454	5.92	44.958
0.80	0	2625	-3522	-10	453	454	3.44	44.975
0.85	0	1545	-3679	-3	1683	454	1.15	44.991

CASE 4B

DETERMINATION OF CLOSING TIME

VALVE SIZE 12" VALVE CLASS 150

ACTUATOR Bettis 11721 C-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 2.25

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 .05 SEC.

DEG.	LOCA TORQUE (IN.LBS)	PRESSURE DROP (PSI)
10	1180	44.93
20	1093	44.75
30	752	44.03
40	61	42.27
50	-1061	38.36
60	-2611	31.28
70	-4729	17.33
80	-6776	12.44
90	-4404	5.97

DETERMINATION OF CLOSING TIME

12 - 150 CLASS VALVE WITH A N721C-SR80 ACTUATOR

Case 4B

THE VALVE OPENING IS RESTRICTED TO 60 DEGS.

THE VALVE IS IN THE PREFERRED DIRECTION

Tspring begin= 5930
ACT. VOL.= .72
MEDIA=AIR
PACKING TORQUE= 756
BUILDING PRESSURE= 3.1

Tspring ending= 3770
ACT. YOKE RADIUS= 2.5
VALVE Cv= 4942
SEAL TORQUE= 1183

ACT. PRESS= 80
HYDRO. TORQUE @ 90= 761
Dstem= 1.25

SOL. VALVE Cv= 2.26
SHUT-OFF PRES. DROP= 45
Dgage= 11.703

DEG.	10	20	30	40	50	60	70	80	90
AERO TORQUE	1180	1093	756	61	-1061	-2611	-4729	-6776	-4404
PRES DROP	44.93	44.75	44.03	42.27	38.36	31.28	17.33	12.44	5.97

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE bearing	ANGLE degrees	DELTA P sec
0.00	2024	7665	-3029	-3682	756	315	60.00	31.280
0.05	1161	6801	-3029	-3682	756	315	60.00	31.280
0.10	481	6121	-3029	-3682	756	315	60.00	31.280
0.15	0	5570	-3029	-3682	756	315	60.00	31.280
0.20	0	3753	-2777	-1831	453	401	46.55	39.708
0.25	0	2712	-2681	-917	453	432	36.97	42.802
0.30	0	2254	-2686	-465	453	444	30.31	43.975
0.35	0	2121	-2736	-286	453	448	25.21	44.374
0.40	0	2051	-2813	-143	453	451	20.86	44.687
0.45	0	2091	-2907	-90	453	452	17.11	44.801
0.50	0	2171	-3016	-61	453	453	13.71	44.863
0.55	0	2267	-3139	-35	453	453	10.60	44.919
0.60	0	2389	-3274	-23	453	453	7.75	44.945
0.65	0	2525	-3418	-15	453	454	5.13	44.964
0.70	0	2003	-3570	-8	1121	454	2.71	44.981
0.75	0	1522	-3689	-3	1715	454	1.02	44.992

A

APPENDIX E

Comparison of Actual to Calculated Closing Times

DETERMINATION OF CLOSING TIME

VALVE SIZE 14" 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 2.2

MEDIA ________ — VALVE C_v ________

HYDRODYNAMIC TORQUE @ 90 ________ — SHUT OFF PRESSURE DROP ____ PSI

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

STEM DIA. 1.375 IN. — GAGE DIA. 12.974 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

Timing begins 5930 — Timing ending 3770
ACT. VOL.= [illegible] — ACT. YOKE RADIUS= 2.5 — ACT. PRESS= 80 — SOL. VALVE Cv= 2.26
~~PACKING TORQUE= 832~~ — ~~SEAT TORQUE= 1454~~ — ~~Dstem= 1.375~~ — ~~Dgage= 12.774~~
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	3396	8489	-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	542	5534	-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	3042	-3542	0	499	0	70.34	0.00
0.90	0	2498	-2997	0	499	0	58.98	0.00
1.00	0	2279	-2779	0	499	0	46.80	0.00
1.10	0	2176	-2676	0	499	0	35.19	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	[illegible]	[illegible]	0	499	0	8.79	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. 19157-03A		TRAVELER NO. 83-19157-03-0100	
CUSTOMER Stone+Webster	PURCHASE ORDER NO. NMP2-P304D	ITEM	TAG NO. 2CPS*AOV104
OPERATOR TYPE N721C-SR80-M3HW	MANUFACTURER BETTIS	SERIAL NO. 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~~ design 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:

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

Open to Closed:

First time: 1.7 sec. (w/actuator)
Second time: 1.7 sec. (w/actuator)
Third time: 1.7 sec. (w/ N/A PSI
Fourth time: 60 sec. (Man. overr

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
F. ROSE	7/8/83	Stephen Furow	7/8/83
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE
J. E. Donovan SWEC PQA	7-8-83		

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 PRESSURE 80 PSIG

MEDIA ______

HYDRODYNAMIC TORQUE @ 90 ______

PACKING TORQUE 756 IN.LBS.

STEM DIA. 1.25 IN.

BUILDING PRESSURE 0 PSIG

ACTUATOR YOKE RADIUS 2.5 IN.

SOLENOID VALVE C_v 2.2[illegible]

VALVE C_v ______

SHUT OFF PRESSURE DROP ______ PSI

SEAL TORQUE 1183 IN.LBS.

GAGE DIA. 11.703 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.= .72 | ACT. ARM RADIUS= 2.5 | ACT. PRESS= 80 | SOL. VALVE Cv= 2.26
PACKING TORQUE= 756 | SEAL TORQUE= [illegible] | Dstem= [illegible] | 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	[illegible]	8489	-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	468	5634	-5924	0	756	0	90.00	0.00
0.60	0	5094	-5924	0	756	0	90.00	0.00
0.70	0	4063	-4517	0	453	0	81.52	0.00
0.80	0	[illegible]	[illegible]	0	453	0	70.70	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	[illegible]	[illegible]	0	453	0	7.96	0.00
1.50	0	2489	-3618	0	1128	0	2.02	0.00

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:

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-P304D 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 SEW PQA	7-11-83		

APPENDIX F

Miscellaneous Calculations

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title: Determination of Flow ΔPs with Valve Angle • 70° / 60° Page: F-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

@ 60°

$C_v @ 60° = 2224$ $X_T @ 60° = .46$

VALVE SIZE= 12 IN. CLASS=150

Q= 78000	Cv= 2224	P1= 15.7	Fp= 1	
Fk= 1	Xt= .46	G= 1	'F= 150	Z= 1

DELTA P= 0.0259 PSI

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title ______________________ Page F-2

Calc. By [signature] 7/16/84 Checked By ______________________

14" Valves @ 70°

P_1 = 15.7 psia

Q = 2200 SCFM = 132000 SCFH

G = 1 Z = 1 T = 150 °F

C_v @ 70° = 39.79 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

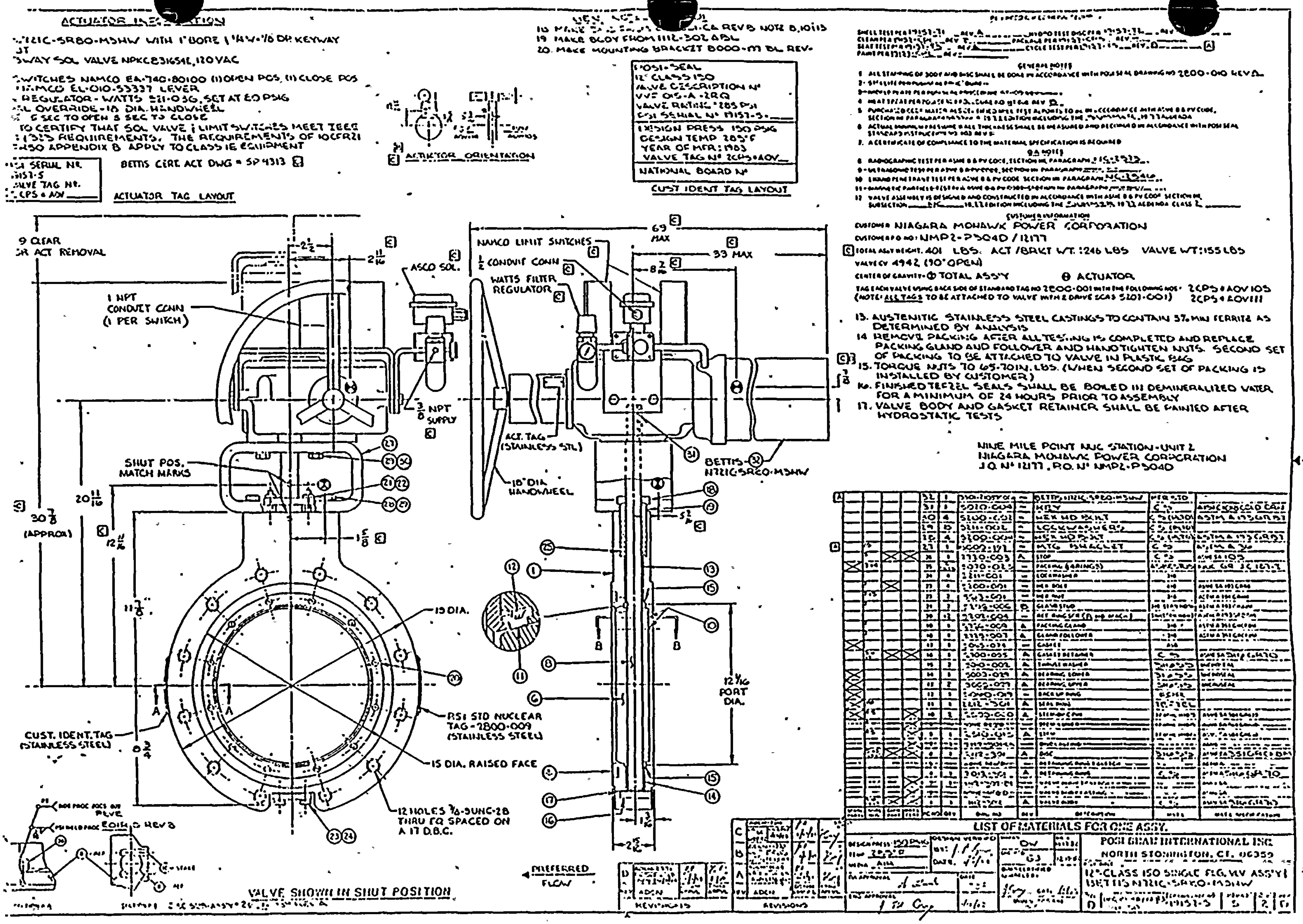
~~DELTA P= 0.0091 PSI~~

@ 60° C_v @ 60° = 2842 X_T @ 60° = .46

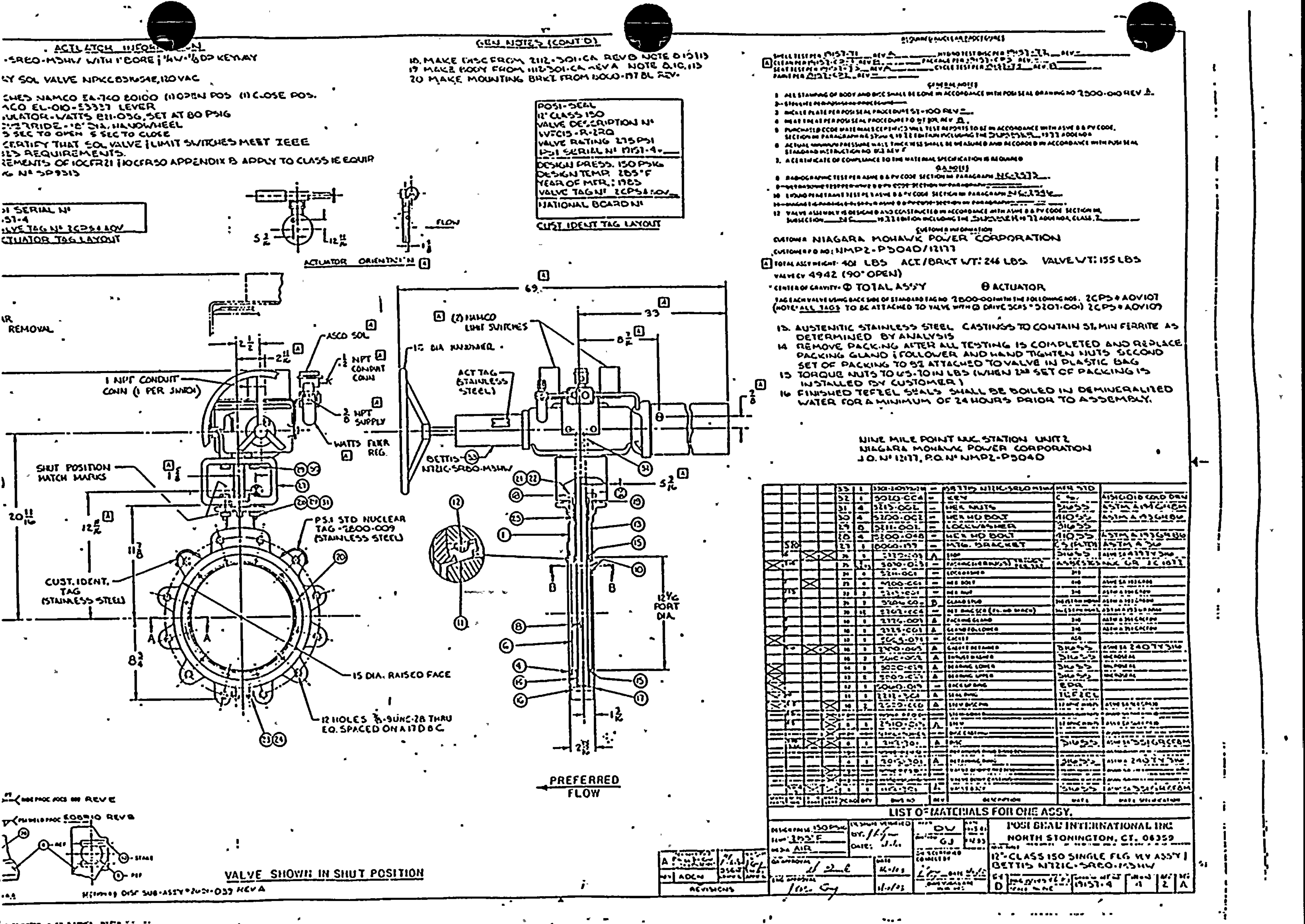
VALVE SIZE= 14 IN. CLASS=150

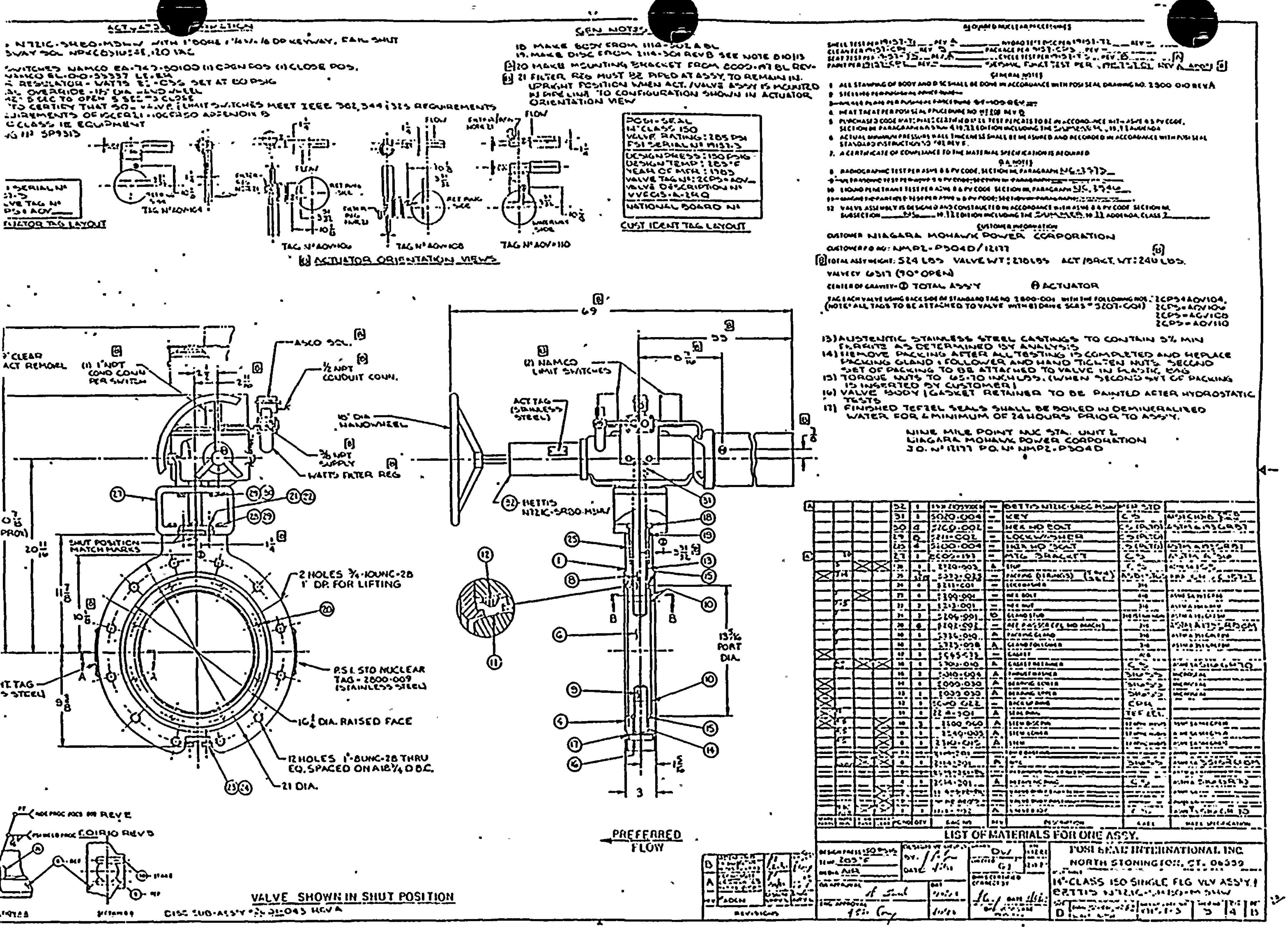
Q= 132000	Cv= 2842	P1= 15.7	Fp= 1	
Fk= 1	Xt= .46	G= 1	'F= 150	Z= 1

DELTA P= 0.0455 PSI



ACTUATOR INSTALLATION
SWITCHES NAMCO EA-740-80100 (1) OPEN POS, (1) CLOSE POS
REGULATOR - WATTS 5H-03G, SET AT 60 PSIG
TO CERTIFY THAT SOL VALVE & LIMIT SWITCHES MEET IEEE
BETTS CERT ACT DWG # SP 4313
ACTUATOR TAG LAYOUT
ACTUATOR ORIENTATION
19 MAKE BODY FROM 1112-302 ABL
20. MAKE MOUNTING BRACKET 8000-113 BL REV-
POSI-SEAL
12" CLASS 150
VALVE DESCRIPTION Nº
VALVE RATING 285 PSI
DESIGN PRESS 150 PSIG
DESIGN TEMP 285°F
YEAR OF MFR: 1983
NATIONAL BOARD Nº
CUST IDENT TAG LAYOUT
GENERAL NOTES
CUSTOMER INFORMATION
CUSTOMER NIAGARA MOHAWK POWER CORPORATION
CUSTOMER P.O. NO: NMP2-P304D / 12177
TOTAL ASSY WEIGHT. 401 LBS. ACT/BRKT WT. 246 LBS VALVE WT. 155 LBS
VALVE CV 4942 (90° OPEN)
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 BOILED IN DEMINERALIZED WATER FOR A MINIMUM OF 24 HOURS PRIOR TO ASSEMBLY
17. VALVE BODY AND GASKET RETAINER SHALL BE PAINTED AFTER HYDROSTATIC TESTS
9 CLEAR FOR ACT REMOVAL
1 NPT CONDUIT CONN (1 PER SWITCH)
ASCO SOL.
NAMCO LIMIT SWITCHES
1/2 CONDUIT CONN
WATTS FILTER REGULATOR
69 MAX
33 MAX
3/8 NPT SUPPLY
ACT. TAG (STAINLESS STL)
18" DIA HANDWHEEL
BETTS N721G-SR80-M5HW
SHUT POS. MATCH MARKS
NINE MILE POINT NUC STATION - UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. Nº 12177, P.O. Nº NMP2-P304D
30 7/8 (APPROX)
19 DIA.
PSI STD NUCLEAR TAG-2800-009 (STAINLESS STEEL)
CUST. IDENT. TAG (STAINLESS STEEL)
15 DIA. RAISED FACE
12 HOLES 7/8-9UNC-2B THRU EQ SPACED ON A 17 D.B.C.
12 1/16 PORT DIA.
PREFERRED FLOW
VALVE SHOWN IN SHUT POSITION
LIST OF MATERIALS FOR ONE ASSY.
POSI SEAL INTERNATIONAL INC
NORTH STONINGTON, CT. 06359
12" CLASS 150 SINGLE FLG. VLV ASSY
BETTS N721G-SR80-M5HW
REVISIONS


GEN NOTES (CONT'D)
18. MAKE DISC FROM 2112-301-CA REV B NOTE 8,15,13
19. MAKE BODY FROM 1112-301-CA REV A NOTE 8,10,13
20. MAKE MOUNTING BRKT FROM 1000-117 BL REV-
POSI-SEAL
12" CLASS 150
VALVE DESCRIPTION Nº
VALVE RATING 275 PSI
DESIGN PRESS. 150 PSIG
DESIGN TEMP. 285°F
YEAR OF MFR.: 1983
NATIONAL BOARD Nº
CUST IDENT TAG LAYOUT
ACTUATOR TAG LAYOUT
ACTUATOR ORIENTATION
FLOW
CUSTOMER NIAGARA MOHAWK POWER CORPORATION
CUSTOMER P.O. NO: NMP2-P5040/12177
TOTAL ASSY WEIGHT: 401 LBS ACT/BRKT WT: 246 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)
16. FINISHED TEFZEL SEALS SHALL BE BOILED IN DEMINERALIZED WATER FOR A MINIMUM OF 24 HOURS PRIOR TO ASSEMBLY.
NINE MILE POINT NUC. STATION UNIT 2
NIAGARA MOHAWK POWER CORPORATION
J.O. Nº 12177, P.O. Nº NMP2-P5040
ASCO SOL
(2) NAMCO LIMIT SWITCHES
15 DIA HANDWHEEL
1 NPT CONDUIT CONN (1 PER SWITCH)
1/2 NPT CONDUIT CONN
3/8 NPT SUPPLY
ACT TAG (STAINLESS STEEL)
WATTS FILTER REG.
BETTIS NT21C-SR80-M3HW
SHUT POSITION MATCH MARKS
PSI STD NUCLEAR TAG 2800-009 (STAINLESS STEEL)
CUST. IDENT. TAG (STAINLESS STEEL)
15 DIA. RAISED FACE
12 HOLES 7/8-9UNC-2B THRU EQ. SPACED ON A 17.00 B.C.
12 1/16 PORT DIA.
PREFERRED FLOW
VALVE SHOWN IN SHUT POSITION
LIST OF MATERIALS FOR ONE ASSY.
POSI SEAL INTERNATIONAL INC
NORTH STONINGTON, CT. 06359
12" CLASS 150 SINGLE FLG. V.V. ASSY & BETTIS NT21C-SR80-M3HW
REVISIONS


GEN NOTES
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 INCH LBS. (WHEN SECOND SET OF PACKING IS INSERTED BY CUSTOMER)
16) VALVE BODY / GASKET RETAINER TO BE PAINTED AFTER HYDROSTATIC TESTS
17) FINISHED TEFZEL SEALS SHALL BE BOILED IN DEMINERALIZED WATER FOR A MINIMUM OF 24 HOURS PRIOR TO ASS'Y.
NINE MILE POINT NUC STA. UNIT 2
NIAGARA MOHAWK POWER CORPORATION
CUSTOMER NIAGARA MOHAWK POWER CORPORATION
CUSTOMER P.O. NO: NMP2-P304D/12177
VALVE CV 6317 (90° OPEN)
CENTER OF GRAVITY - TOTAL ASS'Y
ACTUATOR
2CPS*AOV104
2CPS*AOV106
2CPS*AOV108
2CPS*AOV110
ACTUATOR ORIENTATION VIEWS
CUST IDENT TAG LAYOUT
POSI-SEAL
14" CLASS 150
DESIGN TEMP: 205°F
ASCO SOL.
1/2 NPT CONDUIT CONN.
1/4 NPT SUPPLY
WATTS FILTER REG
10" DIA. HANDWHEEL
ACT TAG (STAINLESS STEEL)
(2) NAMCO LIMIT SWITCHES
BETTIS N721C-SR80-M3HW
SHUT POSITION MATCH MARKS
2 HOLES 3/4-10UNC-2B 1" DP. FOR LIFTING
P.S.I. 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.
13 5/16 PORT DIA.
PREFERRED FLOW
VALVE SHOWN IN SHUT POSITION
69
55
LIST OF MATERIALS FOR ONE ASSY.
DESIGN PRESS 150 PSIG
TEMP 205°F
MEDIA AIR
POSI SEAL INTERNATIONAL INC
NORTH STONINGTON, CT. 06359
14" CLASS 150 SINGLE FLG VLV ASS'Y. / BETTIS N721C-SR80-M3HW
D

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.

IV. SIZING FOR LIQUID FLOW

A. Line size valves with a fluid viscosity (μ) less than 90 centipoise.

$$C_V = \frac{GPM}{\sqrt{\frac{\Delta P}{G_F}}}$$

$$GPM = C_V \sqrt{\frac{\Delta P}{G_F}}$$

$$\Delta P = \left(\frac{GPM}{C_V}\right)^2 G_F$$

C_V = Valve Coefficient
See Tables 7-10

GPM = Flow, U.S. Gallons Per Minute

G_F = Specific Gravity of Liquid at Flowing Conditions

$$= \frac{\text{Density of Liquid at Flowing Conditions}}{\text{Density of Water at Standard Conditions}}$$

ΔP = Differential Pressure Across Valve, PSI

B. Valves installed between reducers with a fluid viscosity (μ) greater or less than 90 centipoise.

$$C_V = \frac{GPM}{F_P F_Y F_R \sqrt{\frac{\Delta P}{G_F}}}$$

$$GPM = F_P F_Y F_R C_V \sqrt{\frac{\Delta P}{G_F}}$$

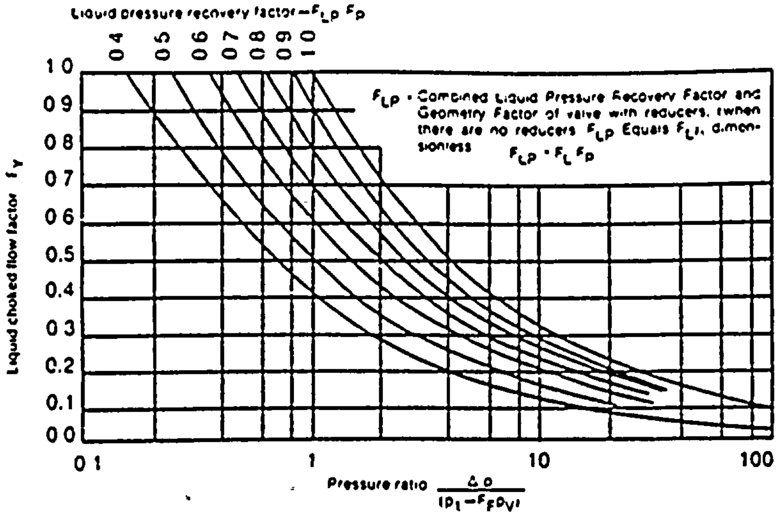
$$\Delta P = \left(\frac{GPM}{F_P F_Y F_R C_V}\right)^2 G_F$$

F_P = Piping Geometry Factor (for valves installed in line size pipe F_P = 1.0) See Figure 2

F_R = Reynolds Number Factor, when viscosity (μ) is less then 90 centipoise F_R = 1.0, See Figure 3

F_Y = Liquid Choke Flow Factor, See Fig. 1

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 coeffi[illegible]ient

D = ID of pipe e[illegible]alve size, inches

D_1 = ID of upstrea[illegible] pi[illegible]ches

D_2 = ID of downstream pipe, inches

FOR INSTALLATIONS WHERE D_1 EQUALS D_2:

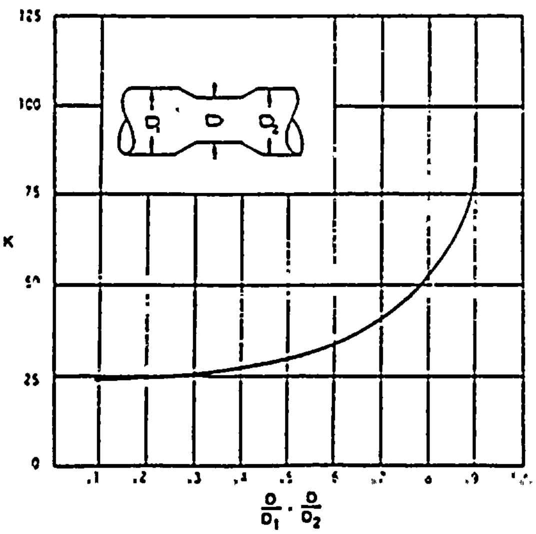
$C_{vp} = KD^2$

WHERE:

D = ID of pipe equal to valve size, inches

K = Refer to Fig. 2

FIGURE 2



CAVITATION

When flowing liquids, cavitation can occur at certain differential pressures across the valve. Generally, cavitation may not damage the valve but can cause damage to downstream piping in addition to creating objectionable vibration and noise. When the differential pressure across the valve is greater than calculated by the following formula, cavitation will occur:

LINE SIZE VALVES

$$\Delta P_T = .8\,F_L^2\,(P_1 - F_F P_v)$$

VALVES INSTALLED BETWEEN REDUCERS

$$\Delta P_T = .8\left(\frac{F_{LP}}{F_P}\right)^2 (P_1 - F_F P_v)$$

WHERE:

ΔP_T = Terminal Pressure Drop (PSI) maximum allowable for sizing purposes, above which cavitation will occur.

F_F = Liquid critical pressure ratio, Fig. 5

F_L = Liquid pressure recovery factor, Fig. 4

P_1 = Upstream pressure, PSIA.

