ILLINOIS POWER COMPANY

U-0571
L30-82(10-22)6
500 SOUTH 27TH STREET, DECATUR, ILLINOIS 62525

October 22, 1982

Mr. Cecil O. Thomas, Chief
Standardization & Special Projects Branch
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Thomas:

Clinton Power Station Unit 1
Docket No. 50-461

Reference: (1) IP Letter U-1431, from G. E. Wuller to J. R. Miller, dated 3/10/82.
(2) IP Letter U-0544, from G. E. Wuller to C. O. Thomas; dated September 16, 1982.

In referenced letter #1, Illinois Power Company committed to demonstrate the capability of the Clinton Power Station (CPS) containment vent/purge butterfly isolation valves to function as designed through further operability analyses (as required by TMI Action Plan Item II.E.4.2(6)). Enclosed are copies of the completed analyses required regarding CPS Safety Evaluation Report (CPS-SER) Outstanding Issue #10a.

The manufacturer of the Clinton Power Station Unit 1 Containment Vent/Purge isolation valves, Posi-Seal International Inc., has performed a dynamic analysis to assure subject valve operability with the loads experienced during a combined Loss of Coolant Accident (LOCA) and a Seismic Event. These analyses were performed in accordance with the NRC guidelines provided to Illinois Power Company (IP) ("Vent and Purge Valve Operability Review List") during the November/December SER meetings. The results are summarized below:

1. Valve closure times during a combined LOCA/seismic event will be less than or equal to the no-flow time demonstrated during shop tests, since fluid dynamic effects tend to close a butterfly valve. Comparisons of calculated no-flow closure times with actual no-flow closure times support the models used.

2. The operability analysis compares the torque requirements of the valves, with the containment and drywell pressurized to 9 and 30 psig respectively, to the capability of the

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actuators to close the valves. The media flowing through these valves is steam/air at 100% R.H. and 330°F. The results demonstrate the capability of the valves to close under all postulated accident and operating conditions.

The effects of piping bends/tees and valve orientation were considered in the torque calculations by modeling drawings of the piping/valve configurations at Clinton.

In addition, sealing integrity has been evaluated. The Posi-Seal butterfly valve sealing mechanism is a combination sealing ring/backing ring. The sealing ring is made of an inert, low-friction, wear-resistant elastomer called TEFZEL. The dynamic sealing mechanism involved results in a tighter seal than that typical of more resilient seals. Details of this sealing mechanism have been provided to you in the Reference #2 letter.

Posi-Seal recommends two actions be taken to ensure valve operability, and thus the validity of this report. These recommendations are as follows:

1) For all 36" valves, it is recommended that the body/bracket bolts be changed to A354 Gr BD material, since in the event of a combined seismic/LOCA loading the present A193 Gr B7 bolts will be overstressed.

2) The subject valves will perform properly provided they are installed with the flow resulting from a LOCA going in the preferred direction and oriented as recommended.

IP agrees with the above recommendations and proposes the following actions:

1) The body/bracket bolts of all 36" valves will be replaced with bolts made of A354 Gr BD material.

2) The orientation of all subject valves will be checked to either verify they match the recommended orientations, or the orientations will be revised in the field. IP is currently checking the installation orientations of these valves. Any discrepancies will be corrected appropriately.

As a result of our meeting with members of NRR on July 20, 1982, we have reviewed potential modifications to the CPS containment ventilation system which would eliminate the need for the use of the large vent valves. We have determined that such modifications would cost a <u>minimum</u> of four million dollars and could impact our construction schedule. It is IP's position

that the enclosed report supports our intention to utilize the presently-designed containment HVAC system on a continuous basis during normal plant operations. This is consistent with our position on continuous vent/purge as previously discussed with members of the NRC Staff.

In summary, we request early staff-review of this report and propose to meet with you, as required, such that this issue can be closed out in the next supplement to the CPS-SER.