P_v = Vapor pressure, PSIA.

increase in the differential pressure across the valve will increase the amount of cavitation and begin oke the flow. At the differential pressure approximated by the following formula, the flow will be ked.

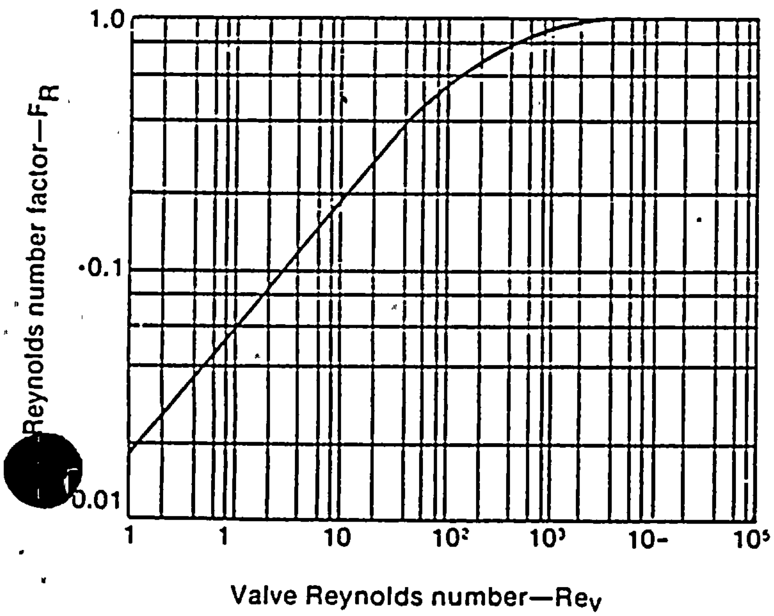
$$\Delta P\ \text{choked} = F_L^2(P_1 - F_F P_v)$$

$$\underset{\text{CHOKED}}{\text{GPM}} = C_v\sqrt{\frac{F_L^2(P_1 - F_F P_v)}{G_F}}$$

WHERE:

ΔP choked = maximum differential pressure above which no further increase in flow will occur.

FIGURE 3



$$R_e = 123.9\,\frac{dvp}{\mu}$$

WHERE:

d = Internal pipe dia., inches.

v = Mean velocity of flow, FPS.

p = Weight density of fluid, pounds per cubic foot.

μ = Absolute (Dynamic) viscosity centipoise.

FIGURE 4

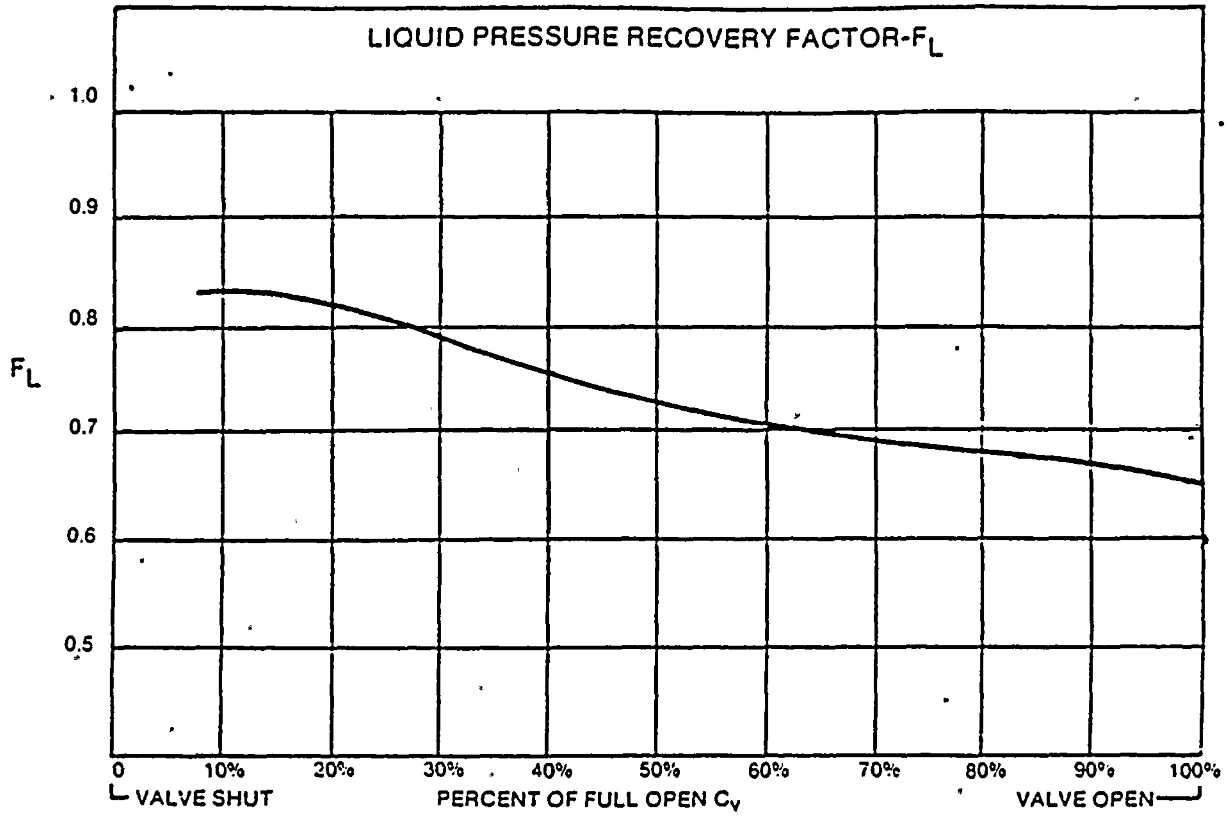
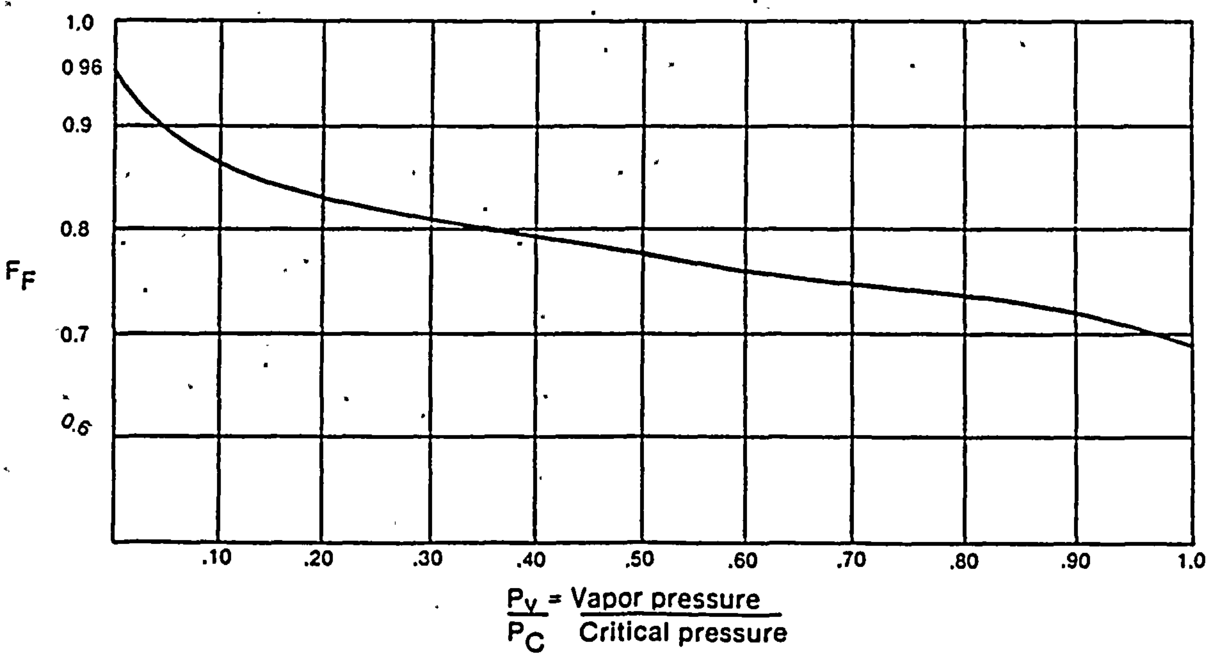


FIGURE 5



V. SIZING FOR GAS FLOW

CRITICAL FLOW

$$Q = 1360\,F_P C_v P_1 Y \sqrt{\frac{X}{GT_1Z}}$$

OR

$$C_v = \frac{Q}{1360 F_P P_1 Y \sqrt{\dfrac{X}{GT_1Z}}}$$

$$Q = Q_f \left(\frac{P_1}{14.7}\right)\left(\frac{520}{T_1}\right)$$

STEAM FLOW

$$W = 63.3 F_P C_v Y \sqrt{\frac{XP_1}{V_1}}$$

OR

$$C_v = \frac{W}{63.3 F_P Y \sqrt{\dfrac{XP_1}{V_1}}}$$

$$\frac{W}{.0764G}$$

WHERE

- Q = Flow in SCFH
- Q_f = Flow at flow conditions CFH
- F_P = Piping geometry factor (See Pg. 3 of 16)
- C_v = Valve coefficient (Tables 7-10)
- P_1 = Upstream pressure in PSIA
- T_1 = Upstream temperature in °R = 460 + °F
- Z = Compressability factor (See Table 3 or Fig. 10 & 11—most application, Z may assumed to be 1.0)
- G = Specific Gravity

$$= \frac{\text{Density of Gas at Standard Conditions}}{\text{Density of Air at Standard Conditions}}$$

(See Table 1)

- X = Pressure drop ratio = $\Delta P/P_1$
- ΔP = Differential pressure across valve in PSI
- Y = Expansion factor

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

WHERE:

- X_T = Rated pressure drop ratio factor (See Fig. 6)
- F_k = Ratio of specific heats factor (see table 2) = K/1.4 = Where K = ratio of specific heats.

WHERE.

- W = Flow in Lbs/hr
- V_1 = Specific volume of steam upstream in Ft³/Lb (See Tables 5 & 6)

Note: For values of K for steam (See Fig. 9)

CRITICAL FLOW

$$Q_{MAX} \quad 907\ 12\ F_P C_V P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}$$

OR

$$C_{V\ MIN} = \frac{Q}{907\ 12\ F_P P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}}$$

$$\Delta P_c = F_K X_T P_1$$

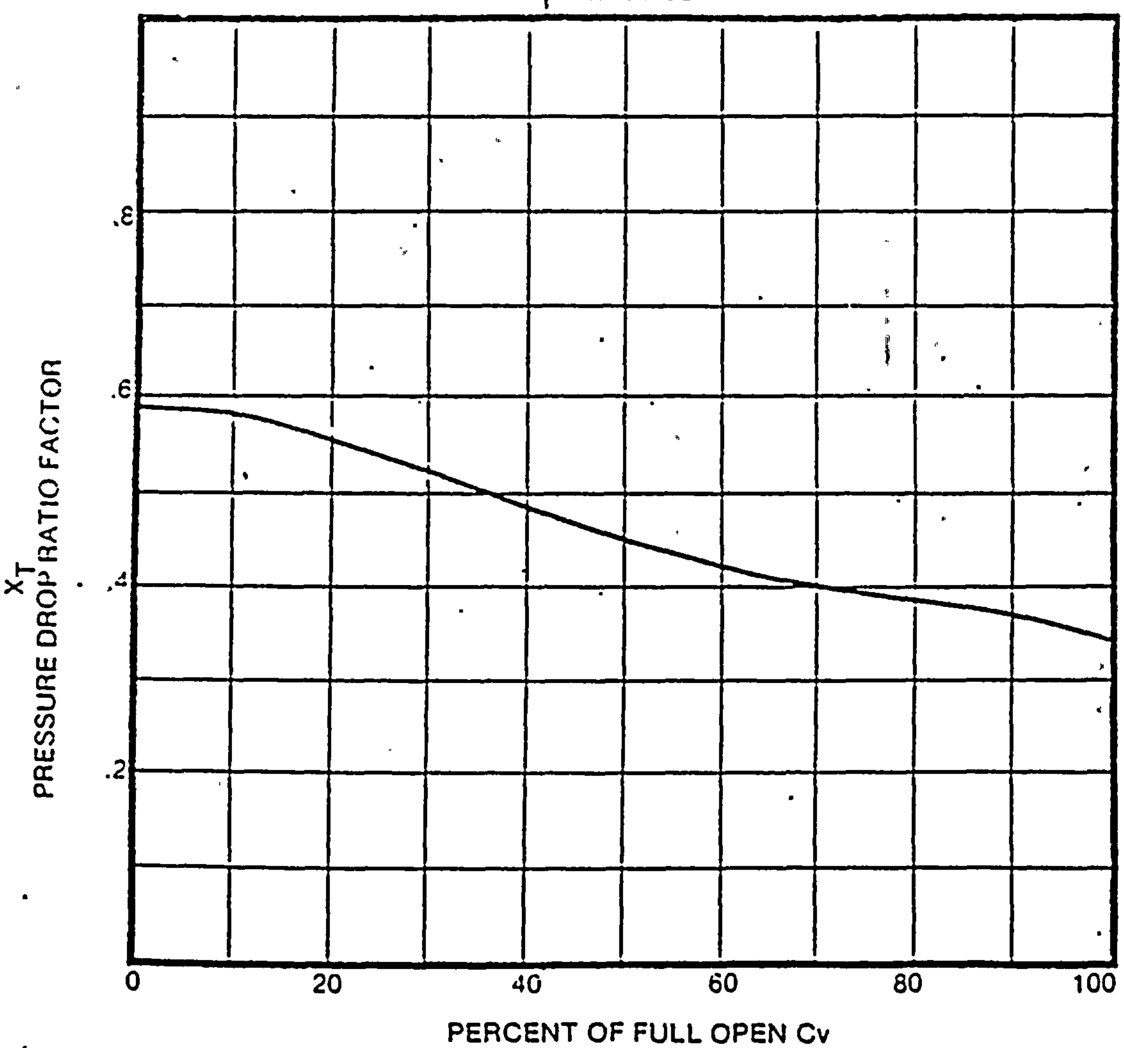
Q_{MAX} = Max Flow that can pass through valve at the stated conditions.

$C_{V\ MIN}$ = Minimum Required Cv 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)

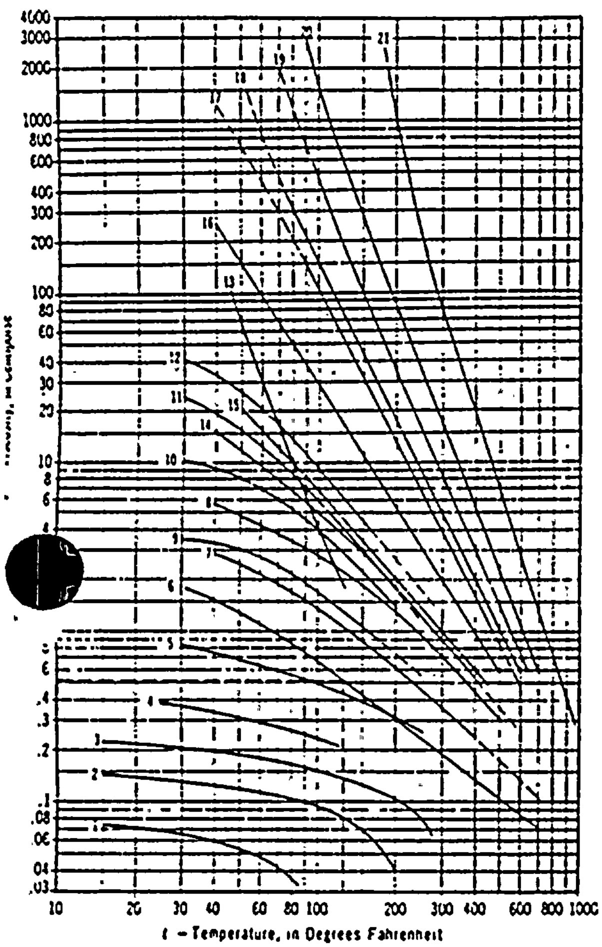
FIGURE 6
X_T VS. % FLOW



VI. TECHNICAL DATA

FIGURE 7

Viscosity of Water and Liquid Petroleum Products

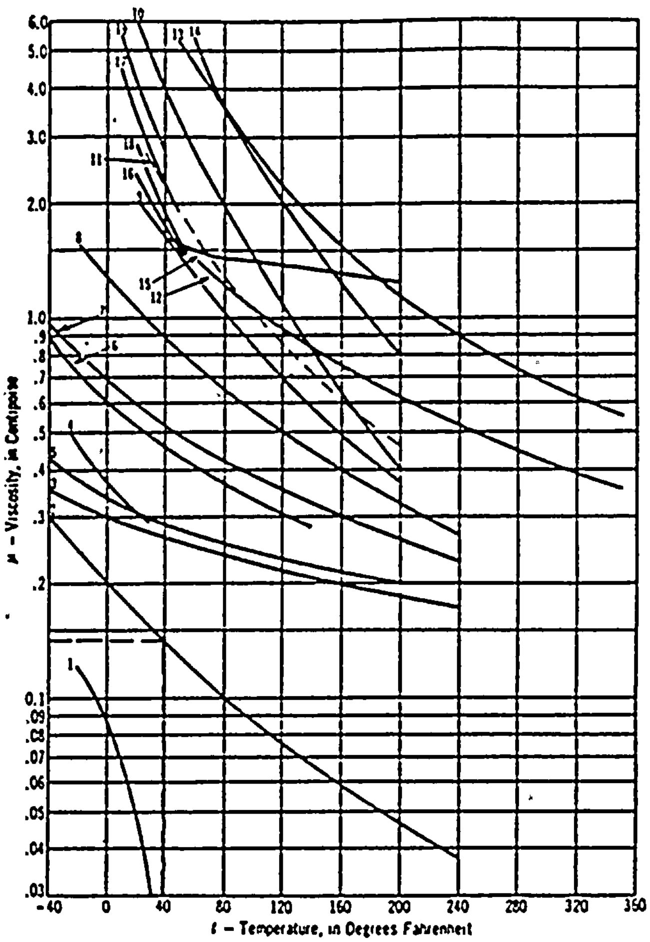


1 Ethane (C_2H_2)
2 Propane (C_3H_3)
3 Butane (C_4H_{10})
4 Natural Gasoline
5 Gasoline
6 Water
7 Kerosene
8 Distillate
9 48 Deg API Crude
10 40 Deg API Crude
11 35.6 Deg API Crude
12. 32.6 Deg API Crude
13 Salt Creek Crude
14 Fuel 3 (Max.)
15 Fuel 5 (Min.)
16 SAE 10 Lube (100 V.I.)
17 SAE 30 Lube (100 V.I.)
18 Fuel 5 (Max.) or Fuel 6 (Min.)
19 SAE 70 Lube (100 V.I.)
20 Bunker C Fuel (Max.) and M.C. Residuum
21. Asphalt

Example: The viscosity of water at 125°F is 0.52 centipoise (Curve No. 6).

FIGURE 8

Viscosity of Various Liquids



1 Carbon Dioxide ...... CO_2
2. Ammonia .... NH_3
3 Methyl Chloride ..... CH_3Cl
4 Sulphur Dioxide ...... SO_2
5 Freon 12 .... F-12
6 Freon 114 .... F-114
7 Freon 11 .... F-11
8. Freon 113 .... F-113
9 Ethyl Alcohol
10. Isopropyl Alcohol
11 20% Sulphuric Acid .... 20% H_2SO_4
12 Dowtherm E
13 Dowtherm A
14 20% Sodium Hydroxide .... 20% NaOH
15 Mercury
16 10% Sodium Chloride Brine ..... 10% NaCl
17 20% Sodium Chloride Brine ..... 20% NaCl
18 10% Calcium Chloride Brine ..... 10% $CaCl_2$
19. 20% Calcium Chloride Brine ..... 20% $CaCl_2$

Example: The viscosity of ammonia at 40°F is 0.14 centipoise

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	SPECIFIC GRAVITY: 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	[illegible]			676		[illegible]
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	159.84	138		575	1485	2.93	5.52
Butadiene	$CH_2CHCH:CH_2$	54.09	24			627		[illegible]
n-Butane	C_4H_{10}	58.12	31	51.6[1]	305	550	0.58	2.0
Butyl Alcohol	$CH_3(CH_2)_2CH_2OH$	74.12	243			711		[illegible]
Carbon Dioxide	CO_2	44.01	-109	839	88	1072	0.8	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	85	291	1118	1.42	2.45
Dowtherm A						474	0.99	
Dowtherm E						575	1.217	
Ethane	C_2H_6	30.07	-127		90	709	0.37	1.04
Ethyl Chloride	C_2H_5Cl	64.52	54			2730	0.90	2.22
Ethylene	C_2H_4	28.05	-155		48	742		0.97
Ethyl Ether	$C_4H_{10}O$				383	522		2.55
Fluorine	F_2	38.0	-306	300	-200	808	1.11	1.31
Helium	He	4.003	-452		-450	33	0.18	0.14
Hydrochloric Acid	HCl	36.47	-115				1.64	
Hydrogen	H_2	2.016	-423		-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	1307	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	0.3	0.55
Methyl Chloride	CH_3Cl	50.49	-11	59	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}	114.22	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	97	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	-45	190[1]	206	617	0.51	1.52
Propylene	$CH_2CH:CH_2$	42.08	-54		198	661		0.61
Propyl Alcohol	$CH_3CH_2CH_2OH$	60.09	208			735		0.80
Propyl 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	70.2	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	713		
Styrene	C_8H_8	104.15	293	0.24[1]	706	580	0.91	3.59
Sulfur Dioxide	SO_2	64.6	14	34.4	316	1142	1.39	2.21
Toluene	C_7H_8	92.14	231	1.03[1]	605	611	0.87	3.18
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 @ 494.8°F.
3. Specific Gravity @ 356.4°F.

FIGURE 9
STEAM — VALUES OF K
Ratio of Specific Heat at Constant Pressure
to Specific Heat at Constant Volume
$K = C_p \ C_v$

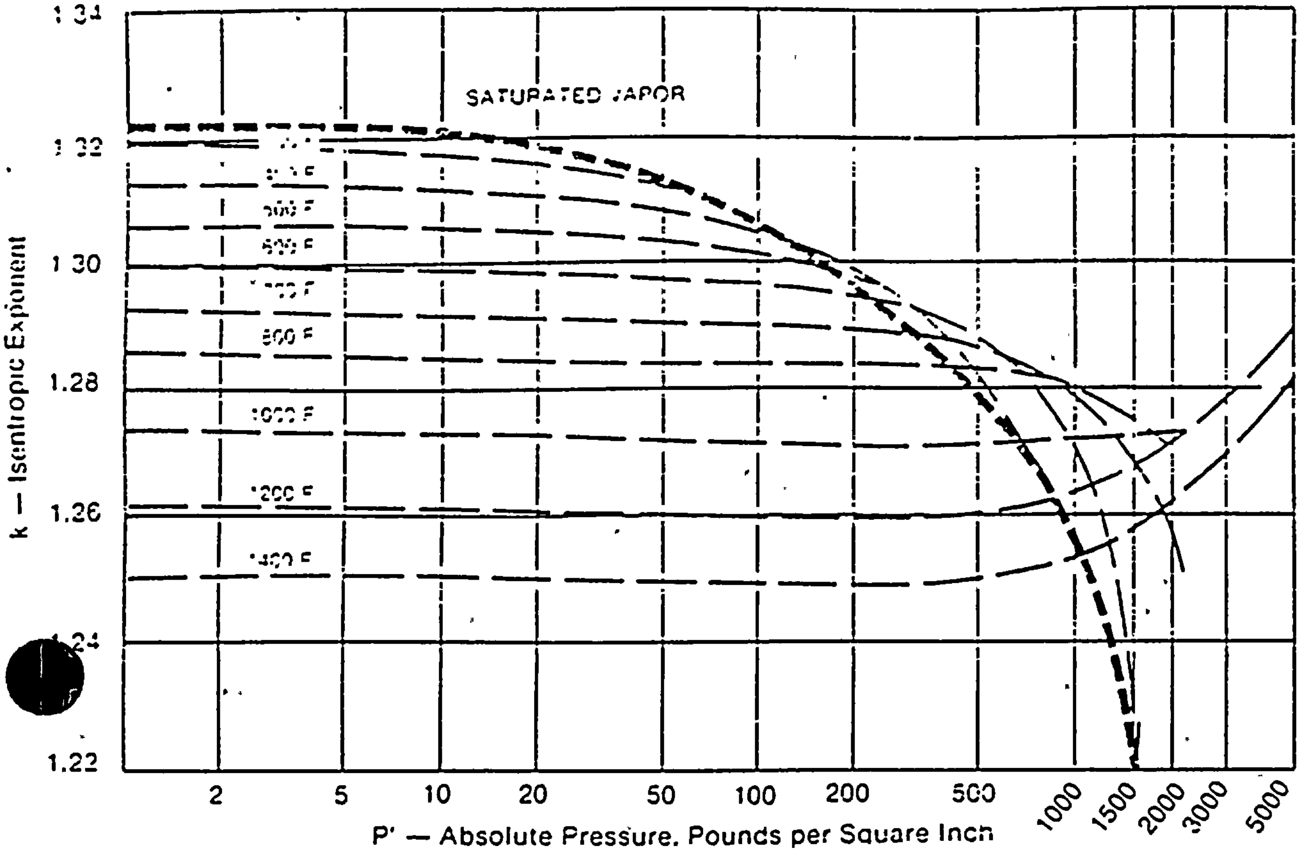


TABLE 2
VALUES OF K FOR VARIOUS GASES

Name of Gas	Chemical Formula or Symbol	K equal to Cp Cv
Acetylene	C_2H_2	1.28
Air	—	1.40
Ammonia	NH_3	1.29
Argon	A	1.67
Carbon Dioxide	CO_2	1.28
Carbon Monoxide	CO	1.41
Ethane	C_2H_6	1.188
Ethylene	C_2H_4	1.22
Freon*	CCL_2F_2	1.136
Helium	He	1.66
Hydrochloric Acid	HCl	1.40
Hydrogen	H_2	1.40
Methane	CH_4	1.26
Methyl Chloride	CH_3Cl	1.20
Neon	Ne	1.667
Nitrogen	N_2	1.40
Nitric Oxide	NO	1.40
Nitrous Oxide	N_2O	1.26
Octane	C_8H_{18}	1.046
Oxygen	O_2	1.40
Propane	C_3H_8	1.128
Sulphur Dioxide	SO_2	1.25
Water Vapor	H_2O	1.329

TABLE 3
COMPRESSIBILITY FACTORS FOR GAS

Gas	Pressure atm	Pressure 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		

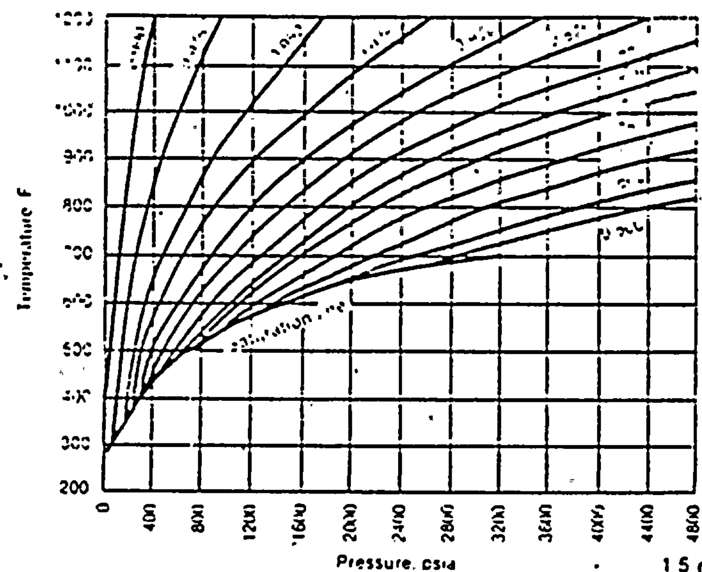
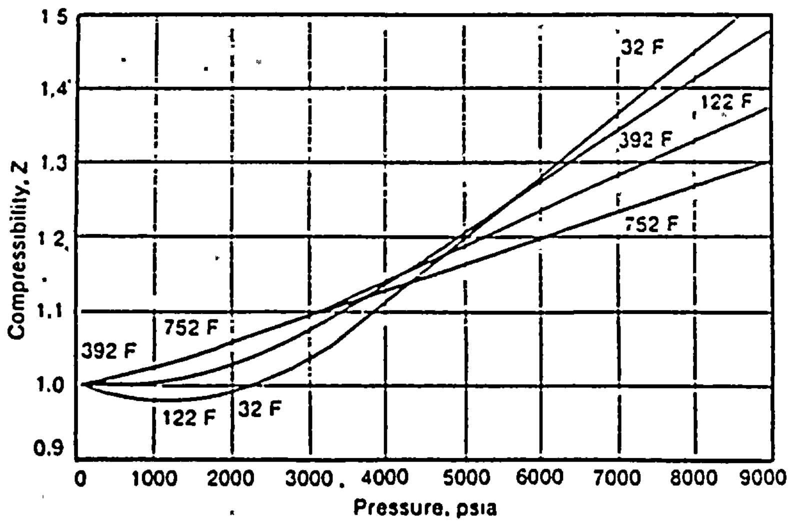


FIGURE 10
COMPRESSIBILITY FACTORS
FOR SUPERHEATED STEAM

FIGURE 11
COMPRESSIBILITY FACTORS
FOR NITROGEN



PROPERTIES OF WATER AT VARIOUS TEMPERATURES

(Referred to Water at 68 F Weighing 62 318 Lb Cu Ft)

TABLE 4

Temp °F	Specific Volume cu ft lb	Specific Gravity	Vapor Pressure PSIA	Temp °F	Specific Volume cu ft lb	Specific Gravity	Vapor Pressure PSIA
32	0 01602	1 0016	0 0835	210	0 01670	0.9609	14 123
33	0 01603	1 0017	0 0922	220	0 01677	0 9569	17 186
34	0 01602	1 0017	0 0960	230	0 01684	0.9529	20 780
35	0 01602	1,0017	0 1000	240	0 01692	0.9484	24 969
36	0 01602	1 0017	0.1040	250	0 01700	0.9439	29 825
37	0 01602	1 0018	0 1082	260	0 01709	0.9392	35 429
38	0 01602	1,0018	0 1126	270	0 01717	0.9346	41 853
39	0 01602	1,0018	0 1171	280	0 01726	0.9297	49 203
40	0 01602	1 0018	0 1217	290	0.01735	0 9249	57 556
41	0 01602	1 0018	0 1265	300	0.01745	0 9196	67 013
42	0 01602	1 0018	0 1315	310	0.01755	0.9143	77 68
43	0.01602	1.0017	0 1367	320	0.01765	0 9092	89 60
44	0 01602	1,0017	0 1420	330	0.01776	0.9036	103 04
45	0 01602	1 0017	0 1475	340	0.01787	0 8920	118 01
46	0 01602	1 0017	0 1532	350	0.01799	0 8920	134 63
47	0 01603	1 0016	0 1591	360	0.01811	0 8361	153 04
48	0 01603	1 0016	0 1653	370	0.01823	0 8302	173 37
49	0 01603	1 0016	0 1716	380	0.01836	0 8741	195 77
50	0 01603	1 0015	0 1781	390	0.01850	0 8673	220 37
51	0 01603	1 0014	0 1849	400	0 01864	0 8609	247 31
52	0.01603	1 0014	0 1918	410	0 01878	0 8545	276 75
53	0 01603	1 0013	0 1990	420	0 01894	0 8473	308 83
54	0 01603	1 0013	0 2064	430	0 01910	0 8402	343 72
55	0 01603	1 0012	0 2141	440	0 01926	0 8332	381 59
56	0 01603	1 0011	0 2220	450	0.0194	0 826	422 6
57	0 01603	1 0010	0.2302	460	0 0196	0 818	466 9
58	0 01604	1 0010	0 2386	470	0 0195	0 810	514 7
59	0 01604	1 0009	0 2473	480	0 0200	0 802	566.1
60	0 01604	1 0008	0 2563	490	0 0202	0.794	621 4
62	0 01604	1 0006	0 2751	500	0.0204	0.786	680 3
64	0 01605	1 0004	0 2951	510	0 0207	0.775	744 3
66	0 01605	1 0002	0 3164	520	0 0209	0 767	812 4
68	0 01605	1 0000	0 3390	530	0.0212	0 757	885 0
70	0.01606	0 9998	0 3631	540	0 0215	0 746	962.5
75	0.01607	0 9991	0 4298	550	0 0218	0 737	1045 2
80	0 01608	0 9984	0 5069	560	0 0221	0.725	1133.1
85	0 01609	0 9976	0 5959	570	0 0224	0.716	1226 5
90	0 01610	0 9968	0 6982	580	0 0228	0.704	1325 8
95	0 01612	0.9958	0 8153	590	0 0232	0 692	1431.2
100	0 01613	0 9949	0.9492	600	0.0236	0.680	1542 9
110	0 01617	0 9927	1 275	610	0 0241	0 666	1661 2
120	0 01620	0.9903	1 692	620	0 0247	0.650	1786 6
130	0 01625	0 9878	2 223	630	0 0253	0 634	1919 3
140	0.01629	0 9850	2 889	640	0.0260	0 618	2059 7
150	0 01634	0 9321	3 713	650	0 0268	0 599	2203 2
160	0 01639	0 9790	4.741	660	0 0278	0 578	2365 4
170	0 01645	0 9755	5 992	670	0 0290	0 554	2531 8
180	0 01651	0 9720	7 510	680	0 0305	0 526	2703 1
190	0 01657	0 9684	9 337	690	0 0328	0 489	2895 1.
200	0 01663	0 9619	11 526	705 4	0 0503	0 319	3205 2

TABLE 5

PROPERTIES OF SATURATED STEAM

Absolute Pressure PSIA	Temperature °F	Specific Volume△ Ft ³/lbs.	Absolute Pressure PSIA	Temperature °F	Specific Volume△ Ft ³/lbs.
14 7	212	26 799	120	341	3.7275
20	228	20 087	130	347	3 4544
25	240	16.301	140	353	3.2190
30	250	13.7436	150	358	3 0139
35	259	11.8959	160	363	2.8336
40	267	10.4965	170	368	2.6738
45	274	9 3988	180	373	2.5312
50	281	8.5140	190	377	2.4030
55	287	7.7850	200	382	2.28728
60	293	7.1736	210	386	2 18217
65	298	6.6533	220	390	2.08629
70	303	6.2050	230	394	1.99846
75	308	5.8144	240	397	1.91769
80	312	5.4711	250	401	1.84317
85	316	5.1669	260	404	1.77418
90	320	4.8953	270	408	1.71013
95	324	4.6514	280	411	1.65049
100	328	4.4310	290	414	1.59482
110	335	4 0484	300	417	1.54274

TABLE 6
SUPERHEATED VAPOR

Pressure (psia)		Temperature (°F) 200	260	300	360	400	460	500	600	700	800	900	1000	1100	1200
	v	38.85	42.56	45.00	48.63	51.04	54.05	57.05	63.04	69.01	74.98	80.95	86.92	92.88	98.84
10	h	1146.6	1175.1	1193.9	1221.9	1240.6	1268.7	1287.5	1335.1	1383.4	1432.5	1482.4	1533.2	1585.0	1637.6
	s	1.7927	1.8341	1.8595	1.8950	1.9172	1.9488	1.9689	2.0160	2.0596	2.1002	2.1383	2.1744	2.2086	2.2413
	v		21.11	22.36	24.21	25.43	27.25	28.46	31.47	34.47	37.46	40.45	43.44	46.42	49.41
20	h		1172.2	1191.6	1220.3	1239.2	1267.5	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	1.8366	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

VII. VALVE INHERENT FLOW COEFFICIENTS - C_V

TABLE 7

VALVE FLOW COEFFICIENTS C_V

CLASS 150 STD. RATING

Valve Size	DEGREES OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
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"	34	113	248	429	677	1015	1421	1827	2256
10"	47	159	349	604	953	1430	2002	2573	3172
12"	74	247	543	939	1482	2224	3113	4003	4942
14"	95	316	695	1200	1895	2842	3979	5117	6317
16"	129	430	946	1635	2581	3872	5420	6969	8604
18"	166	553	1216	2100	3316	4974	6963	8953	11053
20"	208	692	1523	2631	4155	6232	8725	11218	13850
24"	322	1075	2365	4084	6449	9674	13544	17413	21498
30"	508	1693	3725	6434	10160	15240	21335	27431	33866
36"	757	2523	5550	9586	15136	22704	31785	40867	50453
42"	1091	3637	8001	13821	21822	32733	45827	58920	72741
48"	1389	4632	10190	17601	27791	41687	58362	75037	92638
54"	1977	6591	14501	25048	39549	59323	83053	106782	131830
60"	2639	8796	19352	33426	52778	79167	110834	142502	175928
66"	2951	9837	21642	37381	59023	88534	123948	159362	196743
72"	3867	12892	28362	48989	77351	116027	162438	208849	257838

TABLE 8

VALVE FLOW COEFFICIENTS C_V

CLASS 150/150 PSI RATING

Valve Size	DEGREES OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
24"	351	1171	2575	4448	7024	10535	14749	18964	23412
30"	607	2025	4455	7695	12150	18225	25515	32805	40500
36"	910	3032	6671	11523	18194	27292	38208	49125	60648
42"	1198	3992	8783	15170	23953	35930	50302	64674	79845
48"	1590	5299	11658	20137	31795	47693	66770	85847	105984
54"	1977	6591	14501	25048	39544	59323	83053	106782	131830
60"	2639	8796	19352	33426	52778	79168	110835	142502	175928
66"	2951	9837	21642	37381	59023	88534	123948	159362	196743
72"	3867	12892	28362	48989	77351	116027	162438	208849	257838

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	3661
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	62225

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

INHERENT FLOW CHARACTERISTICS
PERCENT OF FULL OPEN C_V VS. DEGREES OF DISC OPENING

CLASS 150 VALVES

FIGURE 12
2" THRU 6"

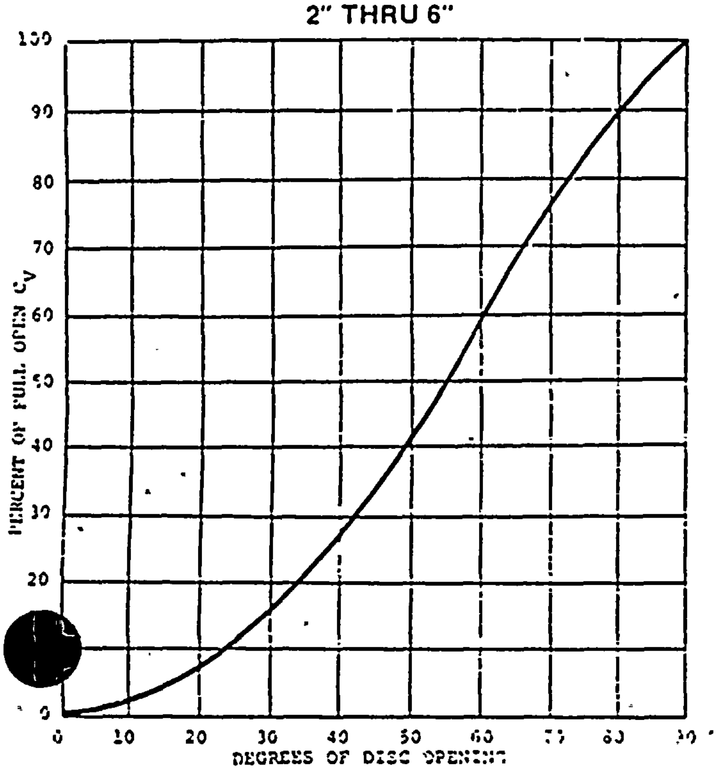


FIGURE 13
8" AND LARGER

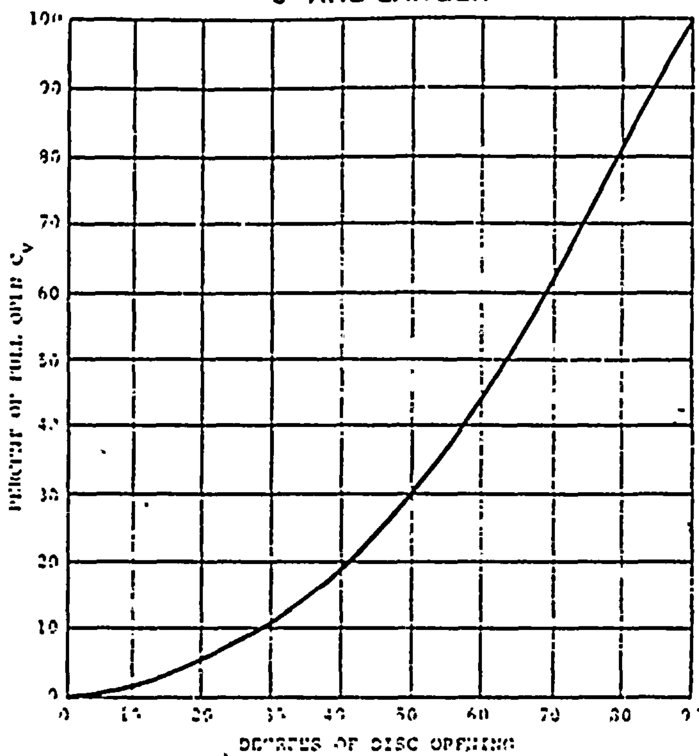


FIGURE 14
CLASS 300 VALVES
ALL SIZES

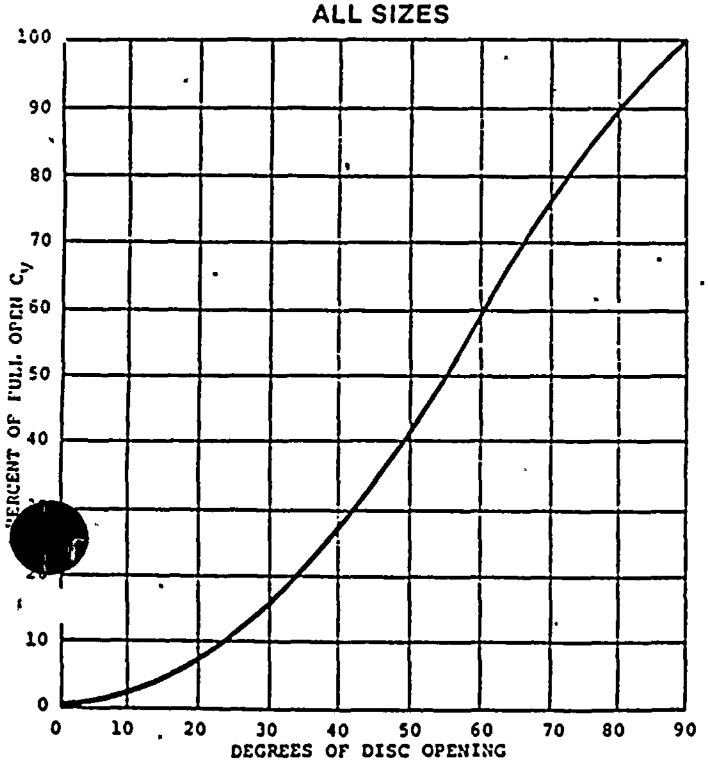
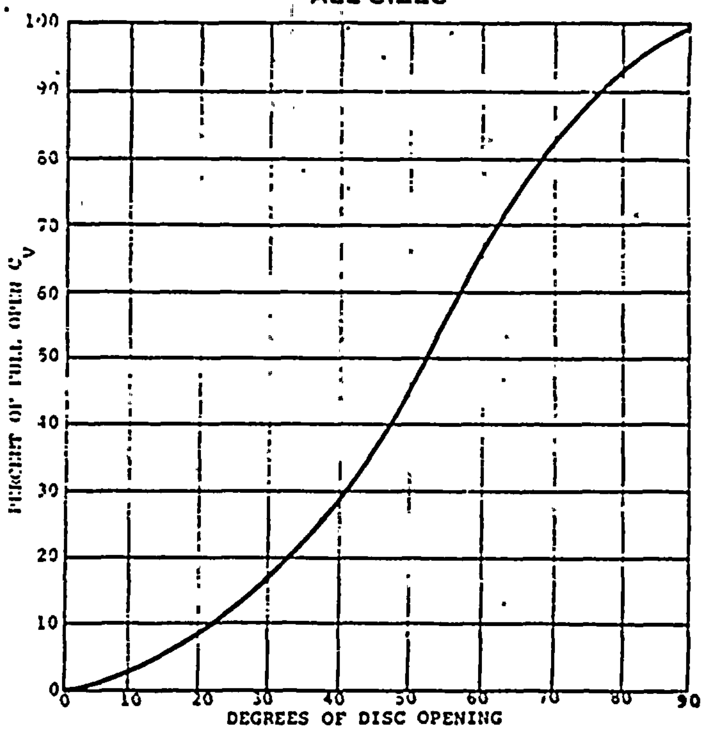


FIGURE 15
CLASS 600 VALVES
ALL SIZES



HYDRODYNAMIC TORQUE

OF

HIGH PERFORMANCE TRUNNION VALVES

The increased use of High Performance Trunnion (Offset Buterfly) Valves has caused increased use in high flow applications and therefore, a need for a more accurate prediction of the Hydrodynamic Torque behavior of this type of valve. Improper actuator sizing, structural damage and control instability are all possible consequences of using inaccurate Hydrodynamic Torque data.

The Trunnion Valve is essentially a modified butterfly valve with the rotary stem offset from the disc sealing surface. See Figure 1. Normally, this style of valve exhibits high opening and closing torques with operating torques depreciating as the valve disc rotates 90° to the fully open position. However, on occasions where a considerable quantity of fluid is being pumped through the valve, the Hydrodynamic Torque may exceed the opening torque or be of sufficient magnitude that the actuator will be unable to further open the valve.

Realizing the importance of having accurate Hydrodynamic Torque data, Posi-Seal International, Inc. in North Stonington, Conn. launched an extensive R&D program inorder to obtain this data. At Posi-Seal's new Hydraulics Laboratory, (See Figure 2 for schematic of lab), Hydrodynamic Torque data was measured on valve sizes 1 1/2" through 14" for valve classes 150 through 600 lb. Additional data was taken on a 14" - 900 and a 14" - 1500 lb. valve. Data was recorded for both preferred and non-preferred fluid flow, measured at every 10 degrees of valve rotation. Inorder to obtain the Hydrodynamic Torque factors, the valve torque was measured while both opening and closing the valve. By averaging the above data, stem packing and bearing friction torques were negated and pure Hydrodynamic Torque was obtained. The above measured torque when divided by the differential pressure across the valve yielded the Hydrodynamic Torque factor for that particular valve at that angular location. This data was statistically analyzed on Posi-Seal's

technical mini computer and equations were developed from which Hydrodynamic Torque factors were calculated for all sizes and classes of high performance Trunnion Valves.

Based upon the flow testing performed at Posi-Seal, the following general observations concerning Hydrodynamic Torque of Trunnion Valves can be made:

(1) For preferred flow, the Hydrodynamic Torque will always want to close the valve. See Figure 3.

(2) For non-preferred flow, the Hydrodynamic Torque will, through 70° to 80° of valve rotation (the exact location varies with valve class), want to close the valve. Beyond this point, the Hydrodynamic Torque will want to open the valve. See Figure 4.

(3) Except for the 90° valve location where the Hydrodynamic Torque factors are of equal magnitude for both preferred and non-preferred flow but of opposite sign, the non-preferred Hydrodynamic Torque factors are considerably less in magnitude than those for preferred flow. See Figures 3 and 4.

(4) All of the Hydrodynamic Torque factors (for both preferred and non-preferred flow) decrease with increase in valve class. ex: Hydrodynamic Torque factors for a 600 lb. valve are significantly less than those for a 150 lb. valve. See Figures 3 and 4.

(5) The Hydrodynamic Torque factors increase approximately proportional to the cube of the valve size. (The exact amount varies depending upon valve class).

The total Trunnion Valve Torque at some angular position (other than opening or closing) is in actuality a summation of three separate torques, stem packing torque, bearing friction torque and the Hydrodynamic Torque discussed above. Except for small size valves (6" and less), the stem packing torque is a small percentage of the total valve torque. For large sized valves, above approximately 45°, the Hydrodynamic Torque is the major component of the total valve torque, below 45° bearing friction torque becomes the major contributor. All three components must be considered inorder to accurately evaluate a valve's performance.

Inorder to better understand the reason for Hydrodynamic Torque occuring, one must visualize the valve's disc as an airfoil. The Hydrodynamic Torque generated at some angle is a composite of fluid flow lift and drag forces acting over the disc's surface. The general formulas for lift and drag being:

$$F_D = C_D P \frac{AV^2}{2} \qquad \text{(Drag)}$$

$$\text{and} \quad F_L = C_L P \frac{AV^2}{2} \qquad \text{(Lift)}$$

Where:

C_D, C_L - Drag and lift coefficients which are related to the geometry of flow obstruction. (Disc)

P - density of the fluid medium

A - projected or surface area of flow obstruction (Disc)

V - velocity of fluid medium

Both the lift and drag forces are dependent upon the shape of the valve disc, its orientation to the flow stream and the direction of fluid flow. As the valve angle is decreased, or flow is reversed, both the magnitude and location of these forces shift causing a change in the resultant Torque. As the valve angle is further decreased the drag forces will increase while the lift forces will deteriate due to increased turbulence and a breakdown of the flow stream along the downstream side of the valve disc. See Figures 5 and 6.

FIGURE No.: 1
SCHEMATIC
OF
HIGH PERFORMANCE TRUNION VALVE

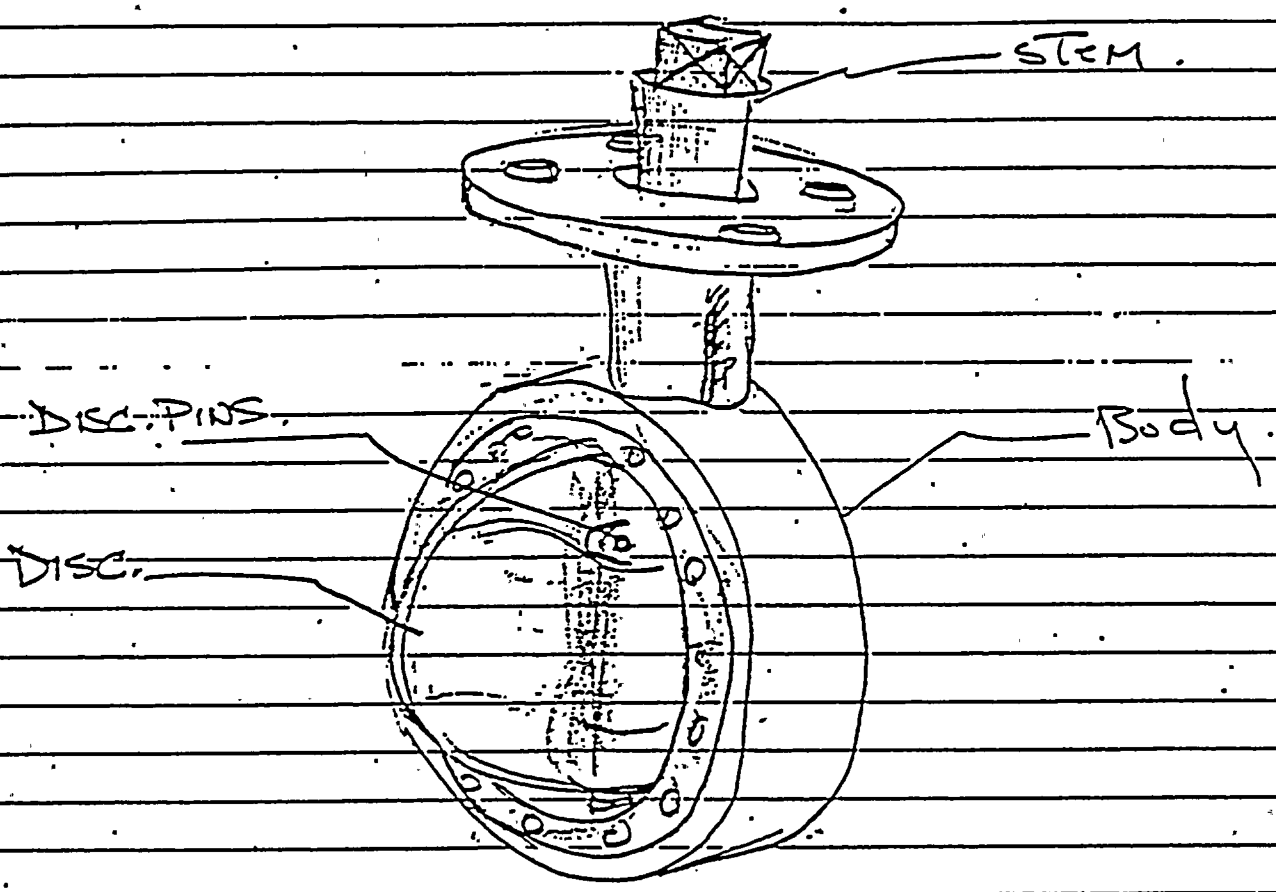
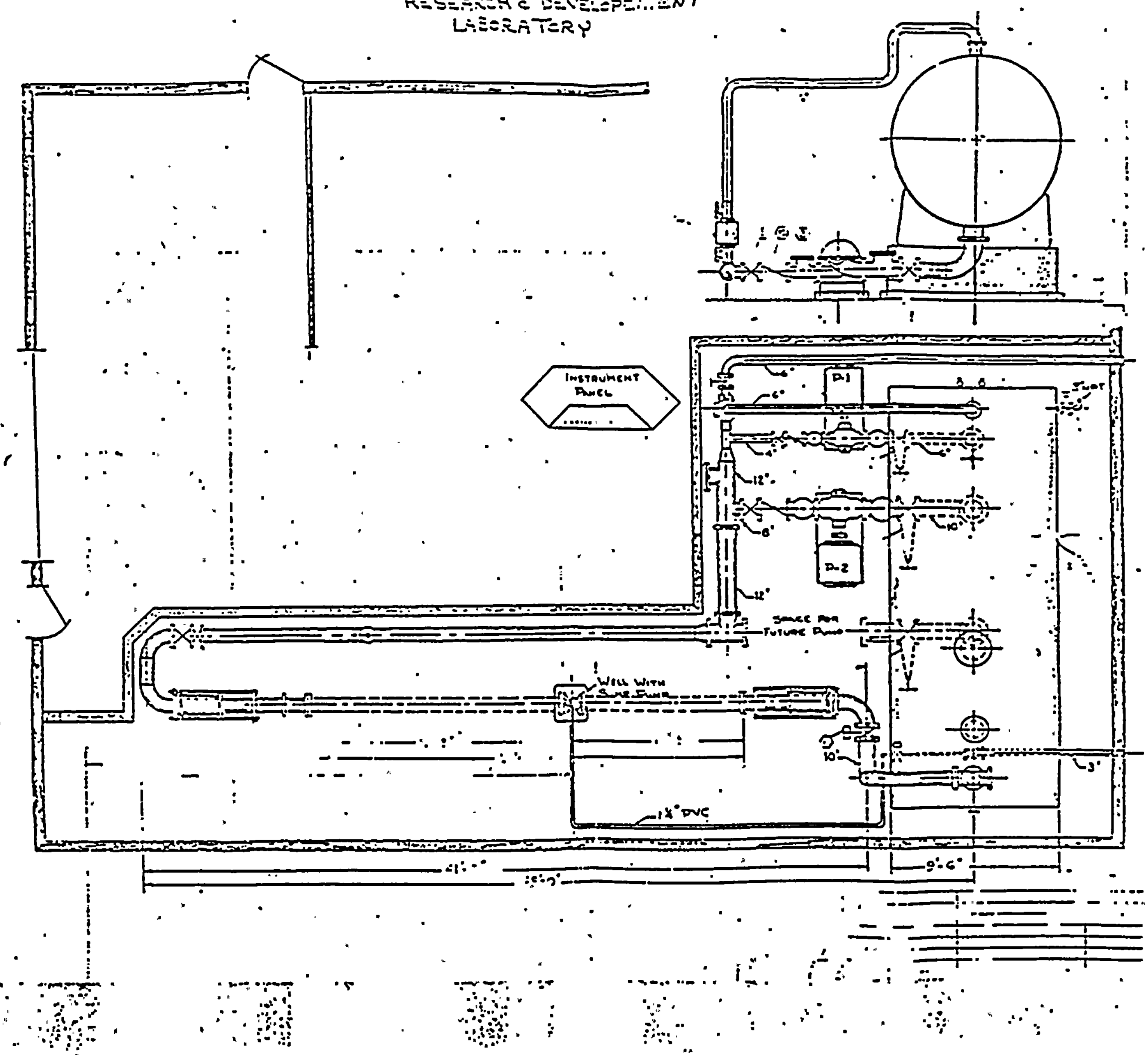
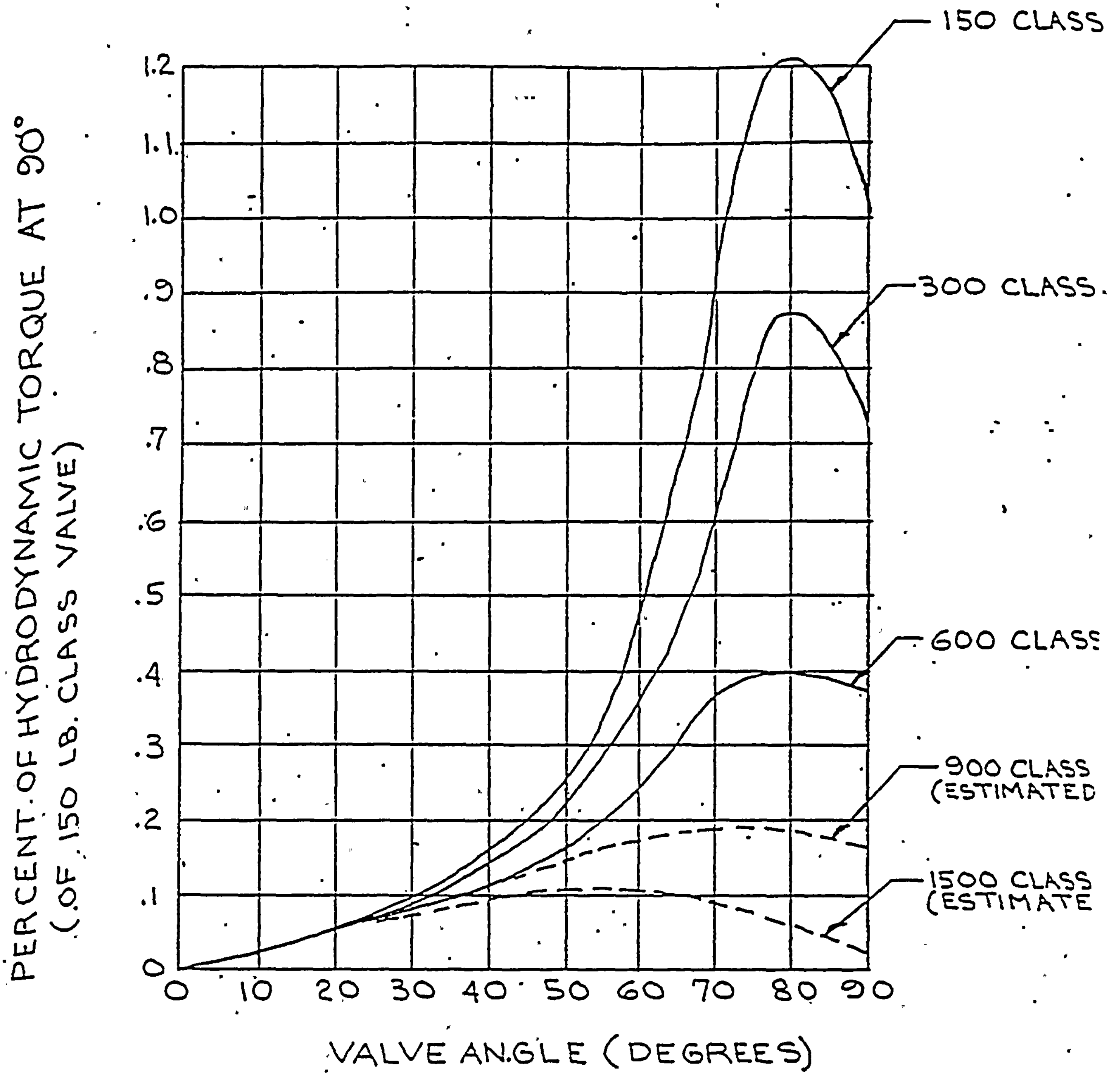