Sincerely,

Terry L. Riley. For

G. E. Wuller
Supervisor-Licensing
Nuclear Station Engineering

TLR/jmm

Enclosure

cc: Mr. J. H. Williams, NRC Clinton Project Manager
Mr. H. H. Livermore, NRC Resident Inspector
Mr. L. C. Ruth, NRC Containment Systems Branch
Illinois Dept. of Nuclear Safety

bcc: CPS/DRC (0982)
L. J. Koch, B-25 w/o encl.
J. D. Geier w/o encl.
J. S. Spencer w/o encl.
E. W. Kant w/o encl.
D. L. Holtzscher w/o encl.
T. L. Riley w/o encl.
C. C. Wheeler w/o encl.
L. S. Brodsky, T-31 w/o encl.
J. G. Cook, T-31 w/o encl.
H. M. Sroka, (S&L), Fl. 21 w/o encl.
D. P. Hall, B-16, w/o encl.

RECEIVED

OCT 0 1 '82

PSI POSI-SEAL INTERNATIONAL, INC.

ROUTES 49 & US 95 NORTH STONINGTON CT

NAME ROOM

DATA TRANSMITTAL FORM

TO: SARGENT & LUNDY ENGINEERS
55 EAST MONROE ST.
CHICAGO, IL 60603
ATTN: H.M. SROKA/J.A. DUDECK

DATE: 9/30/82

SUBJECT:

CLINTON POWER STATION UNITS 1&2
BUTTERFLY VALVES SPEC K2868
PURCHASE ORDER NO. C7902
POSI SEAL REF. NO. 16204

ANS. BY

DATE

Gentlemen:

The documents listed below are submitted for your approval as required by the subject purchase order and referenced specifications. Please acknowledge receipt of same by signing and returning one copy of this form to the attention of: Robert J. Stites

Item	Description	Rev.	Copies
1	NUCLEAR SEIMIC & LOCAL ANALYSIS 16204SL-001	-	1

NOTE: IN ORDER TO HANDLE YOUR ORDER AS EXPEDITIOUSLY AS POSSIBLE, APPROVAL SHOULD BE RETURNED NOT LATER THAN 11-1-82.

CC: MR. BILL HARRINGTON, PROJECT MGR. JACK ORCUTT-EQUIPTROL

Sent By	Title	Date
ROBERT STITES	MANAGER-CONTRACT SALES	9/30/82
Received By	Title	Date

PSI FORM NO. ENG05 REV. A

POSI-SEAL INTERNATIONAL, INC.
North Stonington, CT 06359

NUCLEAR
SEISMIC
& LOCA
ANALYSIS

CUSTOMER:	Illinois Power Co.
P.O. NO.:	C-9702
SPEC. NO.:	K-2868
REF. NO.:	16204
REPORT NO.:	16204SL-003

PSI Item No.	Tag No.
28	1VQ001 A&B
	1VQ002
29	1VQ003
	1VQ004 A&B
	1VR001 A&B
30	1VQ005

CALCULATED BY: [signature]
DATE: 10/20/82

REVIEWED BY: [signature]
DATE: 10/20/82

APPROVED BY: [signature]
DATE: 10/21/82

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ENCLOSURES (1) Valve Assembly Dwgs. 16204-28 Rev. C
16204-29 Rev. C
16204-31 Rev. C

(2) Posi-Seal Technical Bulletin No. 2, dated June 1982

(3) Derivation of Hydrodynamic Torque Curves

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

(5) Calculations of Various Input Parameters

REFERENCES (a) "Formulas for Stress and Strain" by R. J. Roark, McGraw Hill, 5th Edition

(b) "Flow of Fluids through Valves, Fittings and Pipe," Technical Paper No. 410, Crane