FIGURE No.: 2
SCHEMATIC OF POSI-SEAL
RESEARCH & DEVELOPMENT
LABORATORY



HYDRODYNAMIC TORQUE VS VALVE ANGLE

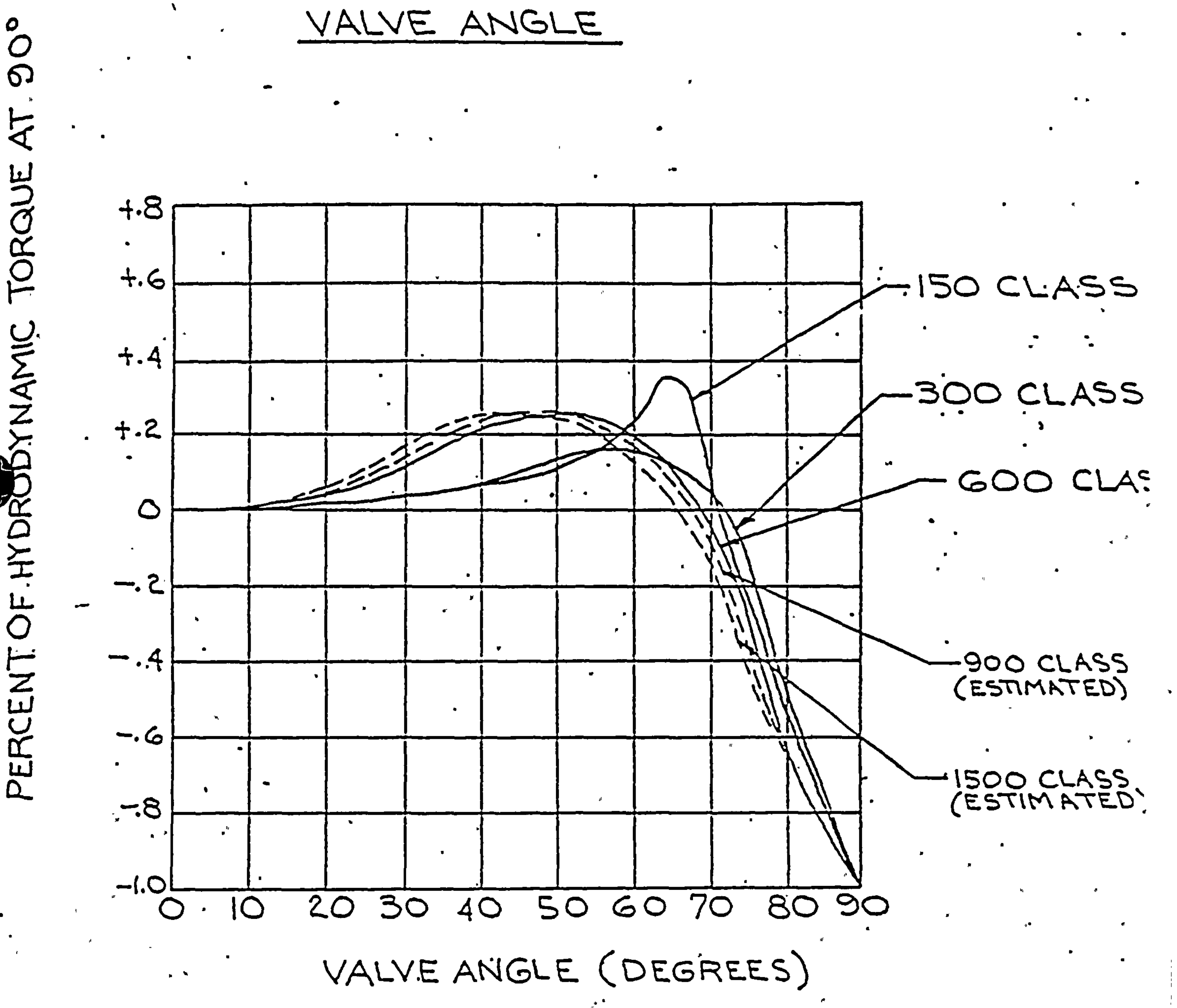


PREFERRED DIRECTION

GANSEN

FIGURE No.: 3

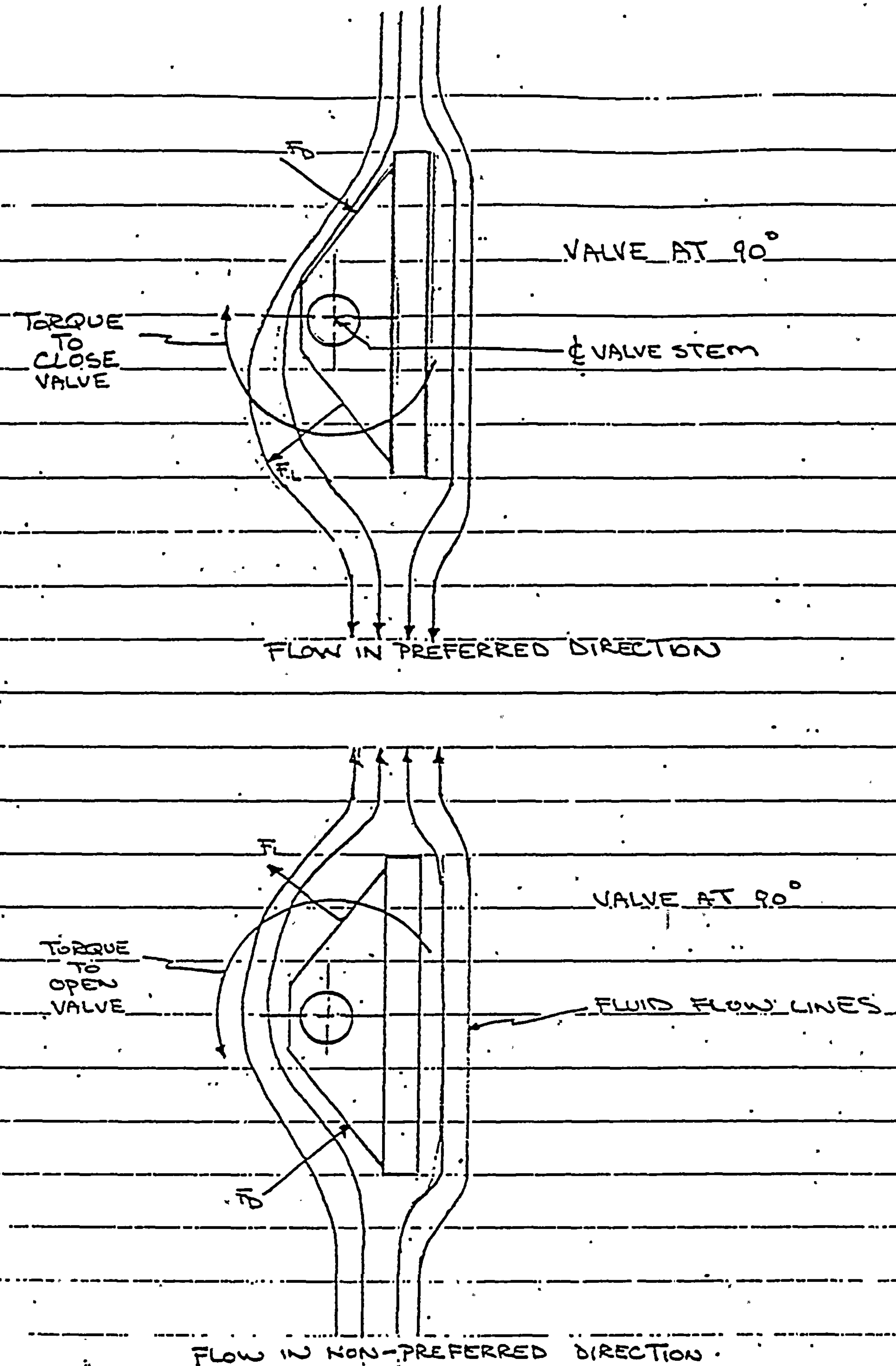
HYDRODYNAMIC TORQUE VS VALVE ANGLE



NON PREFERRED DIRECTION

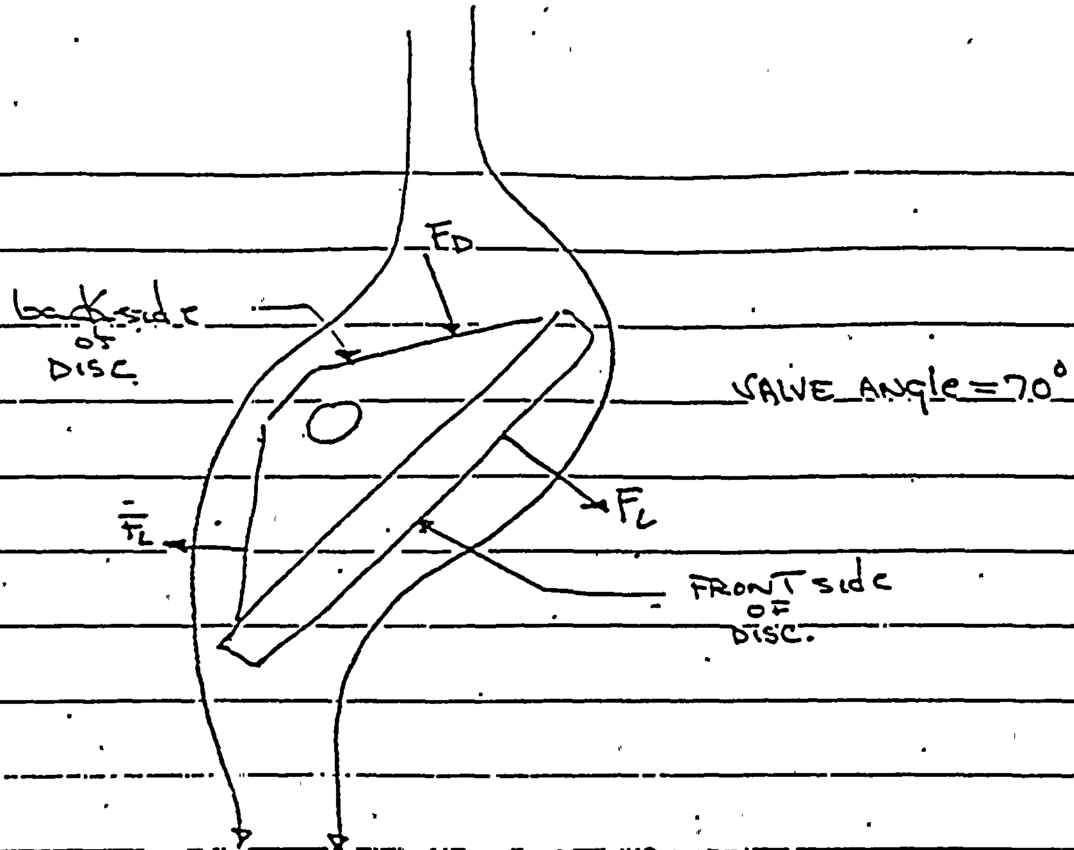
JANSEN

FIGURE No.: 4

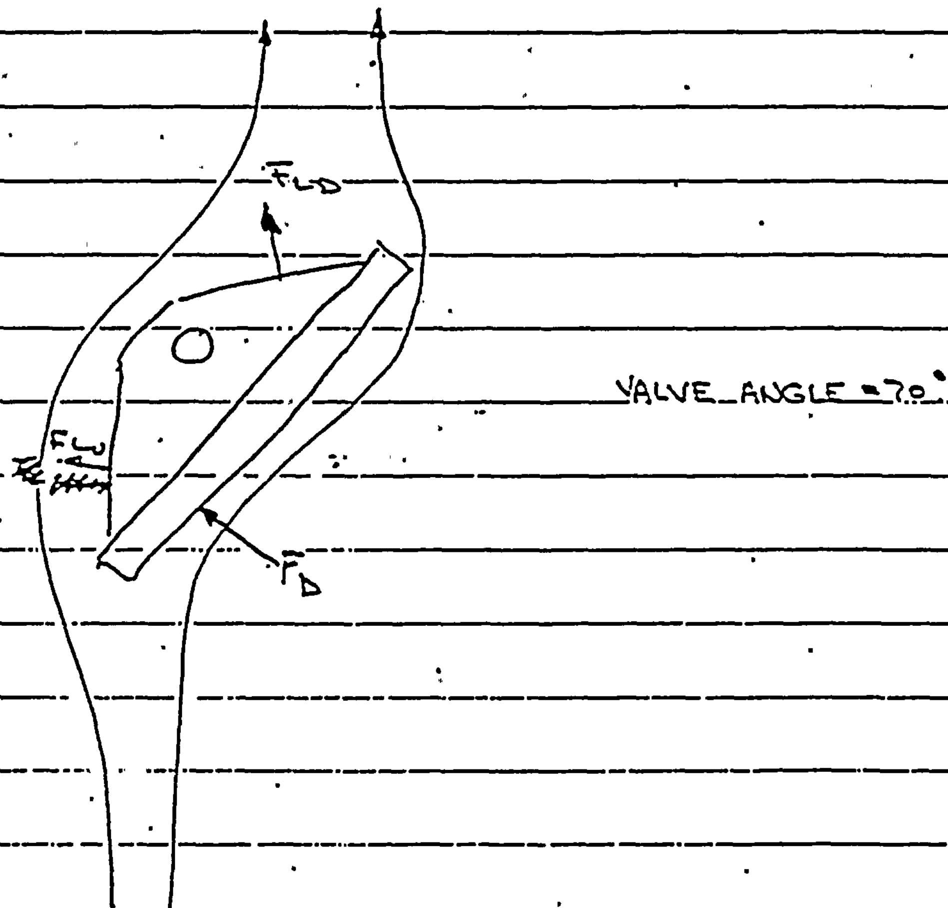


F_D
VALVE AT 90°
TORQUE TO CLOSE VALVE
℄ VALVE STEM
F_L
FLOW IN PREFERRED DIRECTION
F_L
VALVE AT 90°
TORQUE TO OPEN VALVE
FLUID FLOW LINES
F_D
FLOW IN NON-PREFERRED DIRECTION.

FIGURE 5



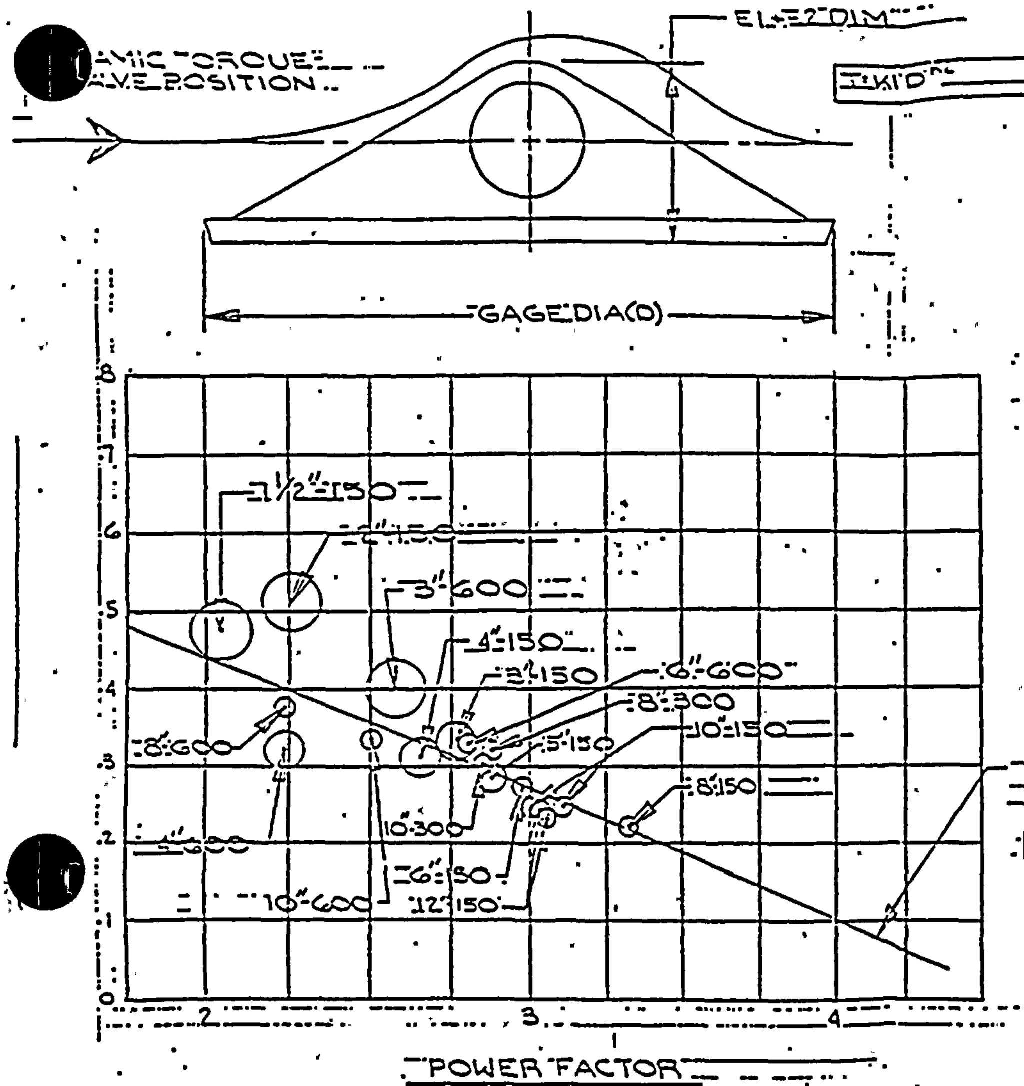
FLOW IN PREFERRED DIRECTION.



FLOW IN NON-PREFERRED DIRECTION

FIGURE 6

SHAPE FACTOR VS. POWER FACTOR



T= HYDRODYNAMIC TORQUE (I
D= DISC. GAGE DIA. (IN).
K1= SHAPE FACTOR

$$= \frac{E1 + E2}{D}$$

K2= POWER FACTOR

$$= B_0 + B_1 \cdot K1$$

B_0, B_1 = COEFFICIENTS DETERMINED BY LINEAR REGRESSION ANALYSIS OF EMPIRICAL DATA

OR:

$$K2 = \frac{LN[T/K1]}{LN D}$$

B_0 = +4.6098
B_1 = -5.9150

PER LEAST SQUA
REGRESSION ANA

$\boxed{K2 = 4.6098 - 5.915\,K1}$

FIGURE 7

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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]/PS
OPENING	0					
	10		42		+45	1.1
	20		41		+55	1.3
	30		39		+60	1.5
	40		36		+75	2.1
	50		33		+85	2.6
	60		31.5		+100	3.2
	70		27	27	+140 125	5.2
	80		22		+155	7.0
	90		19		+140	7.4
CLOSING	90		19		+120	6.7
	80		22		+140	6.
	70		25	27	~~+145~~ 110	4.
	60		34		+100	2.
	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

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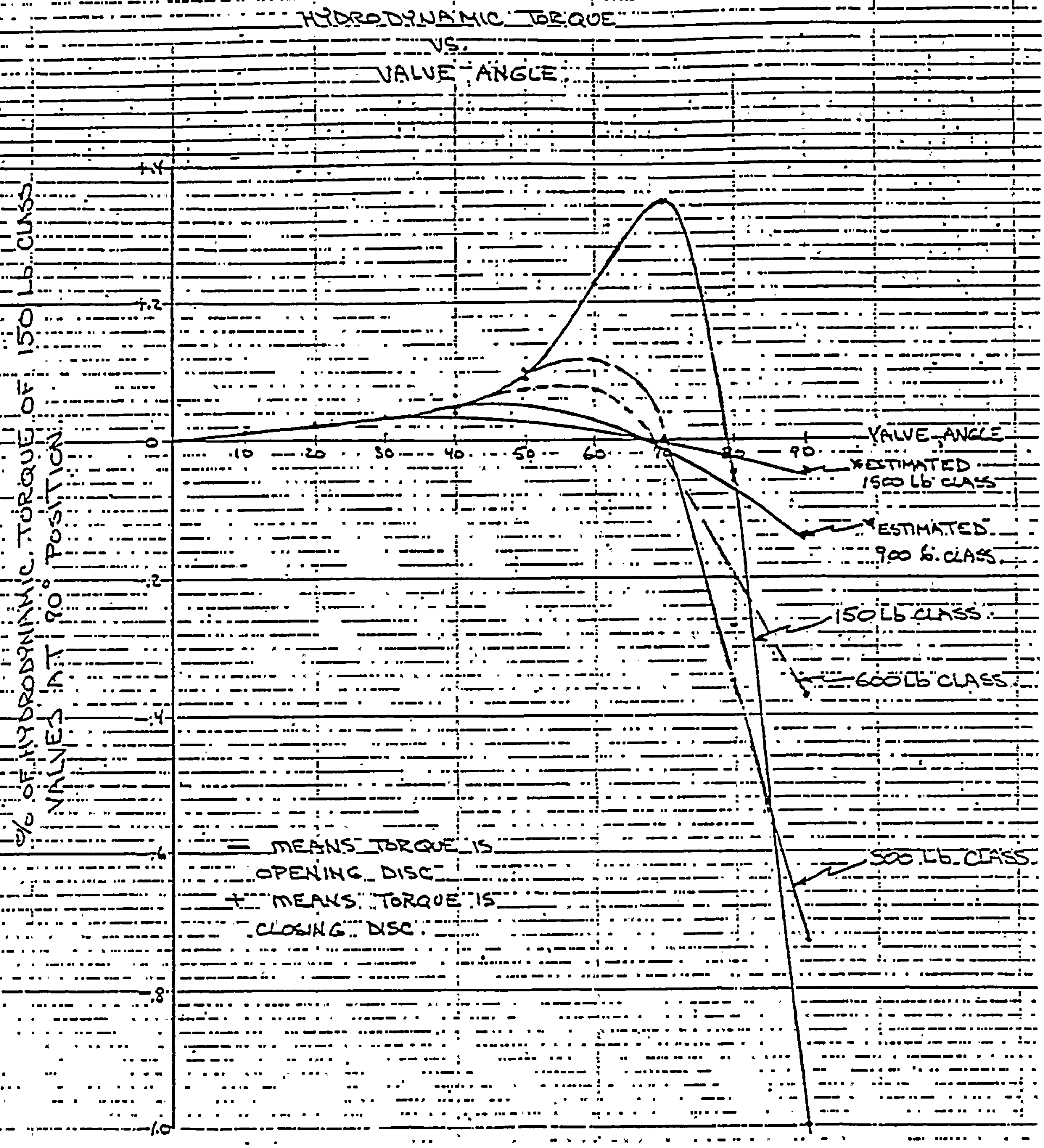
ENGINEERING CALCULATIONS

NON-PREFERRED DIRECTION Page

[illegible]. By Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

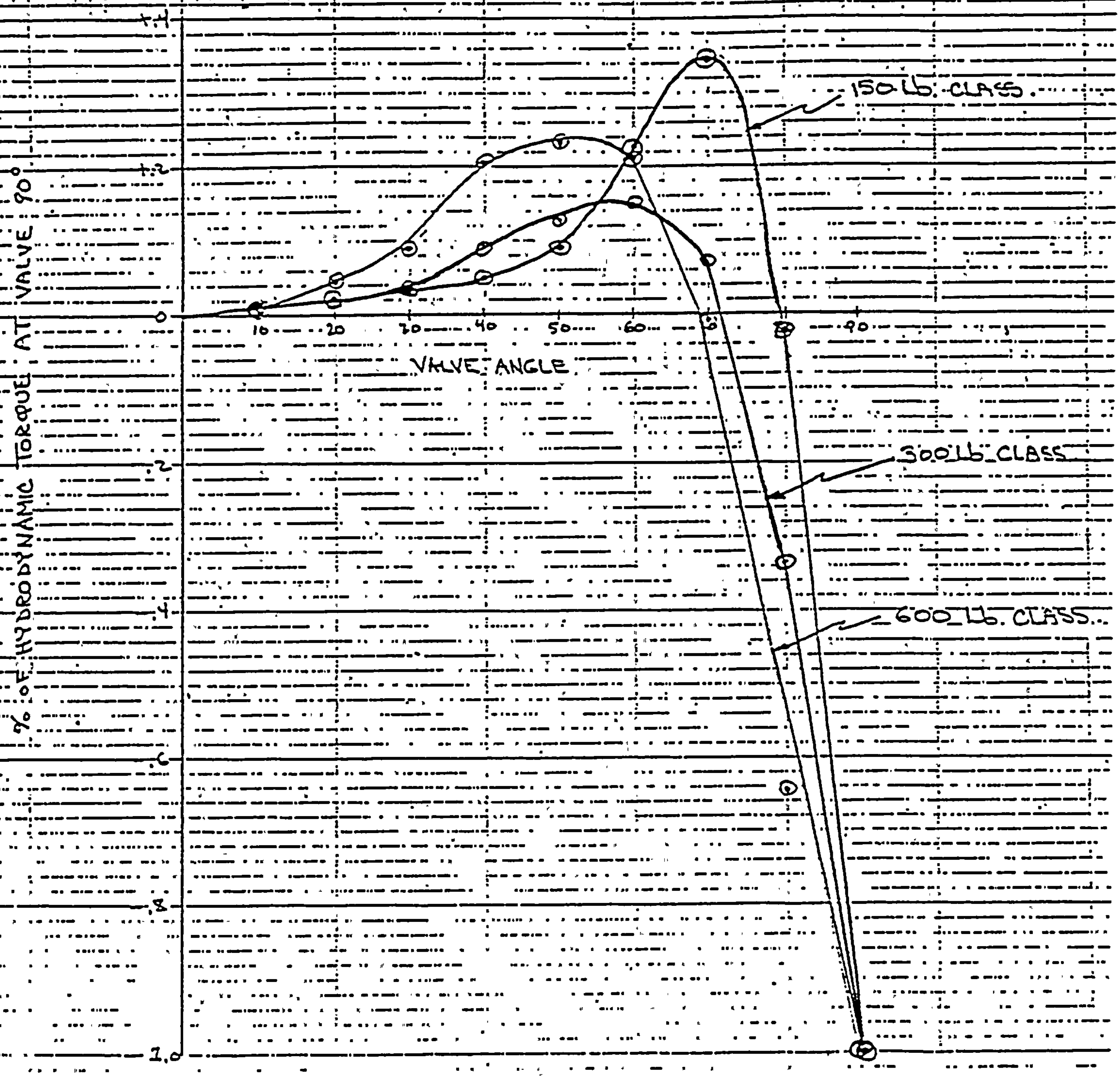
NON PREFERRED DIRECTION

Page

c. By

Checked By

HYDRODYNAMIC TORQUE VS. VALVE ANGLE



POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

Calc. By NON-PREFERRED DIRECTION Checked By ØANSEN 8/15/78

ANGLE	VALVE SIZE - % TORQUE @ 90				AVG.
	10"-150	8"-150	12"-150		
90	(-378.5) -1.0	(-178) -1.0	(-468.5) -1.0		-1.0
80	(-117) .309	(+38.7) +.217	(+20.5) +.044		-.016
70	(+112) +.296	(+63.35) +.356	(+180.5) +.385		+.346
60	(+94) +.248	(+32.55) +.183	(+118.5) +.~~336~~ +.253		+.228
50	(+43.5) +.115	(+15.05) +.085	(+37) +.079		+.093
40	(+15.5) +.041	(+8.35) +.047	(+29) +.062		+.05
30	(+14) +.037	(+4.775) +.027	(+21.5) +.046		+.037
20	(+2) +.005	(+3.125) +.018	(+24) +.051		+.025
10	(0) +0	(+2.165) +.012	(+2) +.004		+.005

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUES Page

By NON-PREFERRED DIRECTION Checked By ØANSEN 8/8/78

ANGLE	VALVE SIZE – % OF TORQUE @ 90°				
	5"–150	6"–150	8"–300	10"–300	AVG.
90	–40.95 (–1.0)	–65.1 (–1.0)	–107.3 (–1.0)	–217 (–1.0)	–1.0
80	0 (0)	–28.9 (–.444)	–31.25 (–.291)	–133 (–.613)	–.337
70	+4.335 (+.106)	+1.3 (+.02)	+20.85 (+.194)	–5.5 (–.025)	+.074
60	+3.91 (+.095)	+6.55 (+.101)	+21.4 (+.199)	+44.5 (+.205)	+.15
50	+1.375 (+.034)	+4.1 (+.063)	+23.8 (+.222)	+40.5 (+.187)	+.127
40	–.27 (–.007)	+3.7 (+.057)	+11.85 (+.110)	+15.5 (+.071)	+.093
30	–.585 (–.014)	+3.25 (+.05)	+6.25 (+.058)	+1 (+.005)	+.025
20	–.45 (–.011)	–.5 (–.008)	+5.35 (+.050)	+1 (+.005)	+.009
10	–.645 (–.016)	+4.6 (+.077)	+1.65 (+.015)	+2 (+.009)	+.020

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUES Page

By NON-PREFFERRED DIRECTION Checked By ØANSEN 8/16/78

ANGLE	VALVE SIZE - % OF TORQUE AT 90°			
	6" - 600	8" - 600	10" - 600	AVG.
90	-46.775 ~~-76.5~~ (-1.0)	-75 (-1.0)	-129.45 (-1.0)	(-1.0)
80	-20.57 ~~-38.75~~ (~~-.51~~ -.44)	-52.5 (-.7)	-101.2 (-.782)	-.641
70	+2.93 ~~+5.0~~ (~~+.065~~ +.063)	-.825 (-.11)	+8.75 (+.068)	+.007
60	+11.936 ~~+25.0~~ (~~+.326~~ +.255)	+13.1 (+.175)	+28.75 (+.222)	+.217
50	+12.435 ~~+25.0~~ (~~+.325~~ +.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

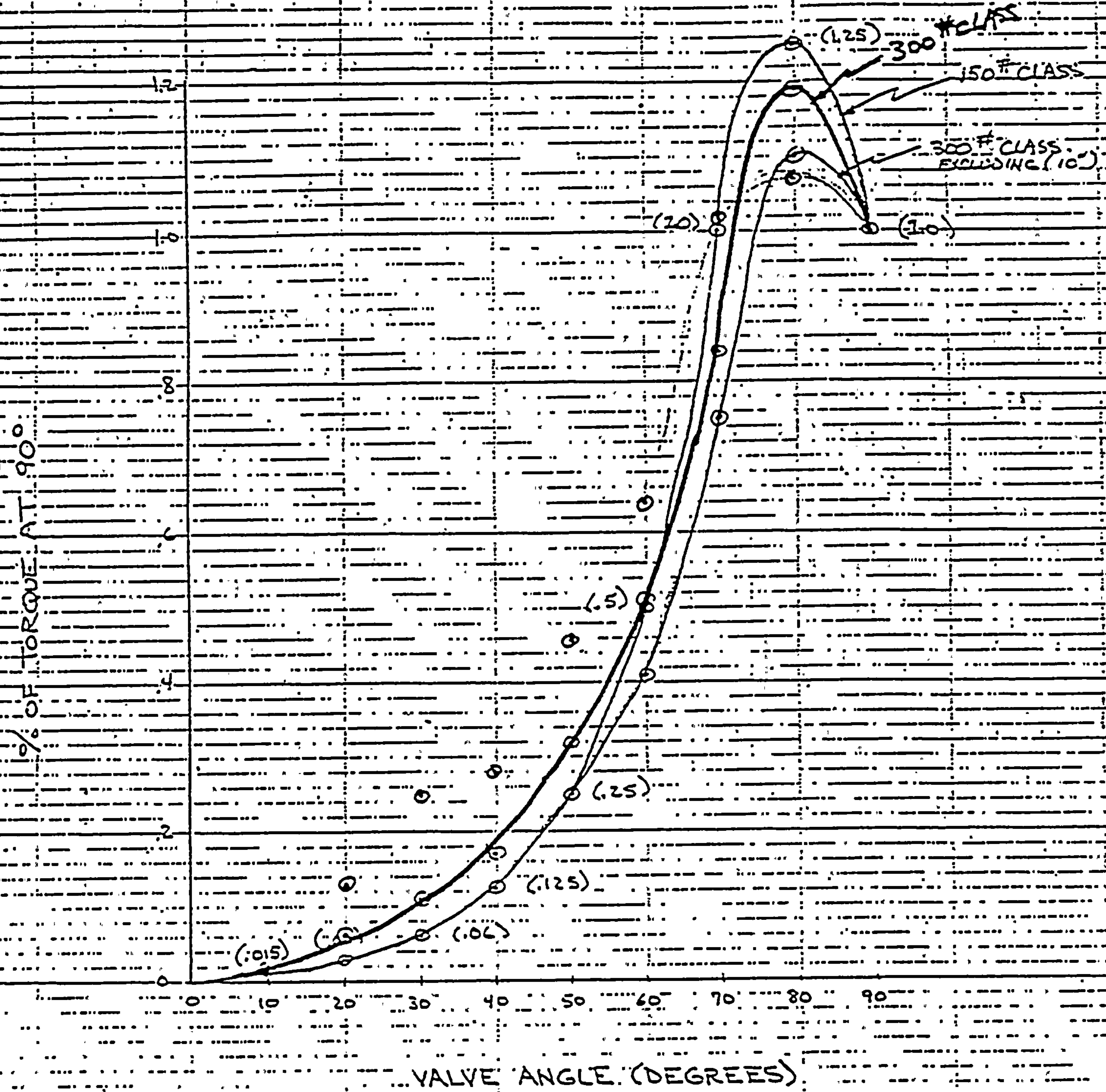
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Page

c. By PREFERRED DIRECTION. Checked By DANSEN 8/8/78

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE



POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUES — Page
.c. By PREFERRED DIRECTION — Checked By DANSEN 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	(61.95) .83	(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.