(c) "Mechanical Vibrations," Church, John Wiley & Sons

(d) "Advance Strength of Materials" by Seely & Smith, John Wiley & Sons

(e) "Eccentrically Loaded Joints" Machine Design, August 1967

(f) Sargent & Lundy Engineering Change Notice No. 2962

(g) "Steam Tables" Keenan & Keyes, Hill and Moore

(h) Sargent & Lundy Dwg. M06-1110

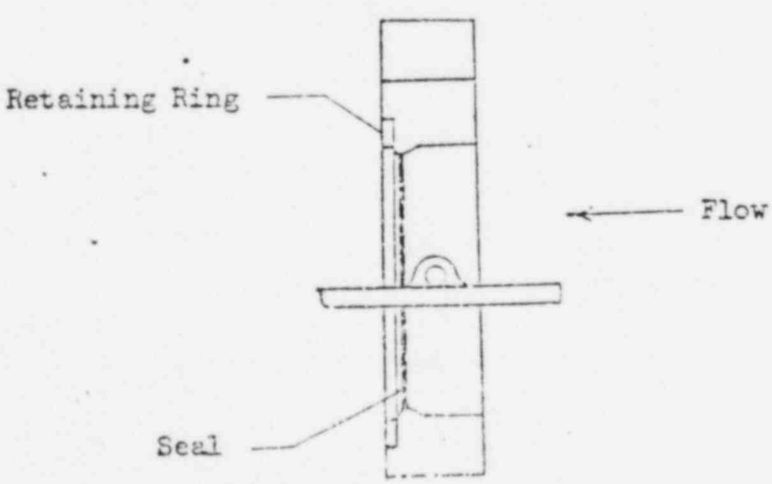
(i) Sargent & Lundy Dwg. M06-1111

SUMMARY

Due to the design of Posi-Seal butterfly valves with the disc being asymmetrical, flow in the preferred direction tends to close the valve. In the nonpreferred direction the disc tends to stay in the open position until it reaches a valve angle of approximately 75°, then tends to close.

For some of the piping systems investigated, the aerodynamic torque resulting from a LOCA is of such a large magnitude that the torque will overcome that of the valve actuator and partially close the valve if the flow is in the preferred direction. These torques, with the valves in the nonpreferred direction, are so large that the actuator cannot overcome them, thus the valve remains in the open position. Therefore, if the subject containment isolation valves are to properly perform their function, it is <u>imperative</u> that they be placed in the <u>preferred direction</u> such that they will go to the shut position in the event of a LOCA. The preferred direction is shown below.

Figure 1



For all 36" valves, it is recommended that the body/bracket bolts be changed to A354 Gr BD, since in the event of a combined LOCA and seismic accident the present A193 Gr B7 bolts will be over stressed. Recommendation concerning the orientation of valves 1VQ003 and 1VQ004B are given on Pages 53, 54 and 55.

As can be seen in the results on Pages 6 and 7, the aerodynamic torques do not exceed the maximum allowable design torques of the actuators, nor do the loads imposed by a LOCA and a seismic event result in excessive stresses except as noted above.

Shown on the following pages is a scenario of what will happen to each valve in event of a LOCA.

LOCA SCENARIO

CASE 1 & 1A - 24" Valves 1VQ001A & 1VQ001B

CASE 3, 3A & 3B - 24" Valve 1VQ002 and 36" Valves 1VQ004A & 1VQ004B

CASE 5 & 5A - 24" Valve 1VQ002 and 36" Valve 1VQ003

CASE 6 & 6A - 36" Valves 1VR001A & 1VR001B Valve

Preferred Direction

The aerodynamic torques are of such large magnitudes that they will overcome the pneumatic torques of the actuators and partially close the valves. Upon actuation, the valves will fully shut.

Nonpreferred Direction

The summation of the aerodynamic, packing and bearing torques is greater than the spring closing torques of the actuators, thus the valves will remain in the open position.

CASE 2, 2A & 2B - 10" Valve 1VQ005 and 36" Valves 1VQ004A & 1VQ004B

CASE 4 & 4A - 10" Valve 1VQ005 and 36" Valve 1VQ003

Preferred and Nonpreferred Directions

Flow through the 36" valves is not substantial enough to cause significant aerodynamic torques since flow through the 10" is choked. As a consequence the valves will remain open until the valve is actuated shut, then they will fully close.

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 g magnitude as given in customer's specification and still maintain operability.

The escape of containment atmosphere during a LOCA will result in large aerodynamic torques on a valve assembly if it is in the open position. This analysis will determine the effect that aerodynamic torque has on the valve assembly and its operation.

The seismic aspect of the analysis will consist of determining the natural frequencies and stresses of the valve assembly in accordance with references noted, 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. The purpose of the frequency calculations is to show that all valve assembly natural frequencies are greater than 33 HZ and therefore, static stress analysis of the valve is applicable. Where resonances occur below 33 HZ, valve and/or bracket are modified in order to drive the fundamental natural frequency above 33 HZ.