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ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUES — Page

By PREFERRED DIRECTION — Checked By QANSEN 8/8/78

ANGLE	VALVE SIZE – % TORQUE @ 90° 5"-150	6"-150	8"-300	10"-300	AVG (ALL)	AVG (EX 10"s)
90	(28) 1.0	(54.62) 1.0	(95.45) 1.0	(180.) 317 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
70	(18) .64	(41.15) .75	(77) .81	(205.5) 1.14	.84	.73
60	(9) .32	(27.64) .51	(39.2) .41	(141) .78	.505	.41
50	(5.2) .19	( ) ~~X~~ 45°	(30.3) .32	(79) .44	.32	.26
40	(3.35) .12	(8.54) .16	(18.1) .19	(39) .22	.17	.16
30	(2.05) .07	(6.32) .12	(9.6) .10	(22.5) .13	.11	.10
20	(1.115) .04	(4.35) .08	(4.35) .05	(13.5) .08	.06	.06
10	(.465) .02	(.85) .02	(3.5) .04	(4.5) .03	.02	.01

* 5" & 6" 150# ARE EQUIVALENT TO 300# CLASS VALVES

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

Calc. By PREFERRED DIRECTION Checked By OANSEN 8/7/78

ANGLE	VALVE SIZE — % TORQUE @ 90°					
	10"-150 (2)	12"-150 (2)	~~8"-150~~	10"-150 (1)	12"-150 (1)	AVG.
90	(245) 1.0	(167.)(333) 1.0	~~(214) 1.0~~	(317) 1.0	(350) 1.0	1.0
80	(312) 1.27	(425) ~~2.5~~ 1.28	~~(139) .65~~	(326) 1.03	(434) 1.24	1.21
70	(227) .93	(345) 1.04	~~(83) .39~~	(234) .74	(322) .92	.91
60	(122) .50	(186) .56	~~( )~~	(118) .37	(183) .52	.49
50	(59) .24	(104) .31	~~( )~~	(59) .18	(77) .22	.24
40	(30) .12	(87) .26	~~( )~~	(32) .10	(34) .10	.15
30	(16) .07	(33) .10	~~( )~~	(25) .08	(24) .07	.08
20	(9) .03	(26) .08	~~( )~~	(14) .04	(18) .05	.05
10	(3) .01	(11) .03	~~( )~~	(8) .02	( ) .03	.02

(8)

DELETE
NOT GOOD
DATA

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUE DETERMINATION Page ______

Calc. By [signature] DATE: 12/16/77 Checked By ______

VALVE SIZE: 150

VALVE DIRECTION: ~~STEM UPSTREAM~~ STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON/BUNA

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	(IN-LB/IN³)/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.[illegible]
	80		18.5		−75	−4.[illegible]
	70		21		−40	−1.[illegible]
	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

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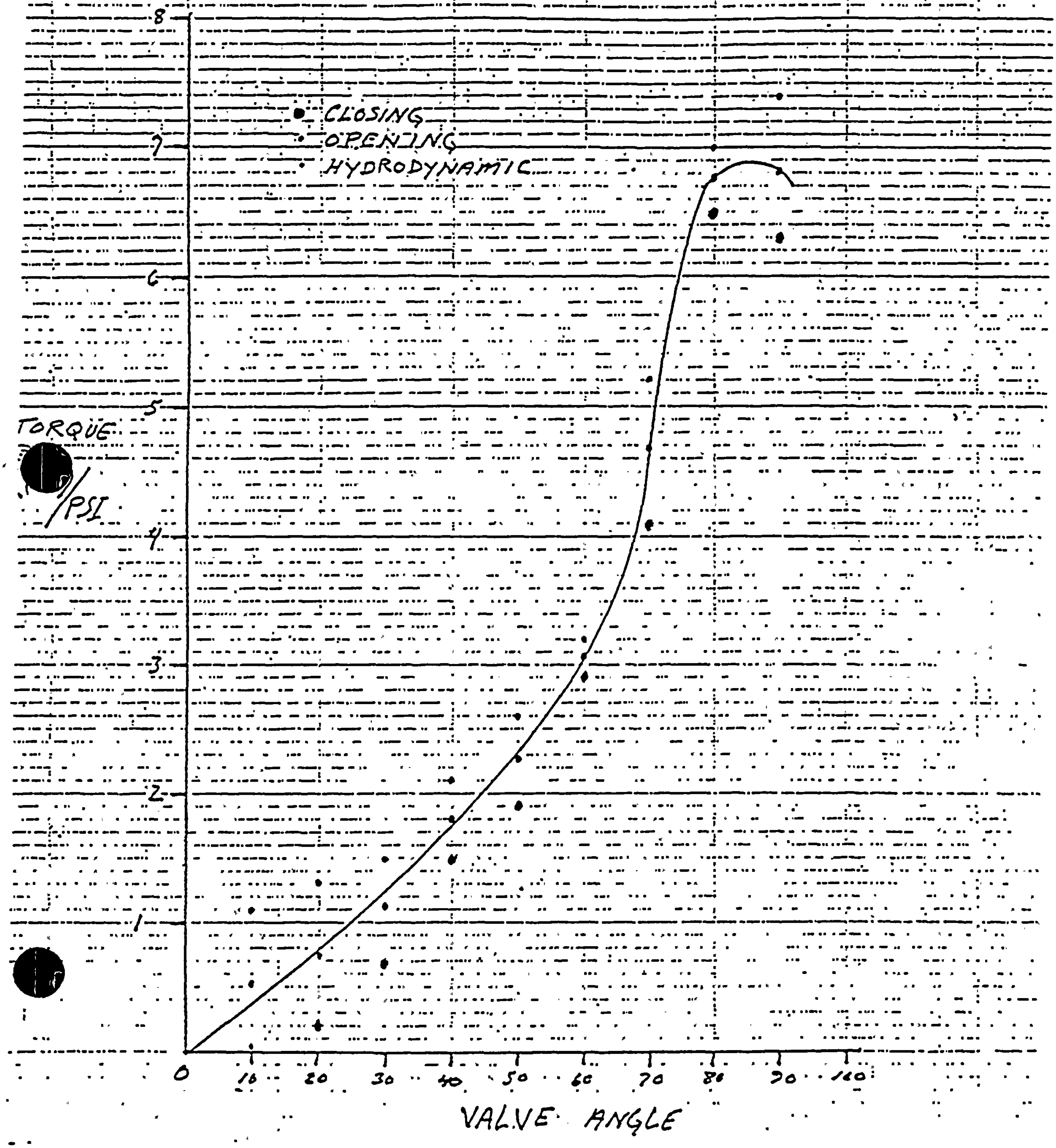
ENGINEERING CALCULATIONS

Title 3-150LB HYDRODYNAMIC TORQUE CURVE Page

Calc. By C.Lyaesi (STEM UP STREAM) Checked By

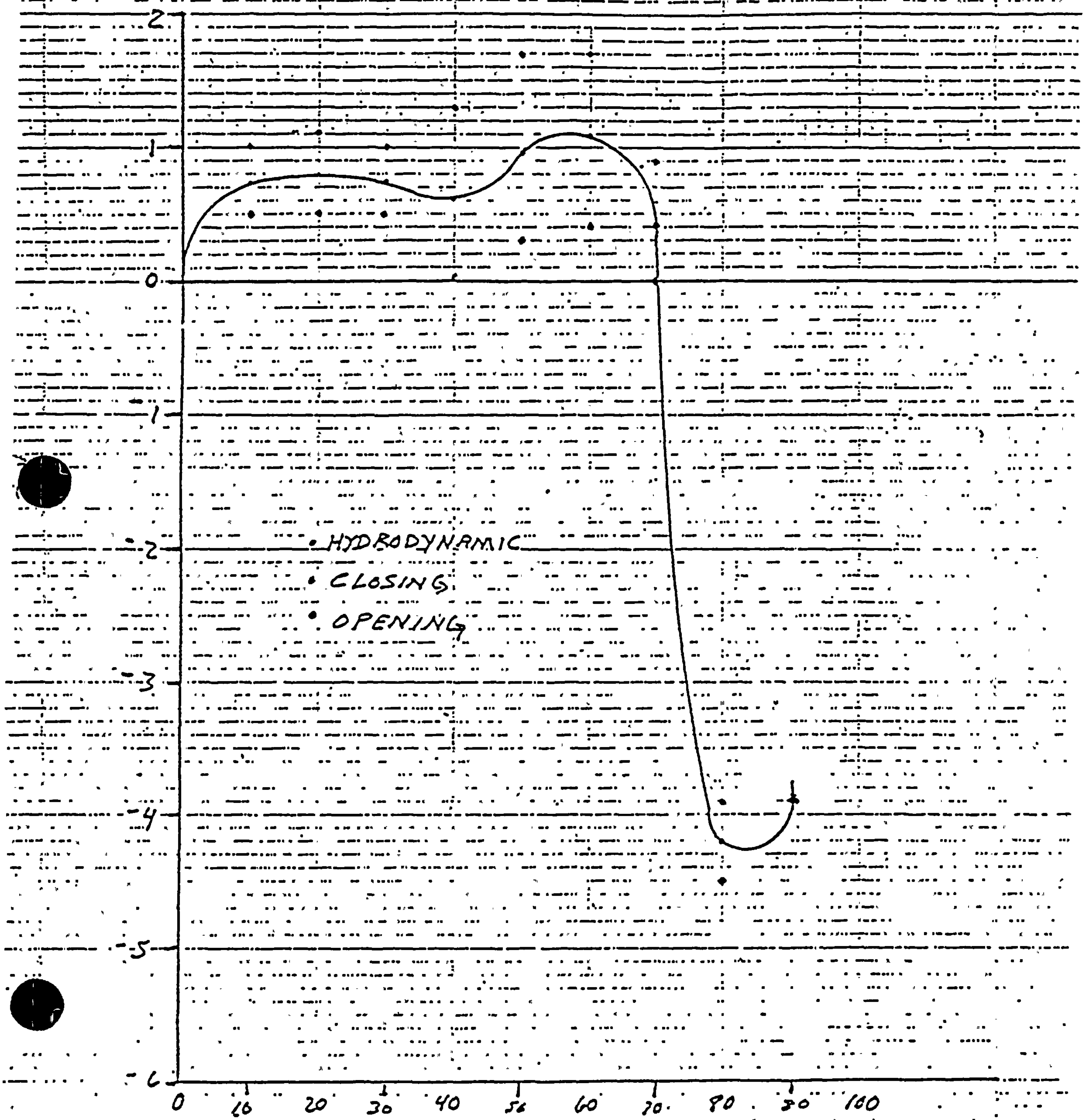


POSI-SEAL INTERNATIONAL, INC.

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 [illegible] DATE: 12/5/77 Checked By

VALVE SIZE: 4"-150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 65 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		46.5		+50	1.07
	20		42.5		+75	1.76
	30		37		+75	2.03
	40		31		+75	2.42
	50		32		+100	3.12
	60		25.5		+125	4.9
	70		17.5		+140	8.0
	80		11.5		+150	13.0
	90		8.7		+125	14.3
			X		X	
CLOSING	90		8.5		+75	8.82
	80		11		+125	11.3
	70		16.5		+125	7.5
	60		27		+125	4.6
	50		31.5		+85	2.7
	40		35		+50	1.4
	30		36.3		+40	1.1
	20		37.8		0	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: Roy 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					
	10		30.5		~~+38~~ +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
						−
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					

PACKING TORQUE: 10 IN-LB OPENING

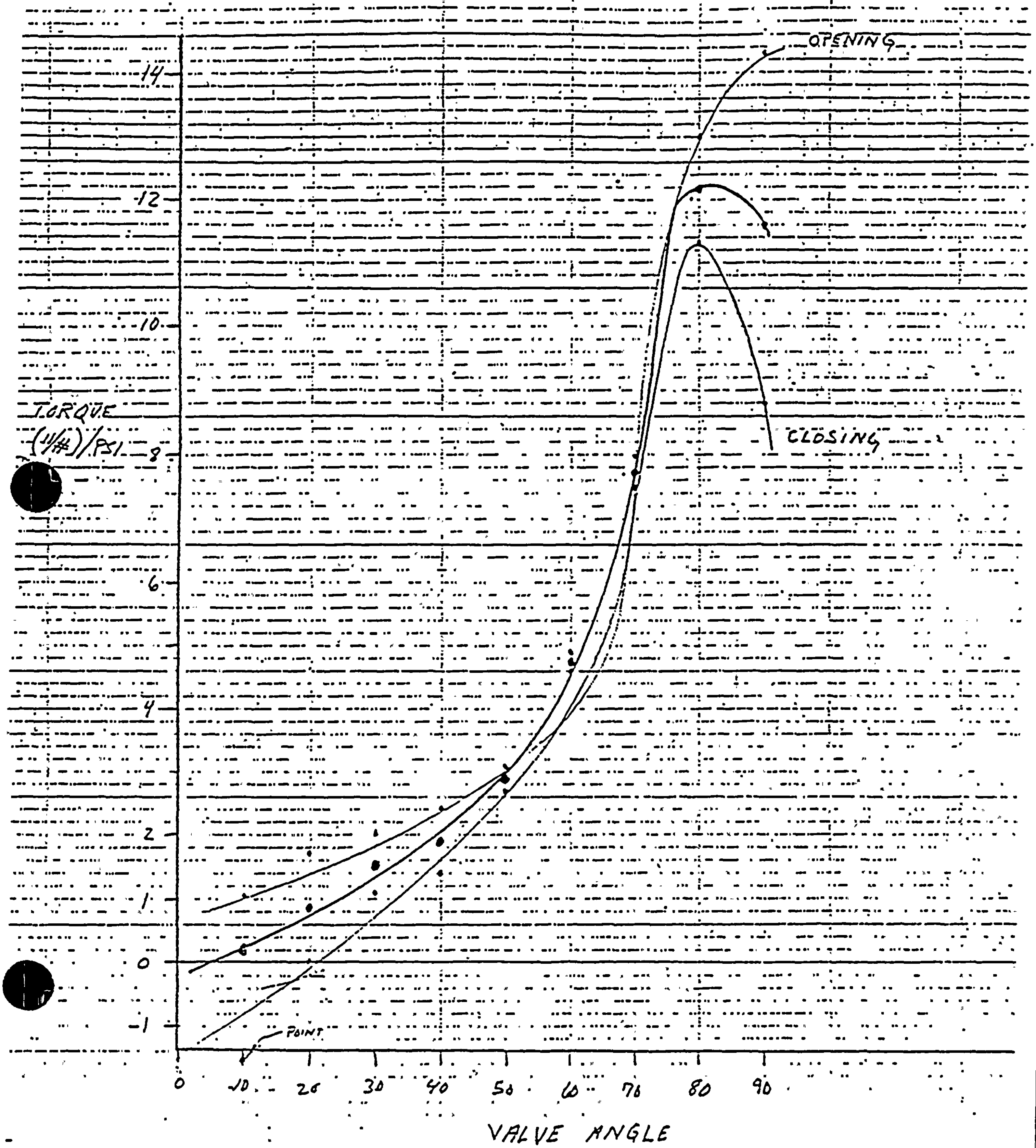
5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (STEM UPSTREAM) Checked By

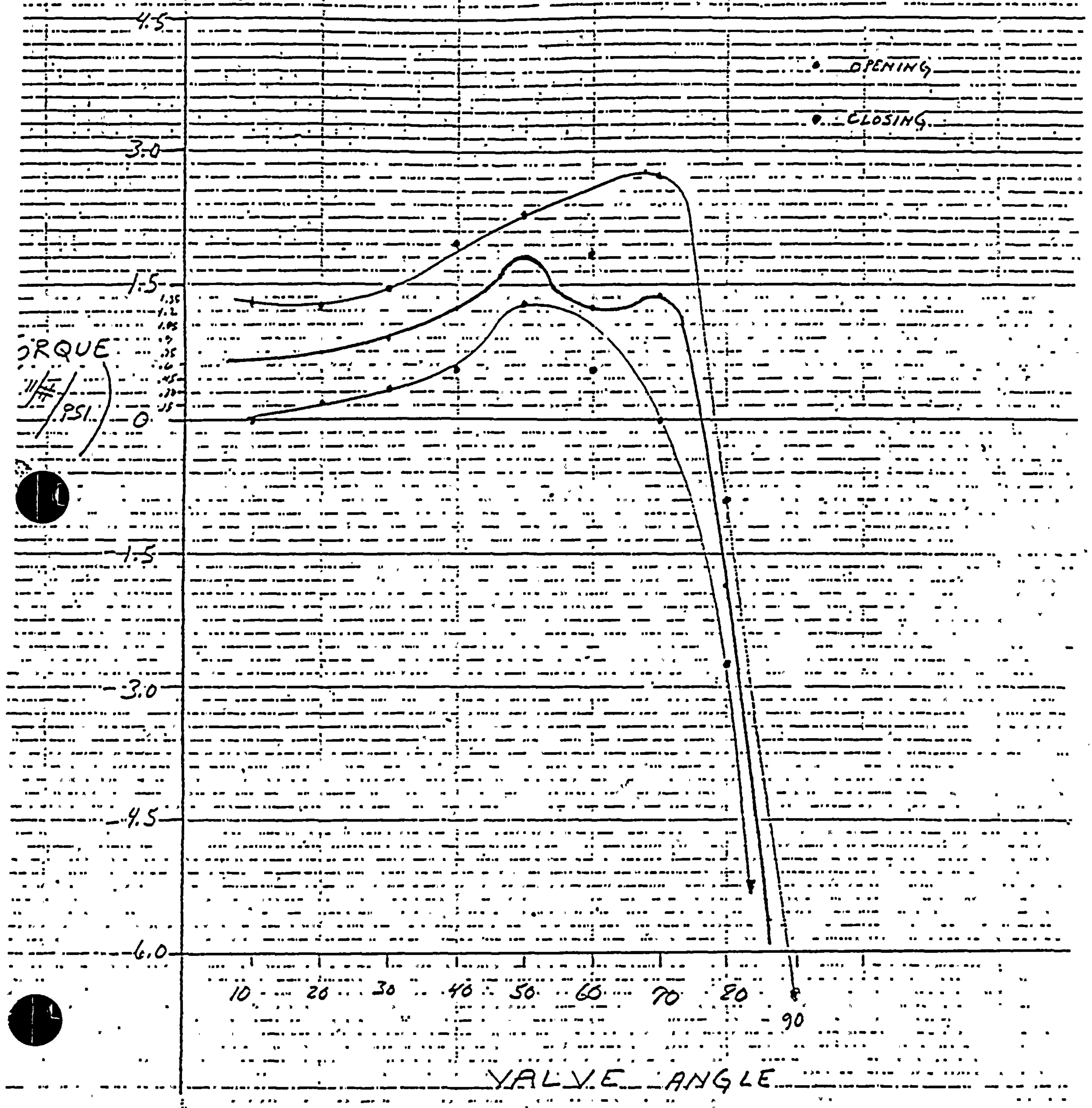


POSI-SEAL INTERNATIONAL, INC.

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): 37 °F

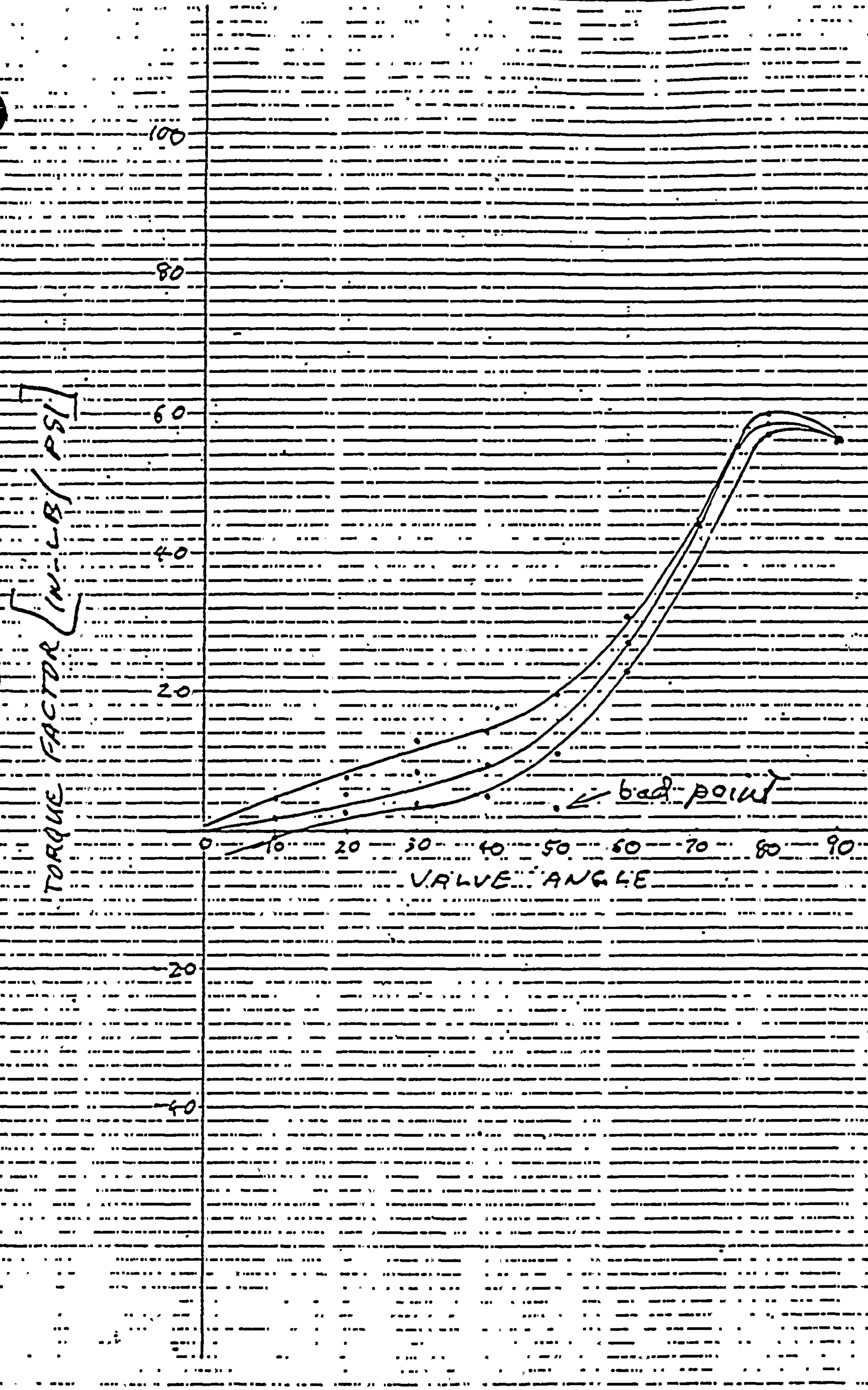
DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
~~OPENING~~ CLOSING	0					
	10	18.1	12		-80	-4.17
	20	18.6	14		0	0
	30	18.6	13.5 ~~17~~		~~55~~ 50	3.7
	40	18.1	13.8		70	5.07
	~~50~~ 45	18.7	15		100	6.67
	60	18.7	14		300	21.43
	70	18.5	12.5		500	40
	80	18.3	11.5		700	60.87
	90	18.4	11		600	54.55
OPENING ~~CLOSING~~	90	18.6	12.8		700	54.69
	80	18.4	12.5		750	60
	70	18.4	13 12.8		550 700	42.3
	60	18.4	13		440	33.85
	~~50~~ 45	19	15		300	20
	40	18.4	12.5		150	12
	30	18.4	14		125	8.93
	20	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

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 : Z

	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		1.9		150	
	30		6.2		80	
	40		7.8		110	
	50		8.2		160	19.5
	60		~~6.5~~ 23		~~206~~ 540	38.6 2
	70		8.75 15		~~500~~ 650	45.7 4
	80		8.5 11.2		530 650	62.3 5
	90		9.1 8.5		500 500	54.9 5
CLOSING	90		9.1 8.5		510 500	
	80		11.5 11		700 600	60.8 5
	70		16.7 16.2		730 750	43.7 4
	60		14.5	22.6	350 520	24.1
	50		14.5		150	3.4
	40		12.5		60	
	30		1.5		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. ØANSEN. DATE: 9/20/77 Checked By

VALVE SIZE: 6" 150/300

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTREAM

VALVE SEAL TYPE: TEF/BUNA TYPE 2

WATER TEMPERATURE (TANK): 63° °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	/PS
OPENING	0					
	10		44.5		+175	3.9
	20		30.0		+75	2.
	30		11		+75	6.
	40		11		+90	8.
	50		10.2		+45	4.
	60		9.7		+45	4.
	70		5.7		+15 2.6	75 C
	80		9.2		−275	−2
	90		8.4		−550	−6
CLOSING	90		8.5		−550	−64.
	80		9.0		−260	−2.8
	70		~~27.5~~		~~+200~~	0"F
	60		23.5		+200	8.
	50		22.5		+85	3.8
	40		18.5		−15	−.8
	30		19.0		−5	−.3
	20		31.5		−110	−3.
	10		28.5		−150	−5.
	0					

PACKING TORQUE: 10 IN-LB OPENING

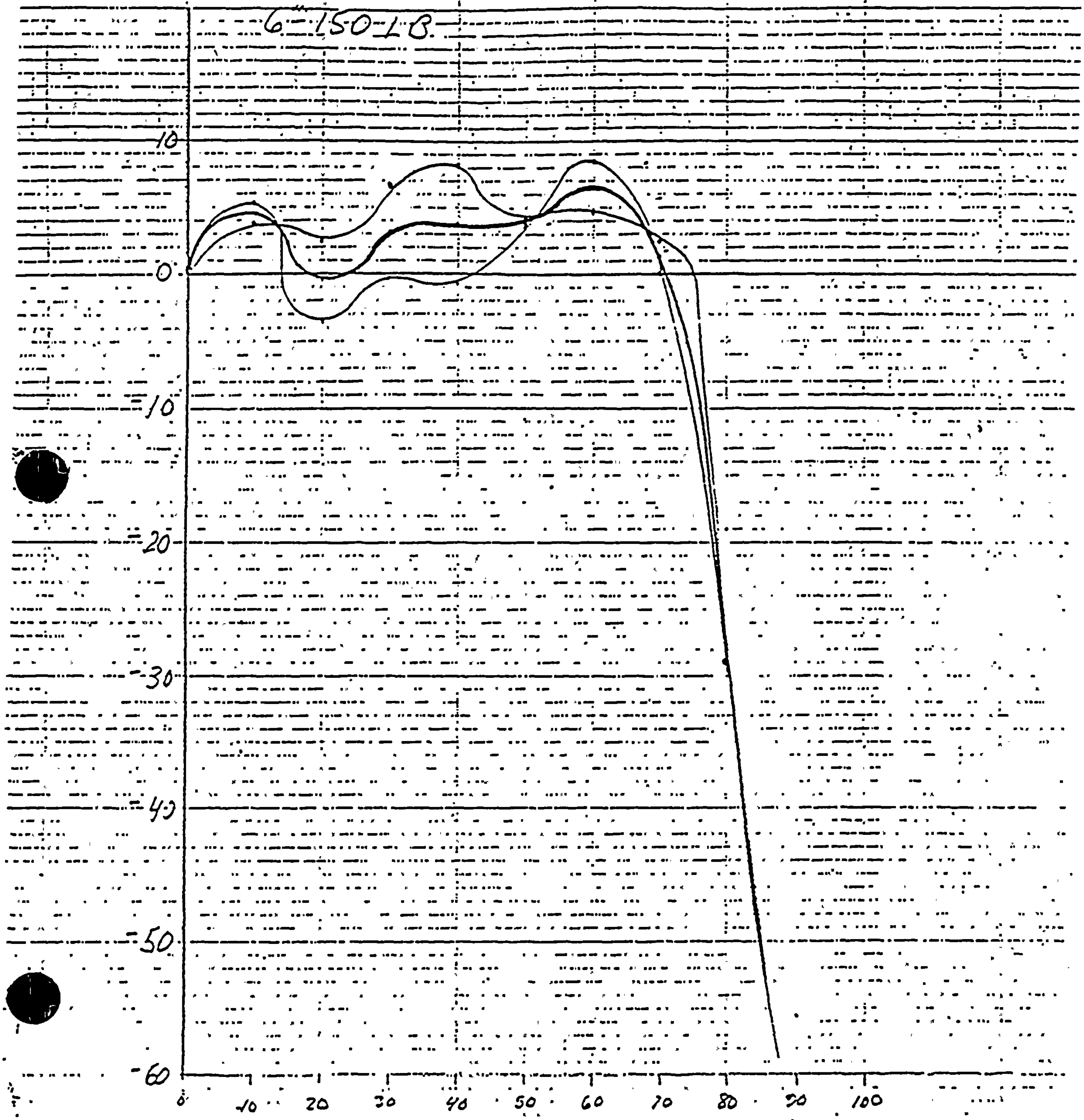
10 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI (STEM DOWN STM) Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

[illegible]e HYDRODYNAMIC TORQUE DETERMINATION Page 5

[illegible]c. 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		700	1.6
	20		56		425	7.6
	30		51.5		550	10.7
	40		43		725	16.8
	50		31		775	25
	60		18		740	41.[illegible]
	70		8.5		700	92
	80		4.5		650	144
	90		2.5		600	240
CLOSING	90		2.0		375	187
	80		3.0		400	13[illegible]
	70		6.0		500	83.[illegible]
	60		12.5		550	4[illegible]
	50		26.5		525	21.[illegible]
	40		38.5	37 400	400	10.[illegible]
	30		37.5	47 350	300	7.[illegible]
	20		41.5	54 400	300	7.[illegible]
	10		54.5		100	4.[illegible]
	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. Lirersi 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	
OPENING	0				900 ft-lb	
	10		58		350	6.0
	20		56		350	6.2
	30		54		375	7.
	40		40		415	10.
	50		28.5		450	15
	60		15		460	30
	70		7.5	ΔP @ 75° = 8.5	450	60
	80		5.3	T @ 75° = 600	410	77
	90		2.6	ΔP @ 85° = 4.5	450	17
				T @ 85° = 0		
CLOSING	90		3.0		550	18
	80		3.0	ΔP @ 85° = 2.5	0	0
	70		7.5	T @ 85° = -36	500	-66
	60		16	ΔP @ 75° = 5.5	550	-34
	50		28	T @ 75° = 375	400	14
	40		39.5		250	6.
	30		46		100	2
	20		54.5		0	0
	10		58		100	-1
	0				900 ft-lb	

PACKING TORQUE: 150 IN-LB OPENING

100 IN-LB CLOSING

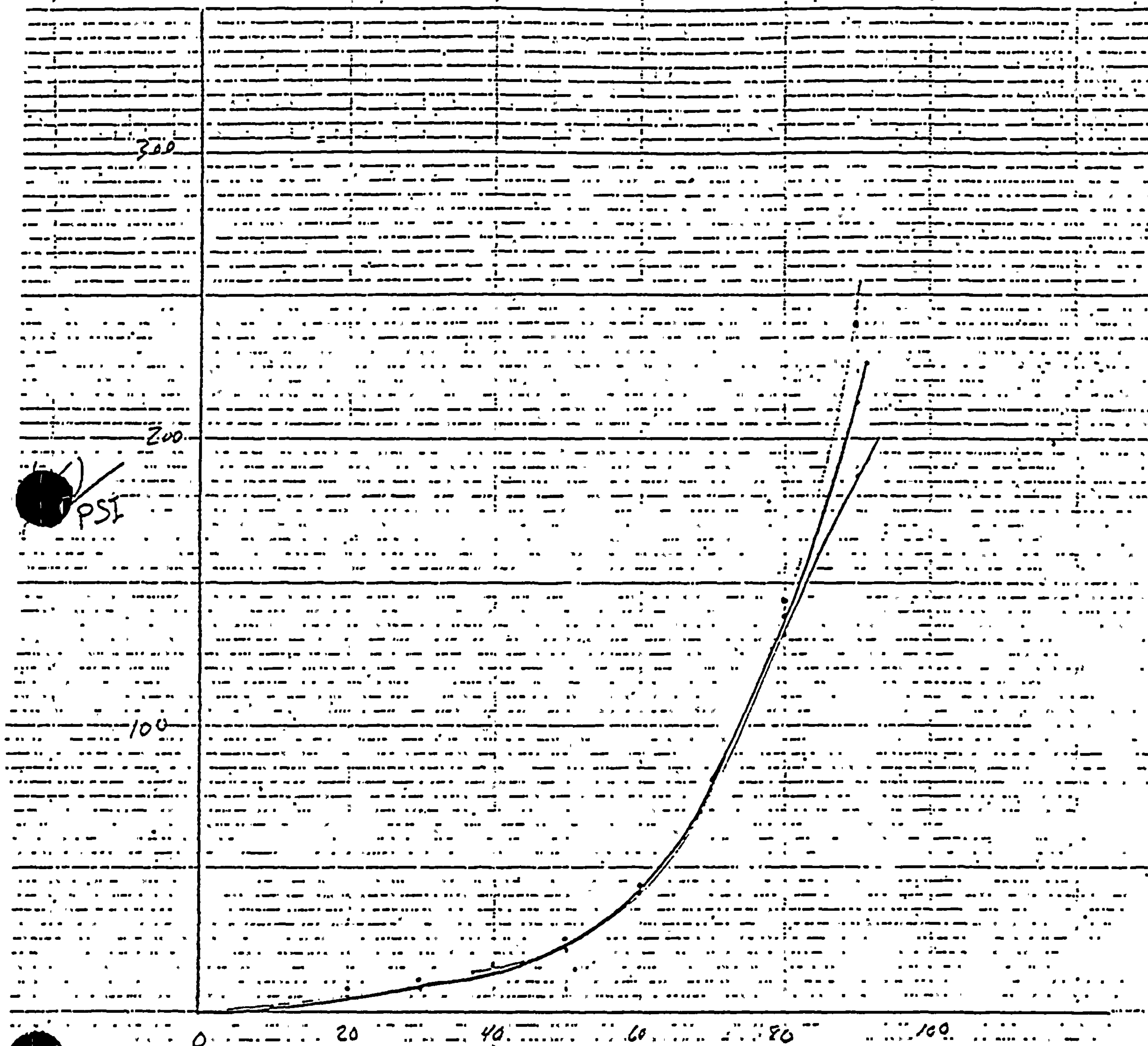
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" 150 LB

Title HYDRODYNAMIC TORQUE (PREFERED) Page

Calc. By C. LIVORSI Checked By



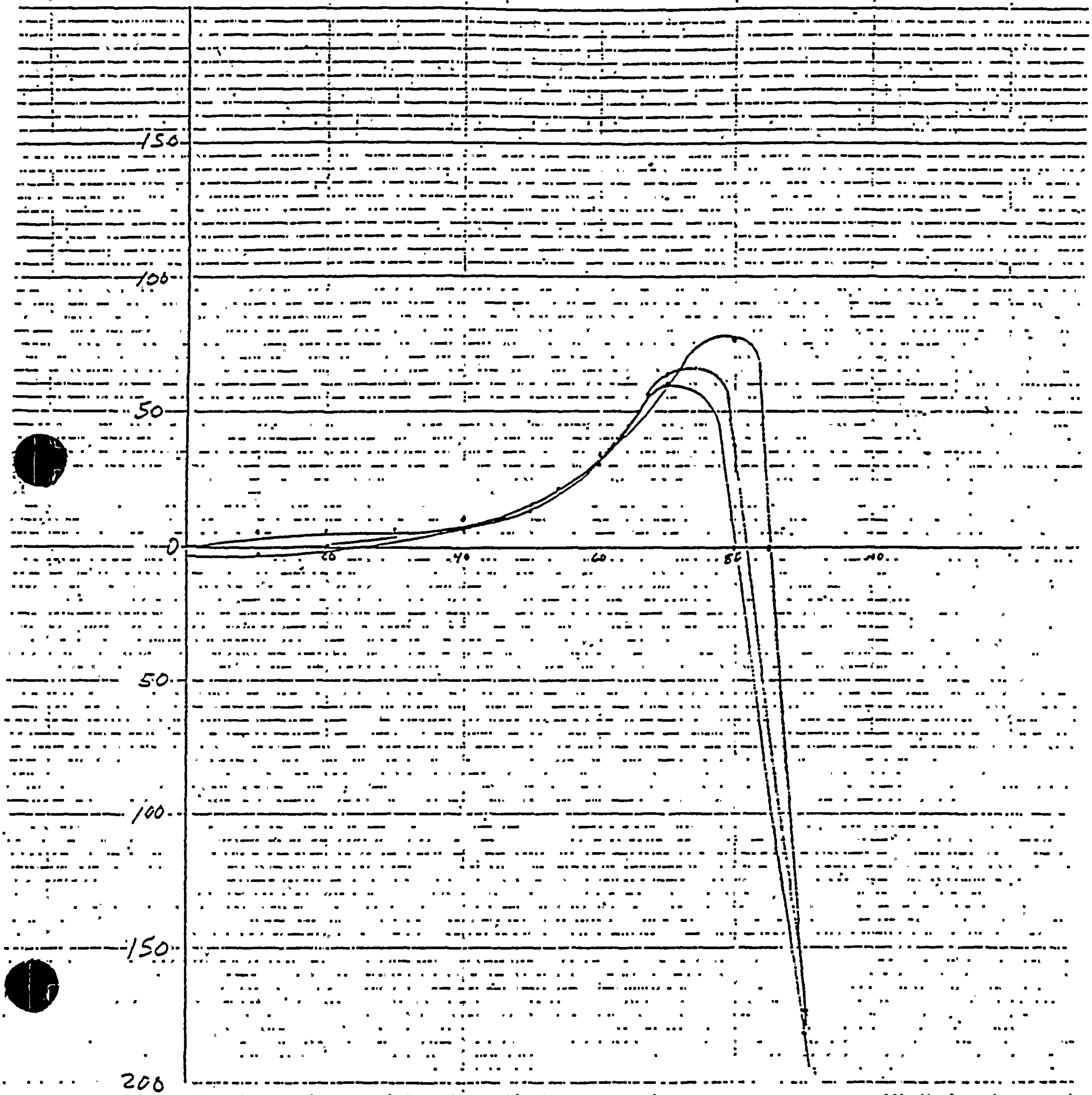
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8"-150

Title HYDRODYNAMIC TORQUE CURVE (UNPREFERED) Page

Calc. By C. LIVORSI 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 / 1200	
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	~~850~~ 900	60
60	18.5	6.3	3590	850	134.?
70	16.0	3.2	3590	800	250
80	15.0	2.2	3580	800	363.6
90	~~41~~	~~75 to 1~~	~~2685~~	~~600~~	[illegible]
	~~40~~	~~1.5~~	~~2623~~	390	[illegible]
CLOSING 90	40	1.5	2673	150	75
80	40	≈ 2.0	2863	250	125
70	41	3.0	2720	275	94.7
60	~~41~~	~~4.0~~	~~2620~~	~~300~~	75
50	42	7.0	2538	~~[illegible]~~ 350-400	57.7
40	45	17.0	2260	375	22
30	51	32.0	1800	325	10
20	~~[illegible]~~ 54	51	1195	0	
10	~~61~~	~~56~~	~~360~~	~~0~~	
0					

PACKING TORQUE: 50 IN-LB OPENING

50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION (#2) Page

Calc. By NC DATE: 6/17/77 Checked By

VALVE SIZE: 10" - 150

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWNSTREAM~~

VALVE SEAL TYPE: TEFLON / BUNA | DISC TYPE 2

WATER TEMPERATURE (TANK): 80 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	IN-#/ΔPSI
OPENING	0	36.8	16.5	218	329	
	10	~~44~~ [illegible]	~~[illegible]~~	~~2[illegible]~~	~~[illegible]~~	
	20	~~[illegible]~~ 5	10.5 ~~[illegible]~~ 5	~~1670~~ 578	~~600~~ 400	
	30	42.8 21.6	10.5 32	1035 1740	750 ~~425~~	23.4
	40	~~22.2~~	~~15~~	~~2217~~	~~400~~	26.7
	50	16.6	7.5	2727	450	60
	60	20.2	6.0	3587	750	125
	70	17.6	3.5	3599	700	200
	80	16.6	2.5 ~~2.0~~	3596	700	280
	90	~~16.0~~	~~1.75~~	~~3595~~	~~450~~	257
		↓	↓	↓		171.4
CLOSING	90	↓	↓	↓	300	
	80	16.3	2.0	3583	650	325
	70	17.3	3.0	3597	700	233
	60	~~19.8~~	~~6.0~~	~~3599~~	~~725~~	120.8
	50	25.5	~~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	772	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 Page #3

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	
OPENING	0	7.5/37.5				
	10	~~[illegible]~~ 45.7/46.3	33/23.5	300/252	850/750 ~~700~~	1100/1175
	20	17.5 45.2	17.5		700	40
	30	8.5			450	53
	40	17.5			700	51
	50	7.0			575	82
	60	5.0			675	135
	70	2.5			625	250
	80	2.0			725	365
	90	1.5			550	[illegible]
CLOSING	90		1.5		400	262
	80		2.0		575	255
	70		3.0		650	[illegible]
	60		6.0		600	[illegible]
	50		13.0		450	[illegible]
	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 Page #4

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	29
	30		43.5		1575	36
	40		28.5		1450	51
	50		13.5		1100	81
	60		6.25		925	[illegible]
	70		3.0		825	275
	80		2.25		800	[illegible]
	90		2.0		550	[illegible]
CLOSING	90		1.75		375	214
	80		2.25		600	267
	70		3.5		625	[illegible]
	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 [signature] 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=
	70		3.5		550 157	75° 2
	80		1.7		−175	−103
	90		1.7		−625	−363
CLOSING	90		1.8		−700	−389
	80		1.8		− 50	−25
	70		3.0		+200	67
	60		6.5		+450	69
	50		13.5		+275	20
	40		~~15.8~~ 8.5		−75	−9
	30		16.5/19/30.5		−50 / −50 / −275	5-3
	20		17.5		−325	−19
	10		18.5		−350	−19
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 6/21/77 Checked By

Full open - Control Valve

VALVE SIZE: 10"-150

VALVE DIRECTION: ~~[illegible]~~ UPSTREAM / STEM DOWNSTREAM

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 80 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		57.5		+1050
	20		47.7		+850
	30		39.5		+750
	40		26.5		+800
	50		14.5		+925
	60		7.0		+800
	70				
	80				
	90				
CLOSING	90				
	80				
	70				
	60		6.5		+350
	50		13.5		+200
	40		25		0
	30		39.5		−450
	20		51.0		−700
	10		58.5		−800
	0				

PACKING TORQUE: 50 IN-LB OPENING

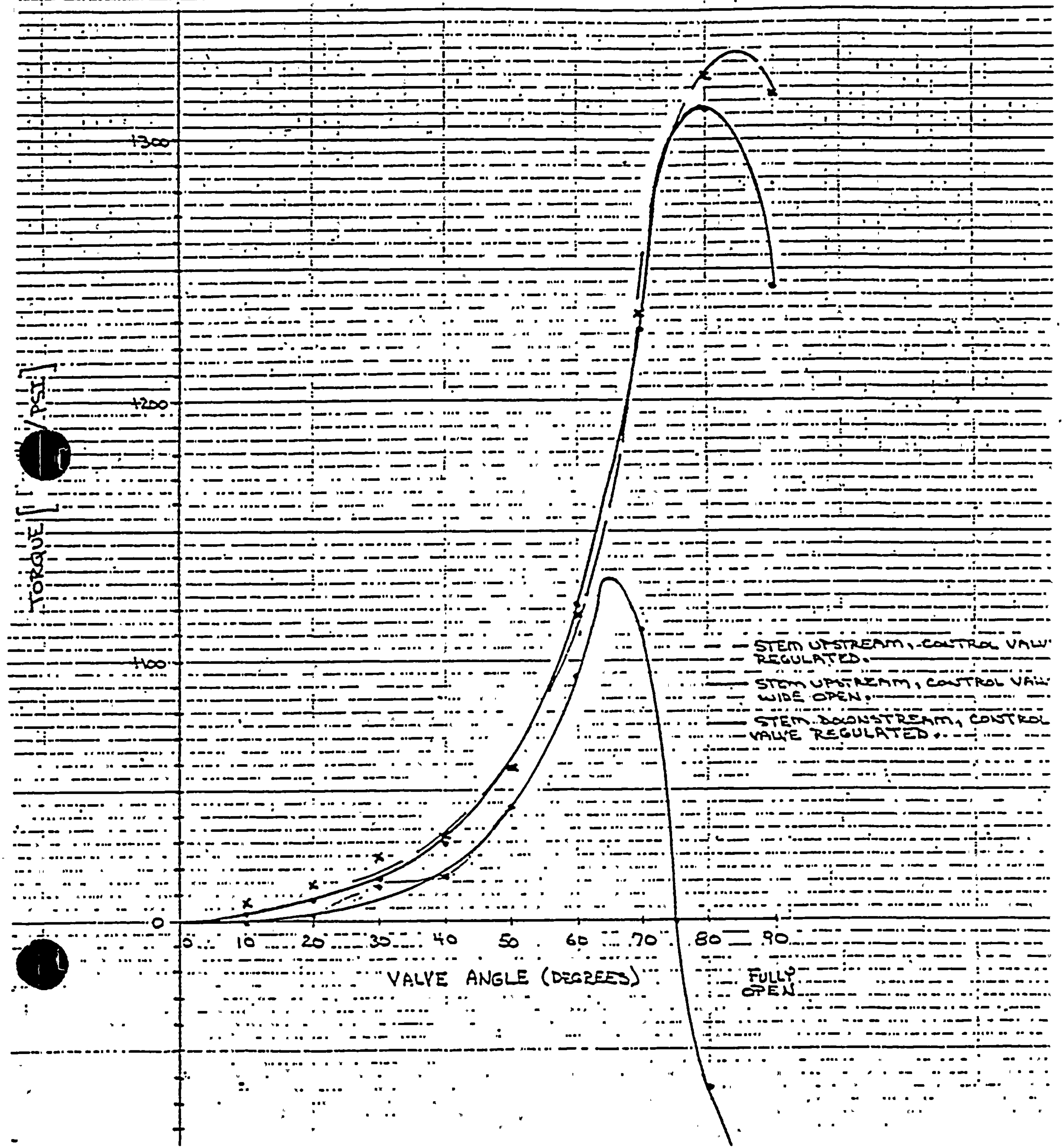
: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: TORQUE VS. VALVE ANGLE 10"-150 Page

Calc. By: R. HANSEN 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	750	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. 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	6.2 55	1800 1000		
	10	41.5	950	23	
	20	25	900	36	
	30	12	550	46	
	40	2.5	350	140	
	50	3	400	133	
	60	3.5	650	186	
	70	1.8	600	333	
	80	1.2	600	500	
	90	.9	300	333	
CLOSING	90	.9	0	0	
	80	1	350	350	
	70	1.4	500	357	
	60	2.7	500	185	
	50	7.4	550	74	
	40	16.5	550	33	
	30	18.5	350	19	
	20	30.6	450	15	
	10	24.5	50	2	
	0	62	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	4000		
	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	100	125	
	70	1.6	200	725	
	60	4.0	300	75	
	50	9.5	10.0	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

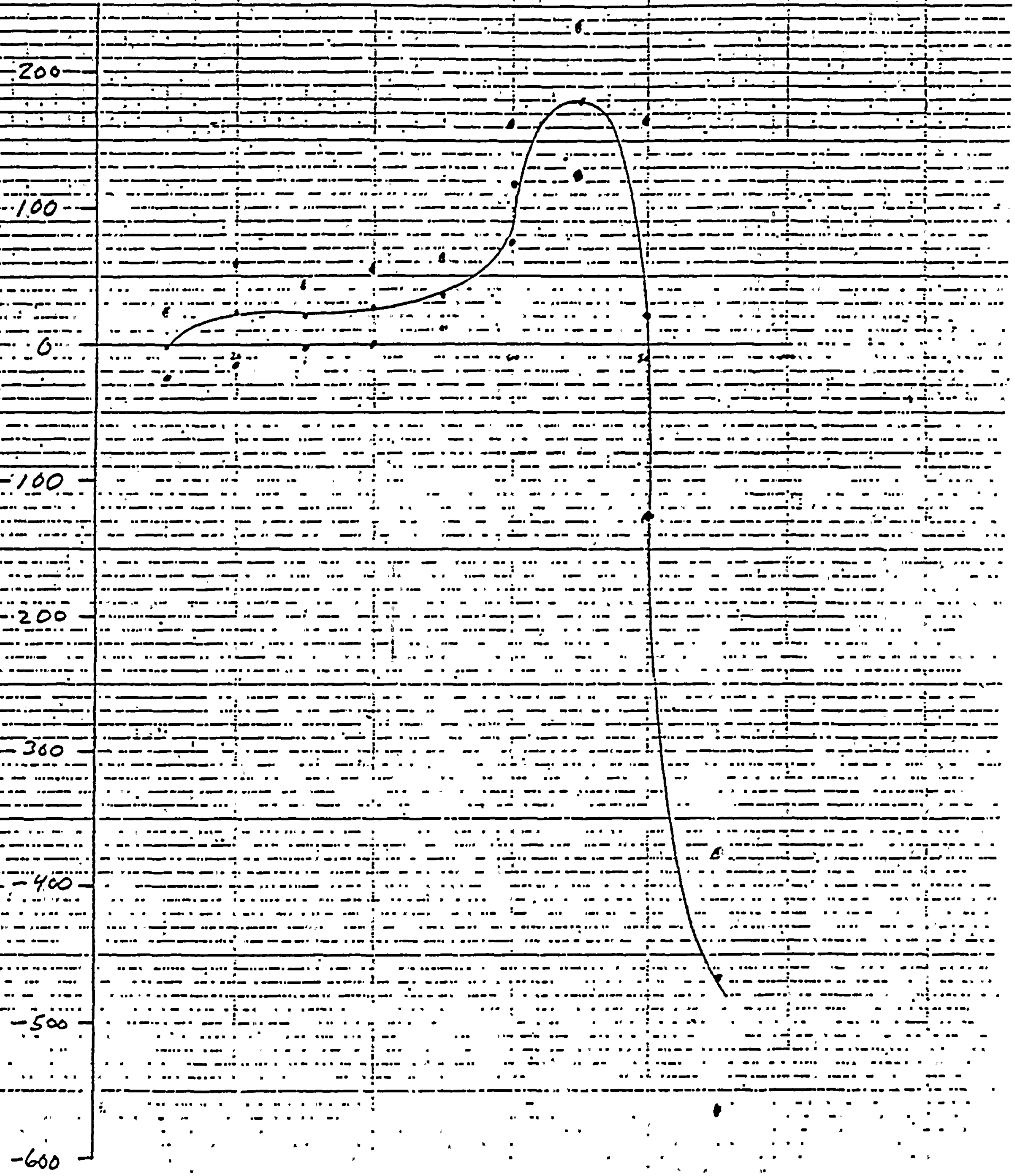
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE 12" 150 Page

Calc. By C. LIVORSI Checked By

STEM DOWNSTREAM

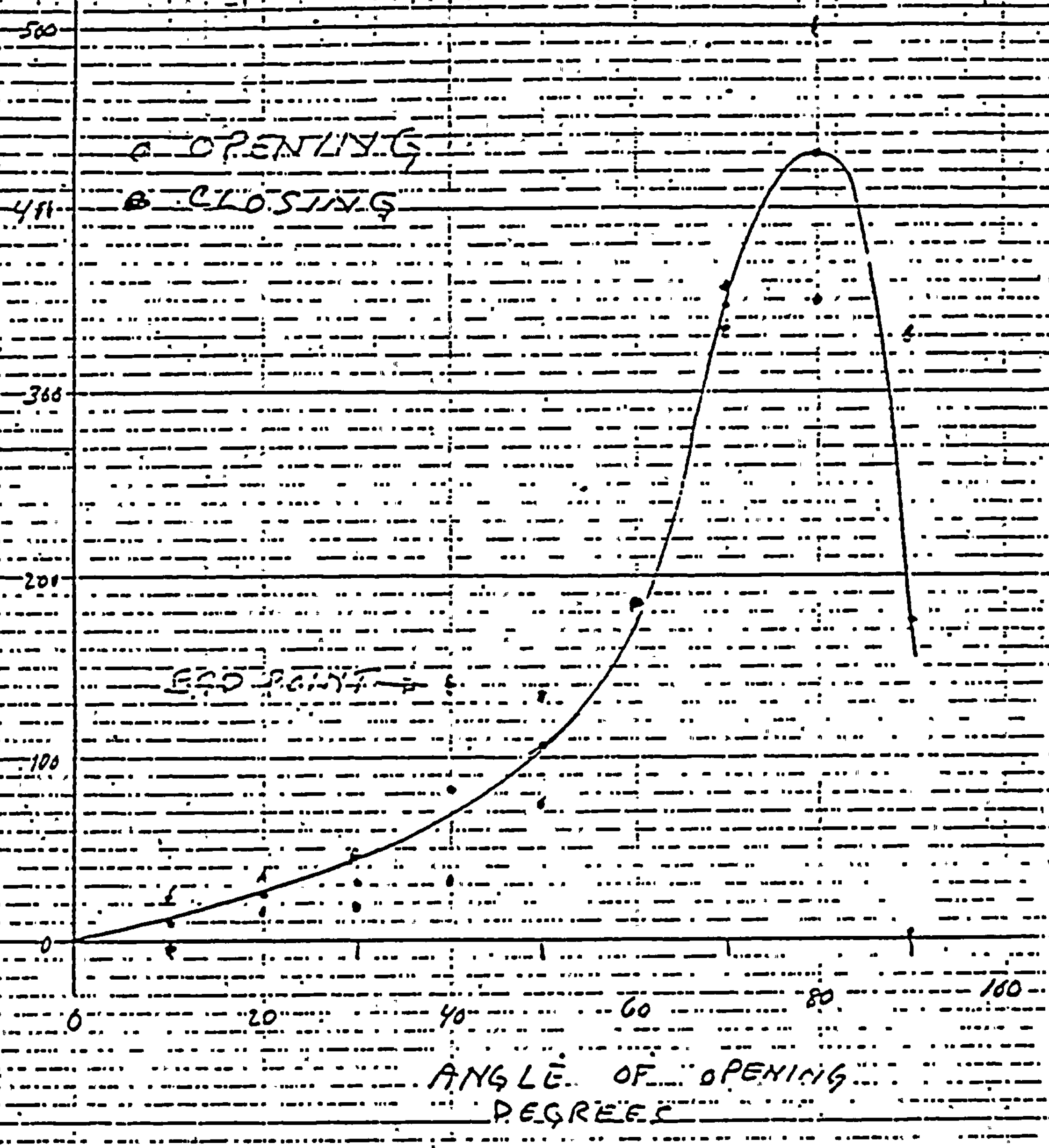


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12-150 STEM UP STREAM HYDRO DYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI Checked By

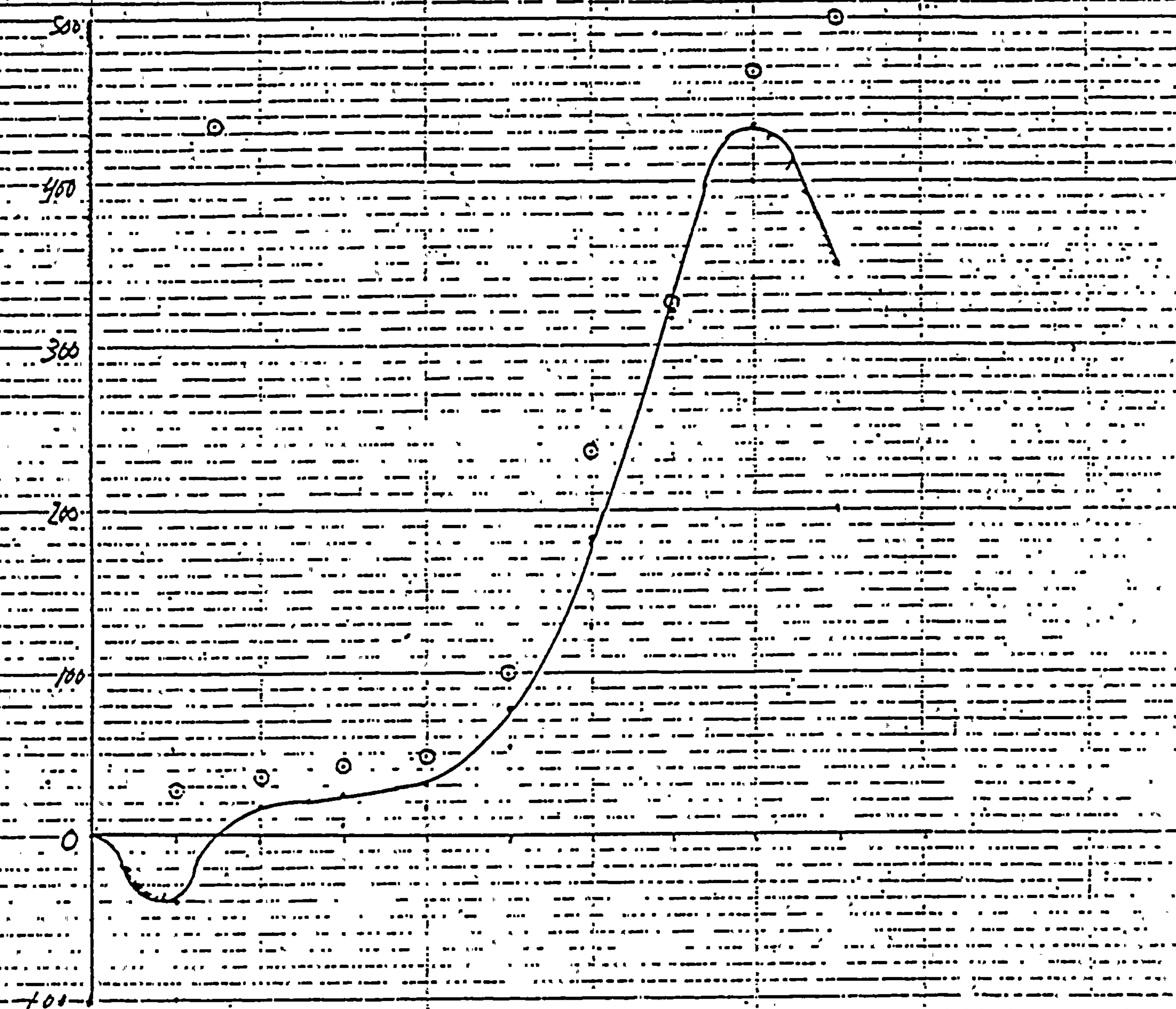


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 (PREFERED) HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. Livorsi Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

e HYDRODYNAMIC TORQUE DETERMINATION Page

lc. By DATE: Checked By

VALVE SIZE: 14" – 150

VALVE DIRECTION: STEM UPSTREAM ☐ / STEM DOWNSTREA[M] ☒

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	21.5 475	22
	20	41	700	17	7 400	57
	30	26.5	900	34	20.5 800	39
	40	16	750	47		
	50	7.2	750	104		
	60	3	700	233		
	70	1.5	600	400		
	80	1	300	300		
	90	.6	-275	-458		
CLOSING	90	.6	-275	-458		
	80	.7	-50	-71		
	70	1.3	300	231		
	60	3	500	167		
	50	7.2	450	62.5		
	40	15.6	200	13		
	30	26.6	150	6		
	20	23.6	400	17		
	10	42.5	-300	-7 ↔ 9	22 -200	
	0					

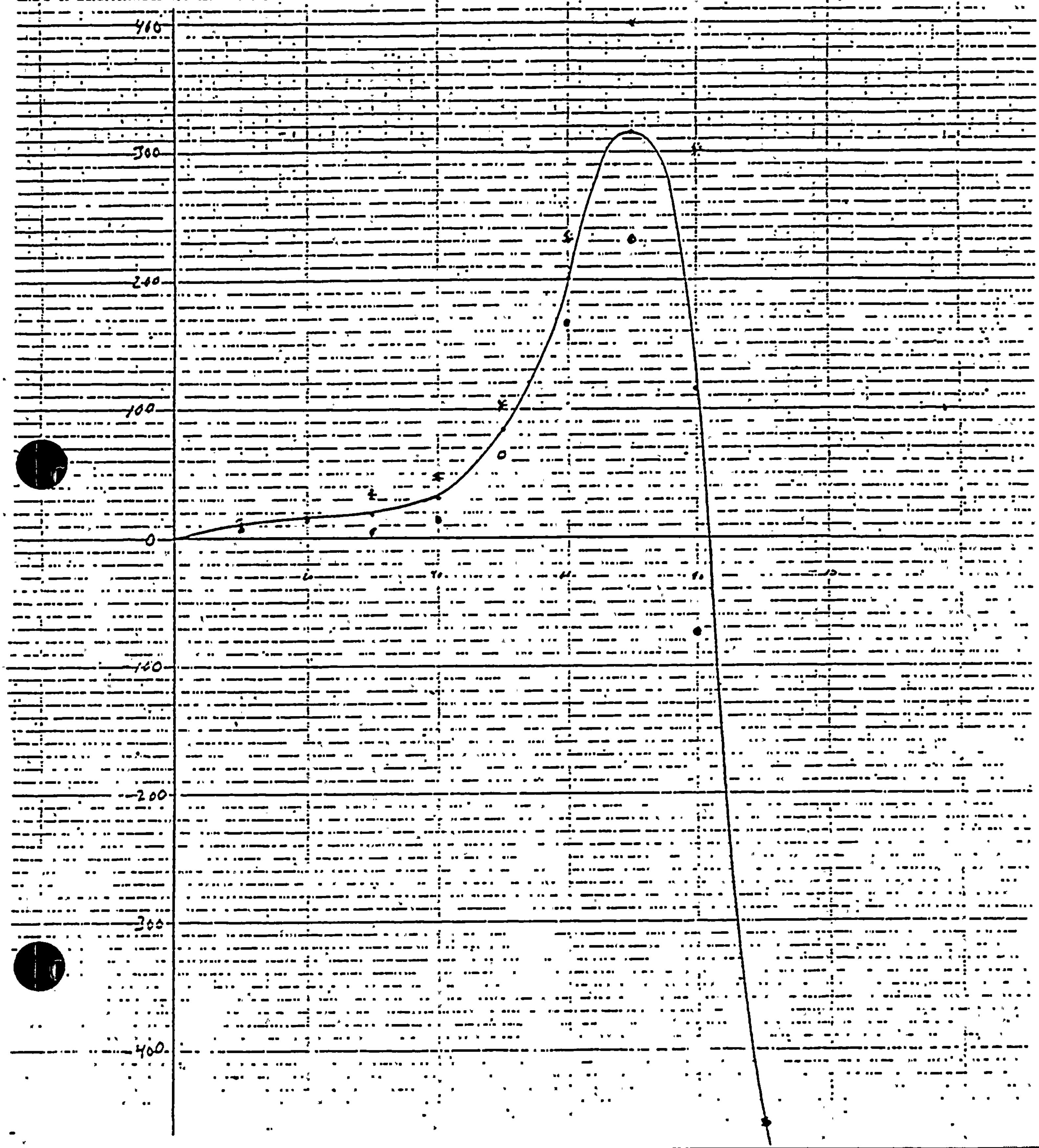
PACKING TORQUE: 5 FT-LB ~~IN-LB~~ OPENING

: 5 FT-LB ~~IN-LB~~ CLOSING

POSI-SEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title 14" 150 STEM DOWN STREAM Page

Calc. By C. LIVORSI Checked By



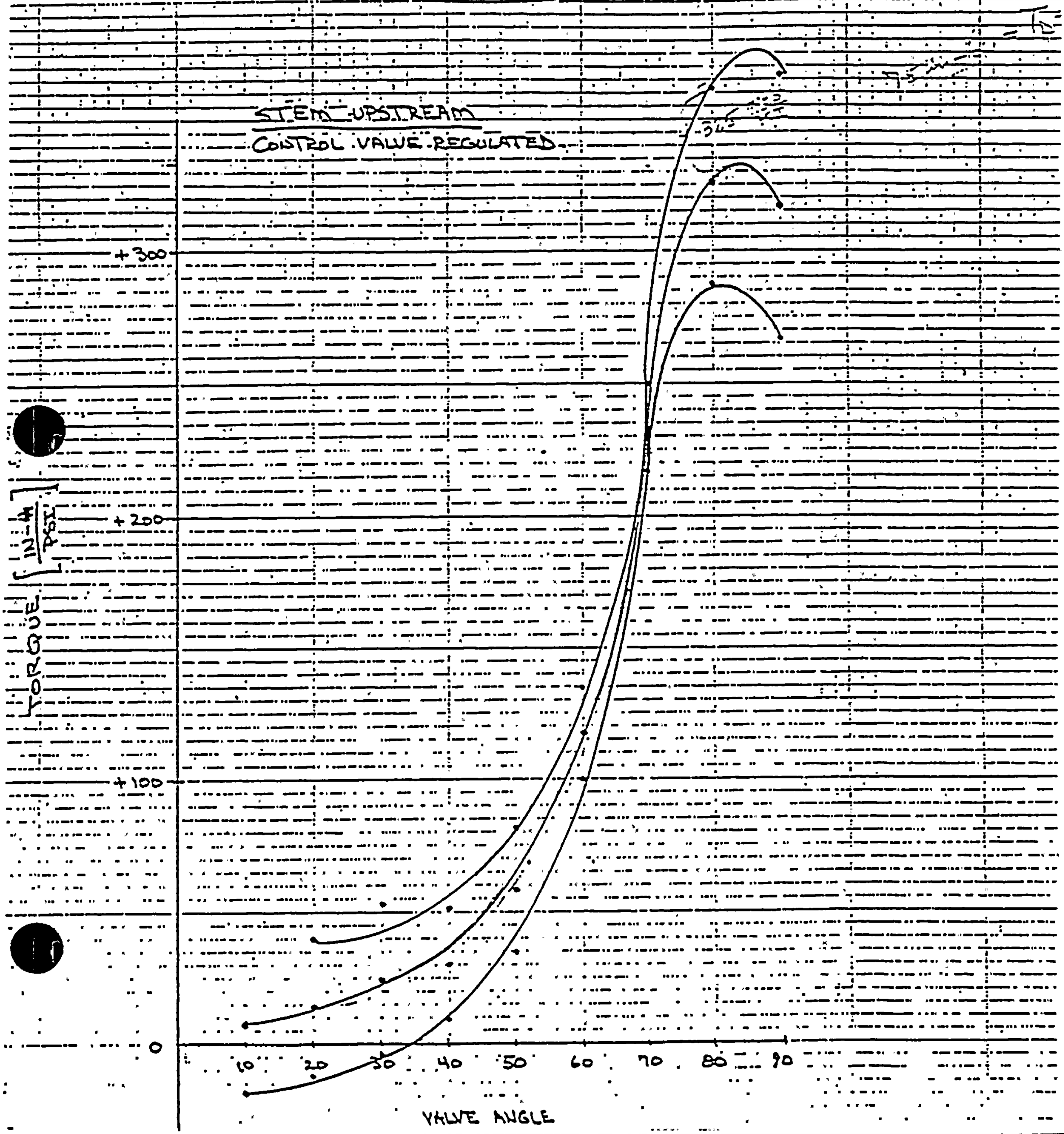
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: TORQUE VS. VALVE ANGLE Page

Calc. By: R. HANSEN Checked By:

10" - 150

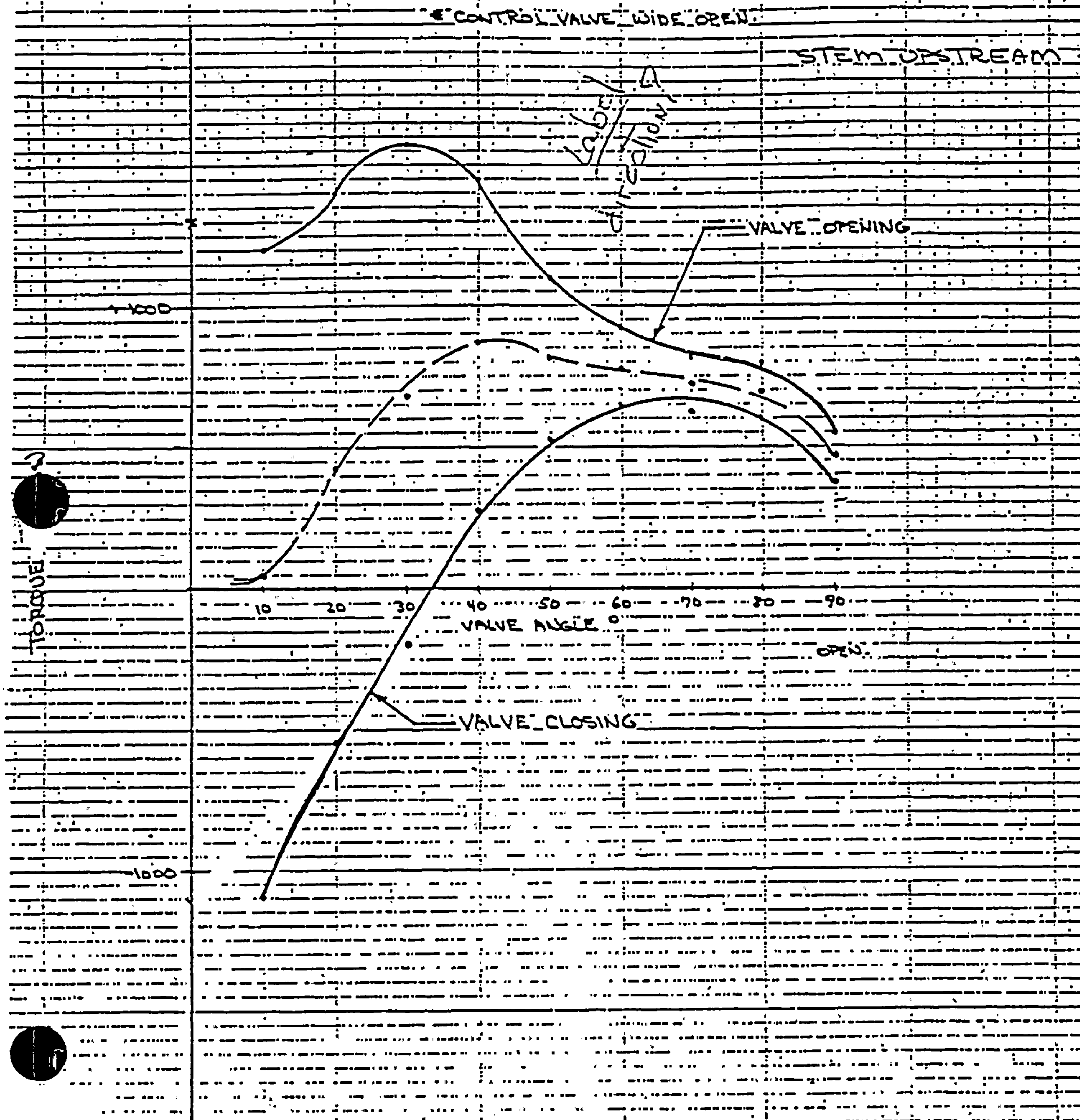


POSI-SEAL INTERNATIONAL, INC.

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

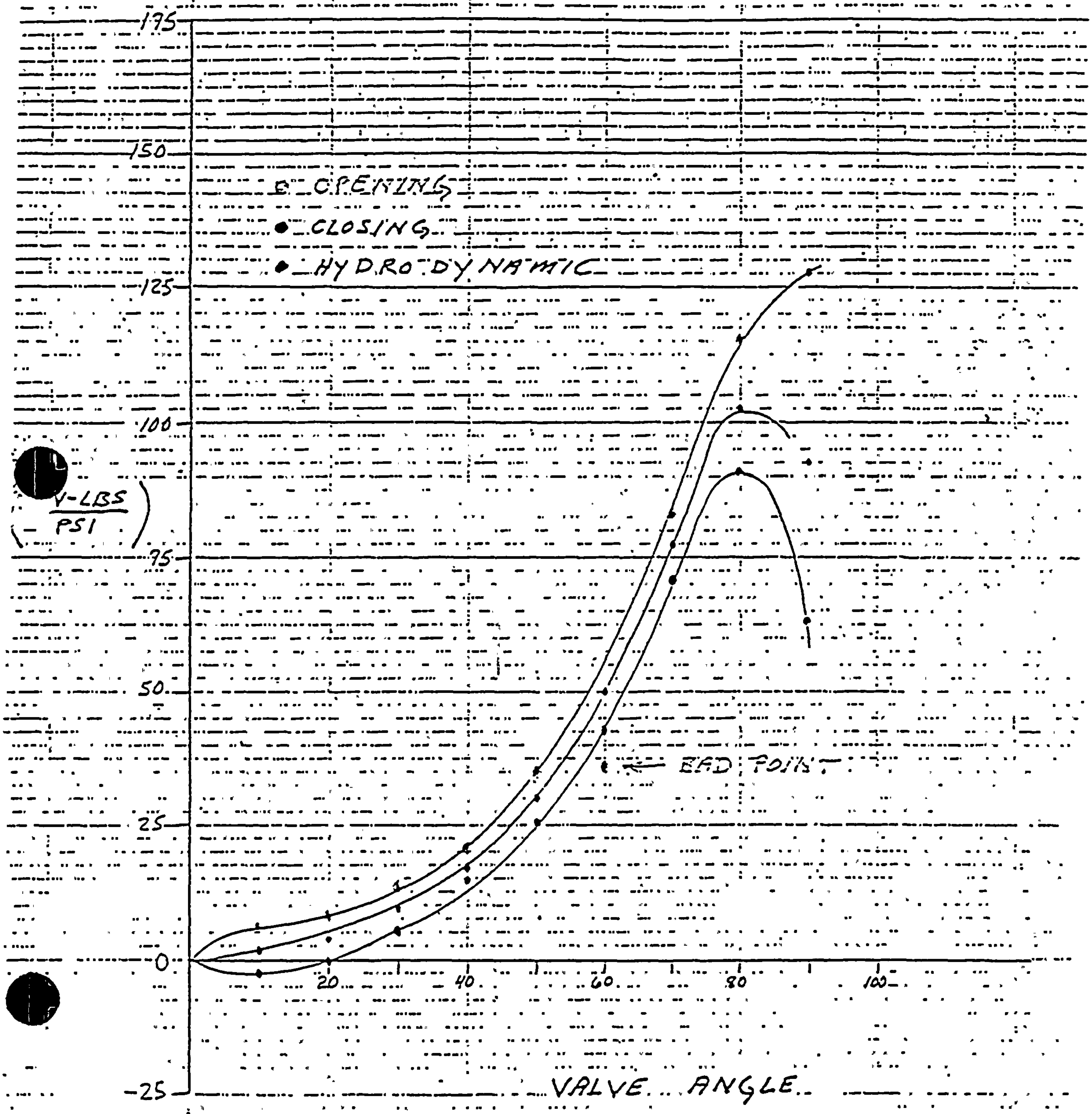
: 200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8" 300 LB HYDRO DYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI Checked By

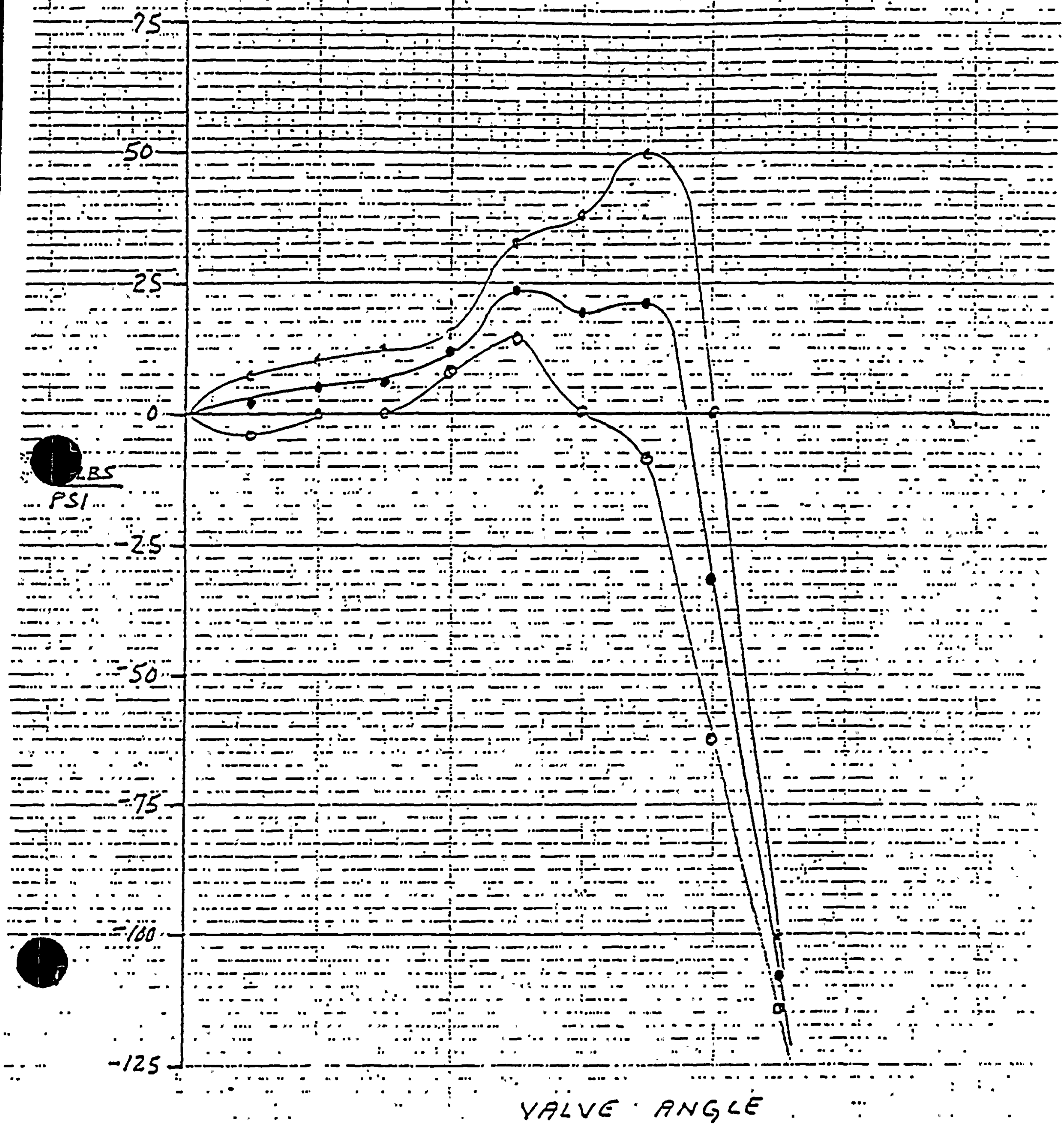


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" 300 HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORST (UNPREFERED) Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ØANSEN DATE: 8/1/77 Checked By

VALVE SIZE: 10" 300

VALVE DIRECTION: ~~STEM UPSTREAM~~/STEM DOWNST

VALVE SEAL TYPE: TEFLON/BUNA

WATER TEMPERATURE (TANK): 83 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0	X	X		
	10		58.5		+700
	20		47.5		+450
	30		37.5		+300
	40		25		+600
	50		14		725
	60		7.5		575
	70		4.5		200
	80		2.5		-250
	90		3		-500
CLOSING	90		3		-825
	80		3		-575
	70		4.5		-275
	60		7		0
	50		12		+175
	40		23		50
	30		37.5		-300
	20		51		-300
	10		57.5		-600
	0		X		

PACKING TORQUE: 175 IN-LB OPENING

250 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By QANSEN DATE: 7/20/77 Checked By

VALVE SIZE: 10" 300

VALVE DIRECTION: STEM UPSTREAM / STEM DN.

VALVE SEAL TYPE: TEFLON / BODA

WATER TEMPERATURE (TANK): 87 °F

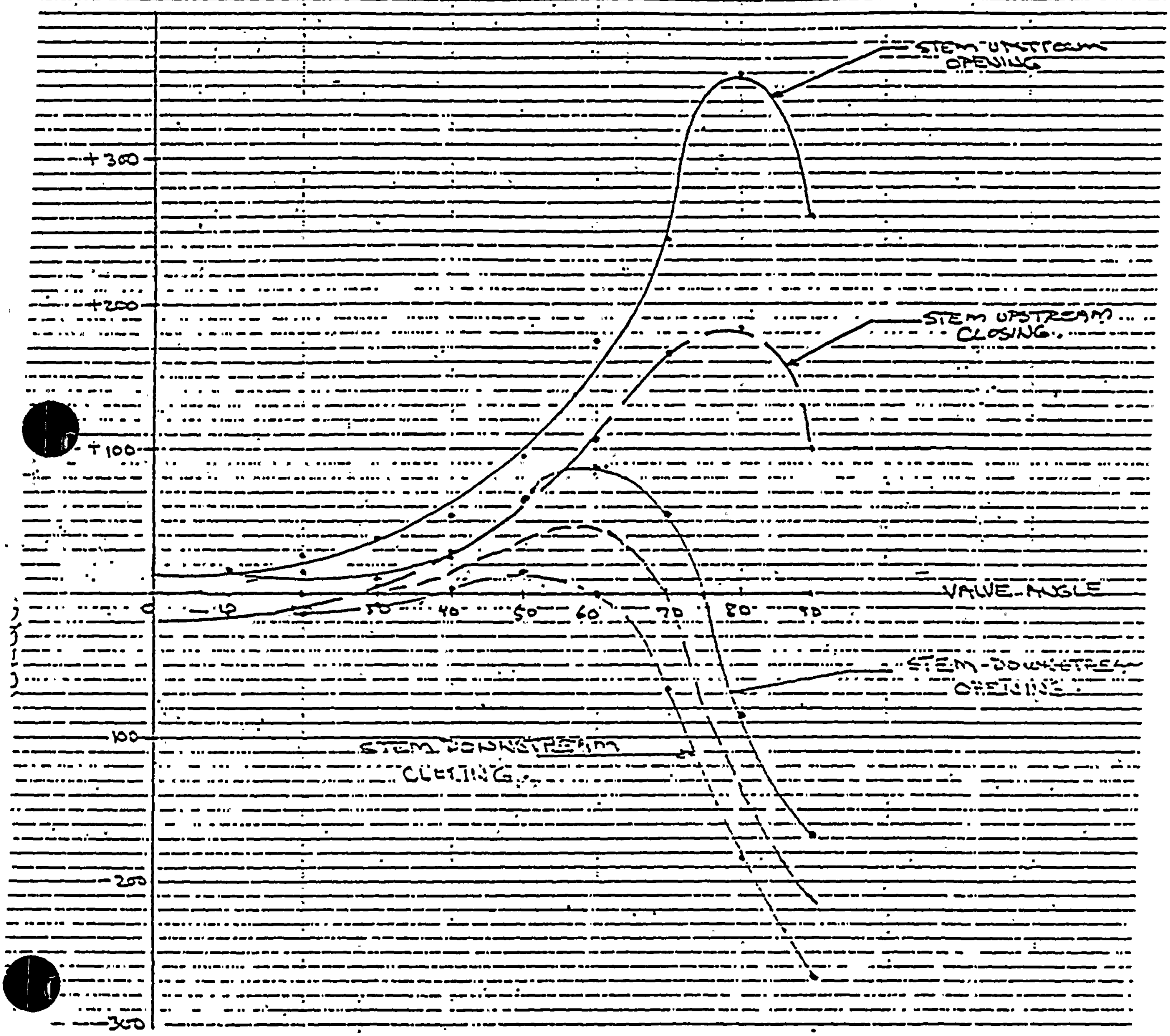
DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
	0				
	10		36		600
	20		26		700
OPENING	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		4
	90		2.5		250
	80		3		550
	70		4.5		750
	60		7.5		800
	50		12		750
CLOSING	40		26		650
	30		12.5		75
	20		26		0
	10		55 20		450 300
	0				

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 OANSEN DATE: 3/21/77 Checked By:

VALVE SIZE: 3" - 600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTR

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		47.5		−5
	20		46.5		−10
	10		47.5		−125
	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: 12/21/77 Checked By:

VALVE SIZE: 3" - 600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNST[...]

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 68 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		54		+75
	20		52		+60
	30		43.5		+75
	40		40.5		+75
	50		43.5		+115
	60		37.5		+120
	70		31.5		+145
	80		26		+160
	90		23		+145
CLOSING	90		23		+140
	80		26.5		+125
	70		31		+115
	60		36		+100
	50		43.5		+75
	40		38.5		+45
	30		41.5		0
	20		43		0
	10		44		−55
	0				

PACKING TORQUE: 10 IN-LB OPENING

5 IN-LB CLOSING

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 DOWNS~~

VALVE SEAL TYPE: TEFLON / EPR

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		49		+275
	20		35		+275
	30		34		+250
	40		23.5		+175
	50		26.5		+175
	60		26		+250
	70		22		+275
	80		17		+250
	90		16.5		+150
CLOSING	90		16.5		+75
	80		17		+150
	70		21.5		+125
	60		27.5		+50
	50		35.5		−10
	40		25		−50
	30		39		−100
	20		48 28		−250 −200
	10		26.5		−200
	0				

PACKING TORQUE: 15 IN-LB OPENING

: 5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

HYDRODYNAMIC TORQUE DETERMINATION Page

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		22.5		−25
	80		19		−75
	90		17.5		−125
			X		X
CLOSING	90		17.5		−150
	80		18.5		−100
	70		23.5		−50
	60		30.5		−25
	50		39.5		−25
	40		47		0
	30		50		−25
	20		49.5		−75
	10		50		−150
	0		X		X

PACKING TORQUE: 250 IN-LB OPENING

: 250 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 8/17/77 Checked By

VALVE SIZE: 6"-600

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOWNSTR

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.
	20		33		+150	+4.
	30		27.5		+250	+8.
	40		25		+400	+16
	50		19.5		+450	+23
	60		20.5		+450 +4.95	
	70		15		+250 +4667	0
	80		10.5/18.5		Ø 250	−1
	90		15.5		650	
			~~X~~		~~X~~	
CLOSING	90		15.5		800	−5
	80		19.0		525	−2
	70		18.5		200	−1(
	60		26		+50	+1.
	50		28		+50	+1.
	40		33		0	C
	30		34		275	−8.
	20		32.5		350	−1C
	10		39		350	−9
	0	Ø	~~X~~	Ø	~~X~~	

PACKING TORQUE: 175 IN-LB OPENING

: 225 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 8/19/77 Checked By

VALVE SIZE: 6-600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTREAM

VALVE SEAL TYPE: ~~TEFLON~~ / BUNA

WATER TEMPERATURE (TANK): 85 °F

DISC TYPE & DWG: RS

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB		
OPENING	0						
	10		30.5	59.5	+200	6.6	+3
	20		33	58.5	+300	9.1	+
	30		24	55.5	+300	12.5	+
	40		25	47.5	+300	12	
	50		26.5	44.5	+400	15.1	+625
	60		20	32.5	+450	22.5	+900
	70		19.6	27.5	+650	33.3	+
	80		19.2	19.0	+1025	53.4	+
	90		14.8	14.8	+750	(50.7)	
CLOSING	90		14.8	14.8	+650	(43.9)	+
	80		19.3	18.8	+750	38.9	+
	70		24.2	24.4	+825	34.1	
	60		20.5	31.5	+225	11	
	50		24.5	43.5	+100	4.1	
	40		34.5	50.5	+25	.7	
	30		34.5	55.5	−50	1.4	
	20		38.5	58	−75	1.9	
	10		34.0	66.5	−275	8.1	
	0						

PACKING TORQUE: 175 IN-LB OPENING

225 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

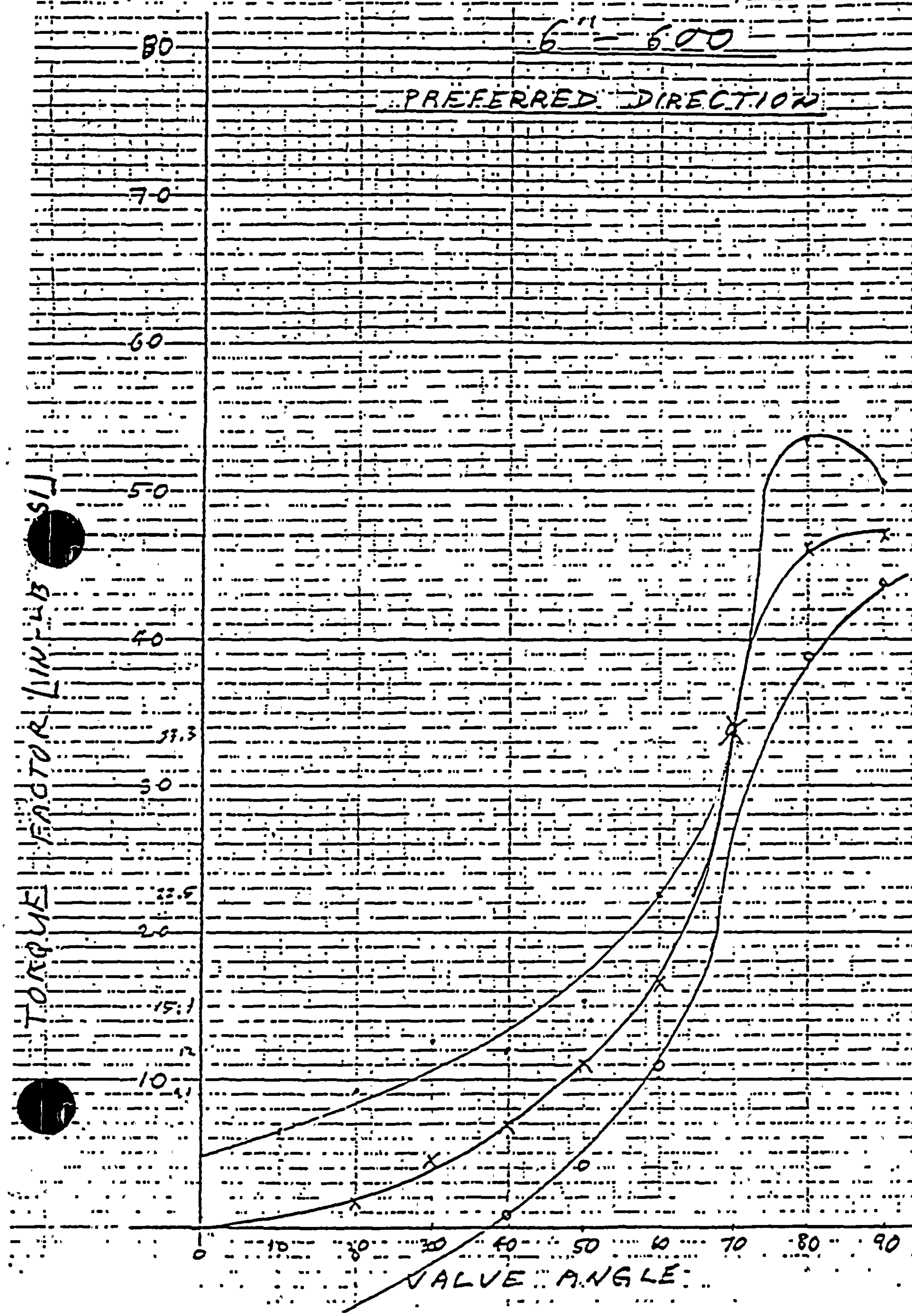
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

Calc. By J. CORY 8/23/77 Checked By

6" - 600

PREFERRED DIRECTION



ANGLE	FACT
0	0
10	8
20	2.0
30	4.0
40	7.0
50	11.0
60	17.0
70	34.0
80	46.0
90	47.0

POSI-SEAL INTERNATIONAL, INC.

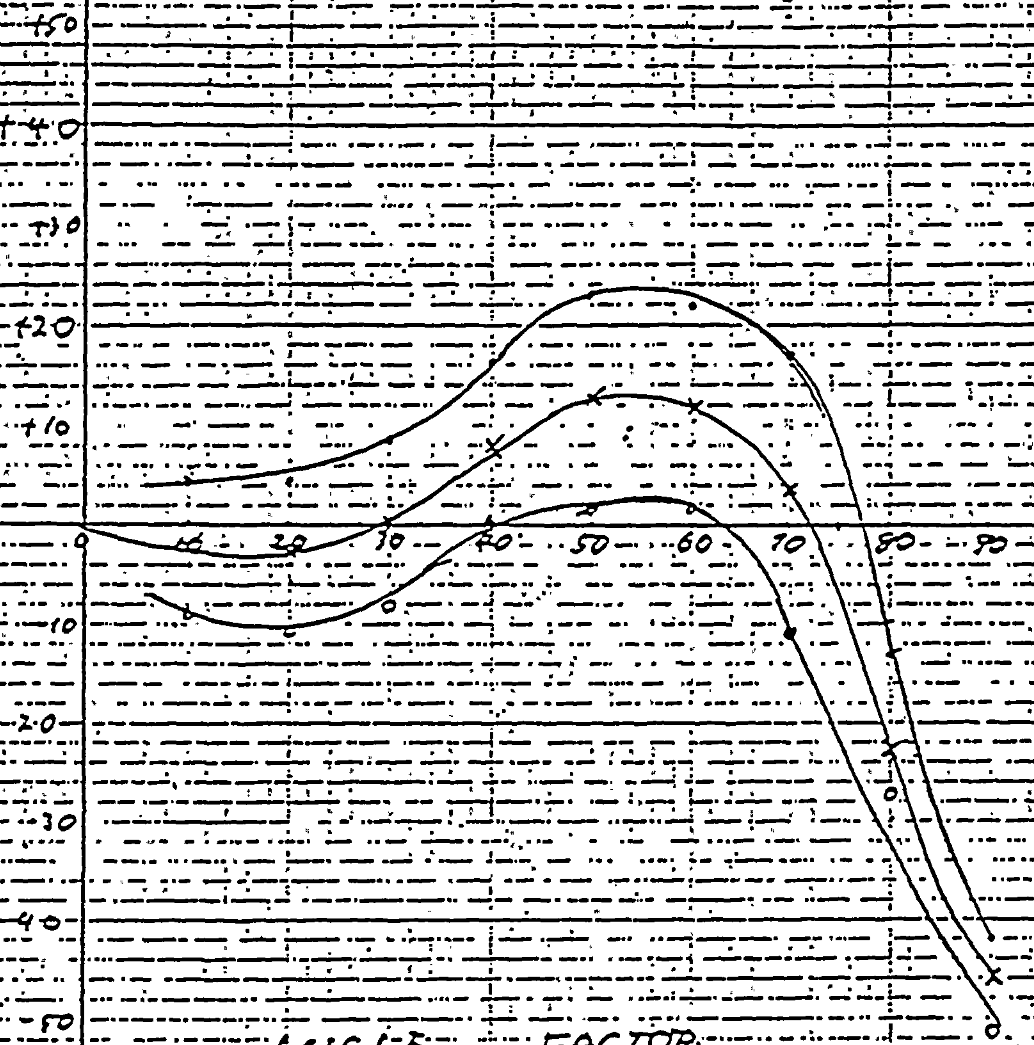
ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

Calc. By J CORY 8/23/72 Checked By

6" - 600

NON PREFERRED DIRECTION



ANGLE	FACTOR
0	0
10	-3
20	-3
30	0
40	7
50	12
60	12
70	4
80	-22

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By: C. Livorsi DATE: Checked By:

VALVE SIZE: 8" 600#

VALVE DIRECTION: STEM UPSTREAM / STEM DOWN ☒

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	35.4	
	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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By C. LIVOCSI DATE: Checked By

VALVE SIZE: 8" 600

VALVE DIRECTION: STEM UPSTREAM ☒ / STEM DOWN ☐

VALVE SEAL TYPE: URATHANE

WATER TEMPERATURE (TANK): 71 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	67	7800		
	10	50.5	400	7.9	
	20	16	300	18.8	
	30	5	250	50	
	~~40~~	~~10~~	~~400~~	~~40~~	
	50	9	600	66.7	
	60	6.0	500	83.3	
	70	4.2	600	142.8	
	80	3.0	400	133.3	
	90	4.6	300	65.2	
CLOSING	90	5.0	0	0	
	80	4.0	200	50	
	70	5.5	325	59.1	
	~~60~~	~~8.0~~	~~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

: 100 IN-LB CLOSING

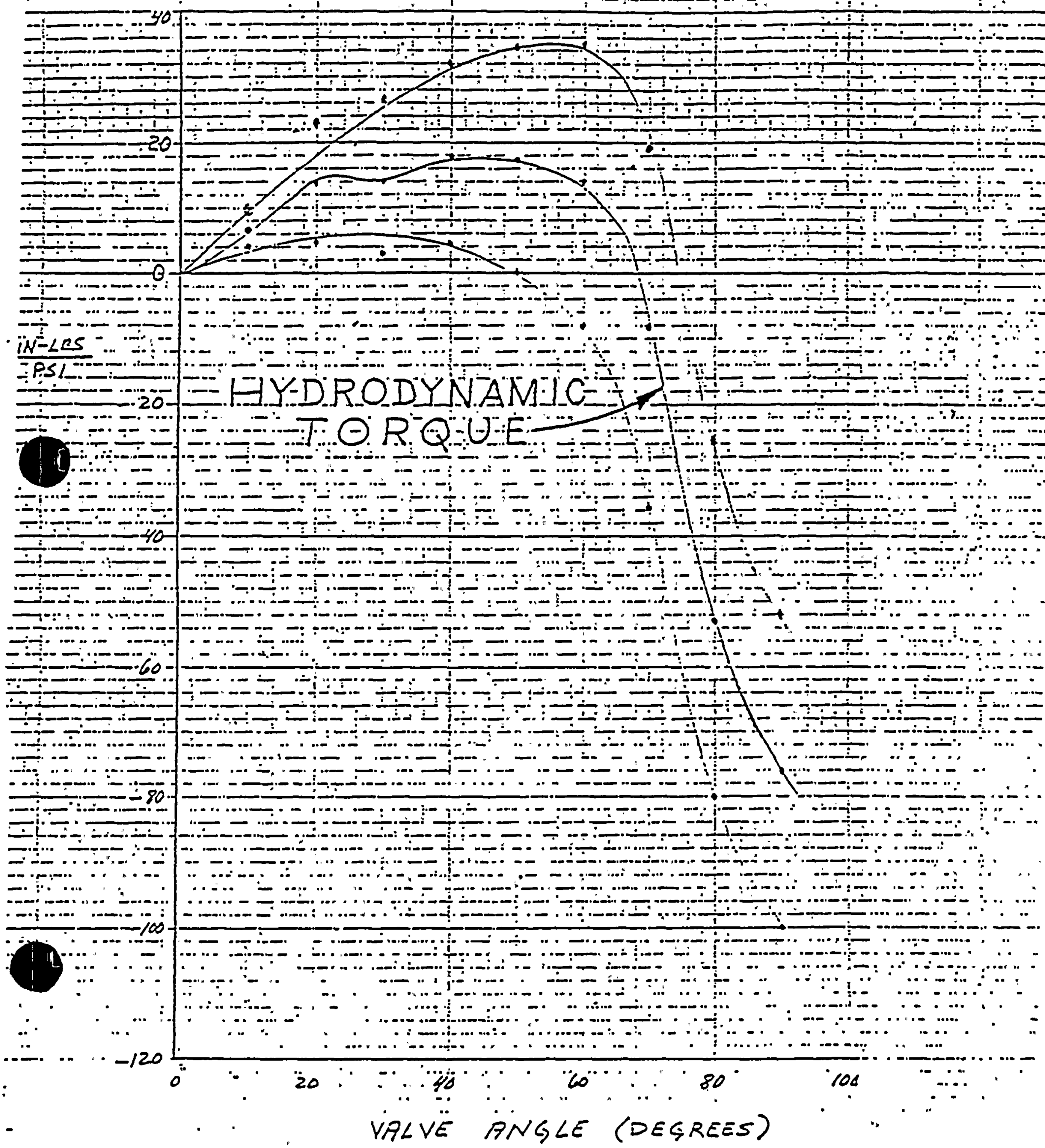
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" - 600 LB

Title HYDRODYNAMIC TORQUE CURVE (NON-PREF. DIRECTION) Page

Calc. By C. LIVORSI Checked By

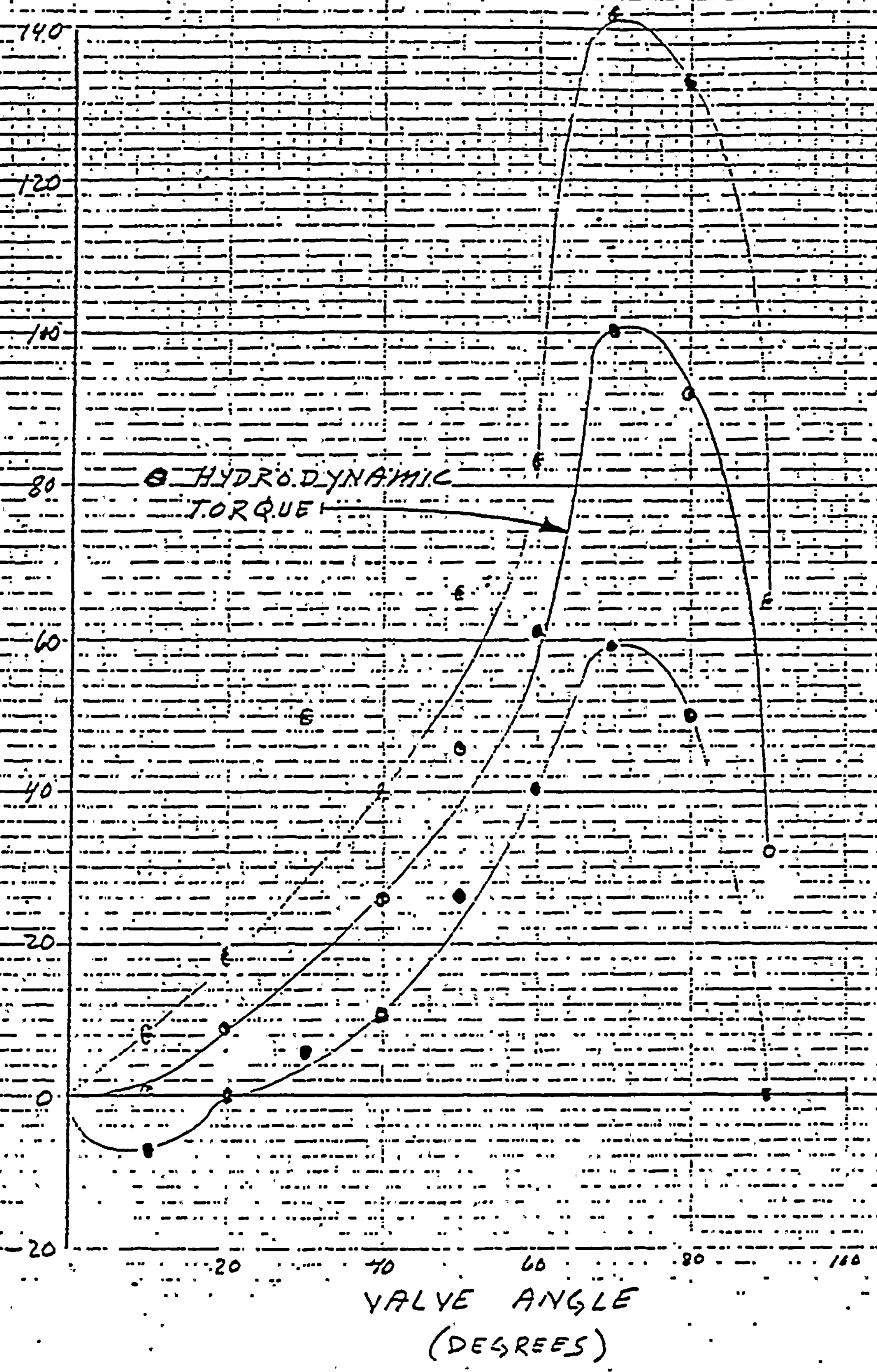


POSI-SEAL INTERNATIONAL, INC.

8" 600 LB ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE (PERF. DIRECTION) Page

Calc. By C. LIVORSI Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By DAISEN DATE: 8/3/77 Checked By

Control valve - regulated

VALVE SIZE: 10" - 600

VALVE DIRECTION: STEM UPSTREAM / ~~STEM DOWN~~

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				
	10		~~47~~ 38.5		+900 ✓
	20		~~34~~ 25.5		+1200 ✓
	30		~~28.3~~ 25		~~+1580~~ 1500
	40		~~19.7~~ 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	~~90~~ 85		4.8		0
	80		4.4		+200
	70		5.9		+450
	60		8.8		+550
	50		13.0		+600
	40		20.8		+650
	30		33		+450
	20		40.4		+50
	10		39		−550
	0				

PACKING TORQUE: 350 IN-LB OPENING

: 400 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

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 DOWN

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		~~+~~ +1500
	50		14.0		+1100
	60		9.1		~~+950~~ +800
	70		5.8		~~+600~~ +400
	80		~~4.3~~ 4.2		23.81 ~~+[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		-400
	20		32		-750
	10		37		-800
	0		X		X

PACKING TORQUE: ~~500~~ 450 IN-LB OPENING

~~400~~ 450 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By [signature] DATE: 8/5/77 Checked By

Control valve wide open

VALVE SIZE: 10"-600

VALVE DIRECTION: ~~STEM UPSTREAM~~ / STEM DOW

VALVE SEAL TYPE: TEFLON / BUNA

WATER TEMPERATURE (TANK): 88 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		57		+1500
	20		48.5		+950
	30		37		+825
	40		25.5		+850
	50		14.5		+900
	60		9.4		+700
	70		6.5		+250
	80		4.3		0 -25
	90		4.6		-300
			X		X
CLOSING	90		4.7		1350
	80		4.2		800
	70		6.4		550
	60		9.3		500
	50		14.0		325
	40		24.5		325
	30		37.2		575
	20		49.0		950
	10		57.5		1025
	0		X		X

PACKING TORQUE: ~~850~~ 750 IN-LB OPENING

~~400~~ 450 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 DOWNSTREAM ☐

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

POSI-SEAL INTERNATIONAL, INC.

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 DOWN

VALVE SEAL TYPE: METAL

WATER TEMPERATURE (TANK): 77 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0				
	10	57.5	150	2.6	
	20	48.5	190	3.9	
	30	39.0	200	5.1	
	40	25.5	170	6.7	
	50	16.5	130	7.9	
	60	12.5	90	7.2	
	70	9.0	50	5.5	
	80	7.5	25	3.3	
	90	6.8	15	2.2	
CLOSING	90	7.0	-115	-16.4	
	80	7.0	-115	-16.4	
	70	7.2	-95	-13.2	
	60	8.0	-90	-11.3	
	50	11.5	-70	-6.1	
	40	19.5	-65	-3.3	
	30	32.0	-70	-2.2	
	20	45.0	-100	-2.2	
	10	54.0	-125	-2.3	
	0				

PACKING TORQUE: 70 ft-LBS ~~IN-LB~~ OPENING

: 70 ft-LBS ~~IN-LB~~ CLOSING

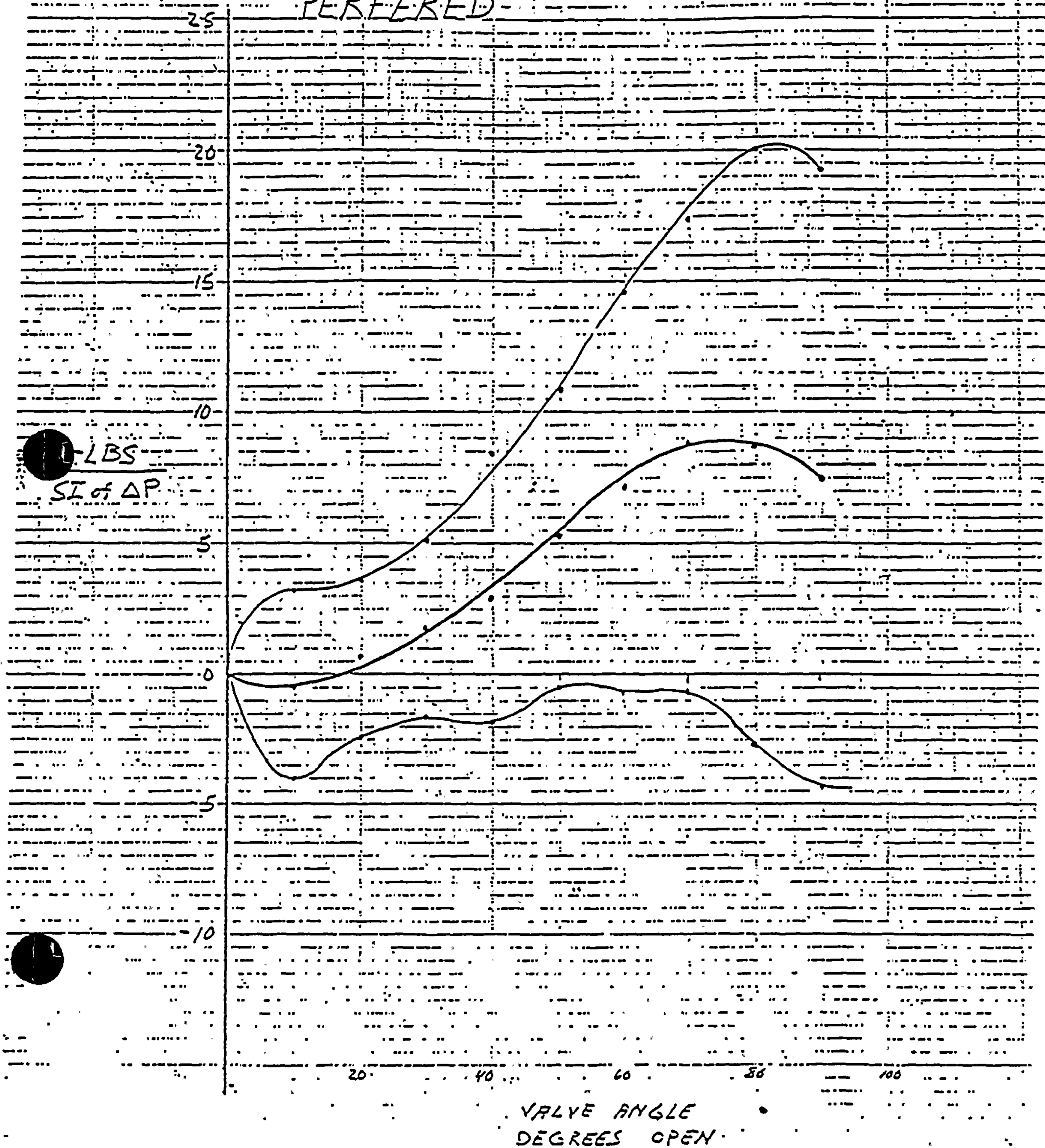
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

By C. Livorsi Checked By

PERFERED

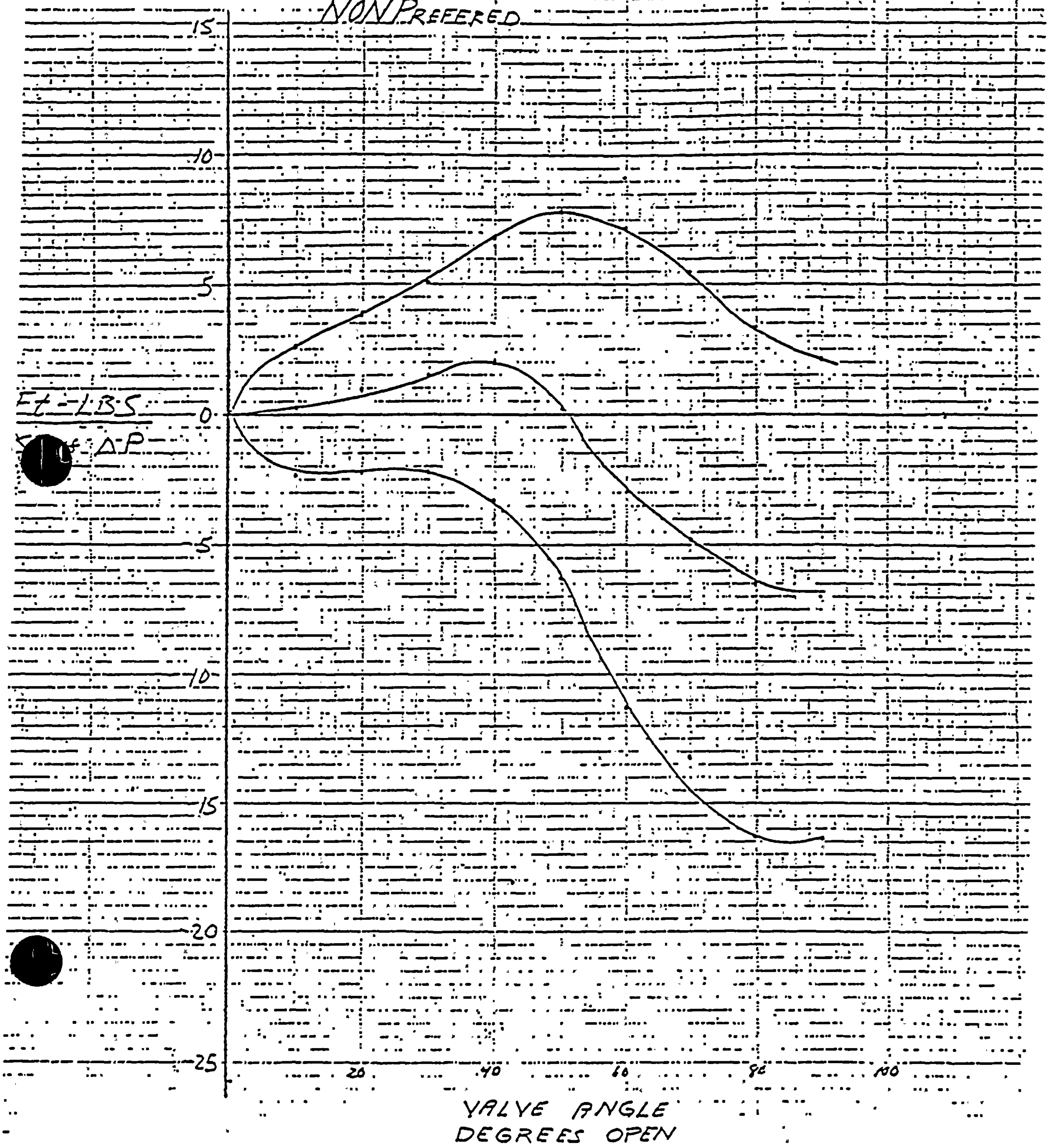


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

14" 1500 LBS HYDRODYNAMIC TORQUE CURVE Page

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	....
[illegible]	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 [illegible]ry 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 (openihg) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

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
[illegible]"	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)

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	−1182
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

VALVE SIZE	10°	20°	30°	40°	50°	60°	70°	80°	90°
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	135553	346428	512112	−30124	−1506212

T_5 values = in. lbs. per PSIΔP.

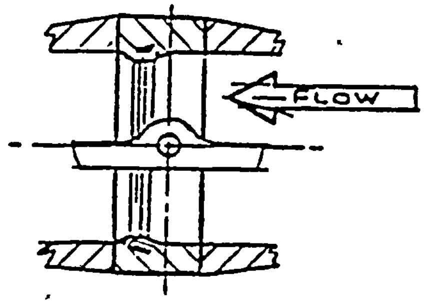
2. Except as noted, T_5 values are positive acting to shut valve.

3. Negative (−) T_5 values act to move the disc to the full open (90°) position.

4. 0 T_5 values $\cong$ < 1.

TABLE 6

CLASS 300 STD RATING



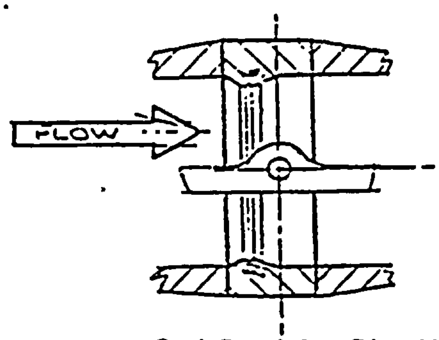
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

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



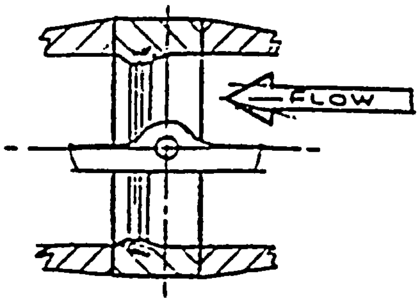
Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque – T_5

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 $\cong <$ 1.

TABLE 8

CLASS 600 STD RATING



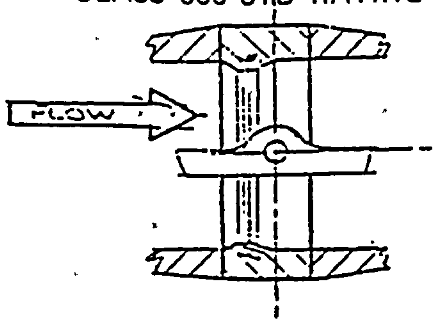
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

VALVE SIZE	T_4 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	0	0	0	0	0	0	0	0	0
4"	0	0	0	0	0	0	0	0	0
6"	0	1	3	3	6	8	13	14	13
8"	0	5	10	12	19	27	44	46	43
10"	1	13	26	29	48	67	107	112	105
12"	1	20	38	43	71	99	158	165	154
14"	2	27	52	58	96	133	213	223	208
16"	2	36	69	78	128	178	284	298	279
18"	3	43	83	93	153	214	341	358	334
20"	3	41	79	88	146	203	324	340	317
24"	12	166	319	357	587	818	1303	1367	1278

1. T_4 values = in. lbs. per PSIΔP.
2. All T_4 values are positive acting to shut valve.
3. 0 T_4 values $\cong < 1$.

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.