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.

All equations are either straight forward or from reference (a) unless otherwise noted.

RESULTS

Tabulation of Maximum Aerodynamic Torques and Closing Times

Case	Valve Size	Matryx Actuator Model	Max. Aerodynamic Torque (in.lbs)	Design Torque of Actuator (in.lbs)	Closing Times (Sec.)		
					Normal	Preferred	Nonpreferred
1	24"	33082-SR80	47,825	57,955	1.3	0.7	-
1A	24"	33082-SR80	46,611	57,955	1.3	0.7	-
2	36"	45102-SR80	2,769	166,660	3.2	3.6	3.9
2A	10"	26062-SR80	2,048	25,413	0.6	0.55	0.7
2B	36"	45102-SR80	2,764	166,660	3.2	3.6	3.9
3	36"	45102-SR80	88,675	166,660	3.2	2.4	-
3A	24"	33082-SR80	48,376	57,955	1.3	0.7	-
3B	36"	45102-SR80	84,344	166,660	3.2	2.4	-
4	36"	45102-SR80	2,768	166,660	3.2	3.6	3.9
4A	10"	26062-SR80	2,048	25,413	0.6	0.55	0.7
5	36"	45102-SR80	88,675	166,660	3.2	2.4	-
5A	24"	33082-SR80	48,376	57,955	1.3	0.7	-
6	36"	45102-SR80	122,133	166,660	3.2	1.8	-
6A	36"	45102-SR80	122,090	166,660	3.2	1.8	-

SEISMIC AND LOCA STRESSES (psi)

Valve Size	Matryx Actuator	Actuator Bolt		Bracket Bolt		Bracket		Valve Neck		Stem		Disc Pin	
		Calc.	Allow.	Calc.	Allow.	Calc.	Allow.	Calc.	Allow.	Calc.	Allow.	Calc.	Allow.
36"	45102-SR80	15013	41250	48900	49500*	5685	22605	6120	28875	32013	59730	30391	35838
24"	33082-SR80	21987	41250	35065	41250	6181	22605	6825	28875	33030	59730	29836	35838
10"	26062-SR80	18305	41250	33240	41250	4713	22605	5667	28875	7988	59730	13653	35838

* This allowable is based on a bolt material of A354 Gr BD which is different than bolt material provided with the valve assemblies, A193 Gr B7. The allowable stress of A193 Gr B7 is 41250 psi.

NOTE: The allowable stresses are based on 1.65 times the allowables given in Section III of the ASME Boiler and Pressure Vessel Code.

CONCLUSIONS

Based on the resulting stresses not exceeding allowable, if the bolt material for the 36" valve body/bracket bolt is changed to A354 Gr BD, Posi-Seal concludes that the subject valves will perform properly during a combined LOCA and seismic event, provided they are installed with the flow resulting from a LOCA going in the preferred direction and orientated as recommended.

It should be noted that the angular velocities of the subject valves shutting are sufficiently slow as to not cause over stressing when the actuator's scotch yoke impacts against its stops. This conclusion is based on Posi-Seal's experience with bigger valves closing in a shorter period of time (e.g., 42" with Matryx 45211-SR80 closing in 0.8 seconds).

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 of 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 six piping systems which are to be investigated. They are:

Case 1	24" Valves 1VQ001A&B
Case 2	10" Valve 1VQ005 and 36" Valves 1VQ004A&B
Case 3	24" Valve 1VQ002 and 36" Valves 1VQ004A&B
Case 4	10" Valve 1VQ005 and 36" Valve 1VQ003
Case 5	24" Valve 1VQ002 and 36" Valve 1VQ003
Case 6	36" Valve 1VR001A&B

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

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

Determination of Flow Conditions

Derivation of equations

Bernoulli's Equation

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

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

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

where P = Pressure PSIG

ρ = Density lb/ft^3

V = Velocity ft/sec

g = Gravitational constant = 32.2 ft/sec^2

h_L = Head Loss

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

$$\rho_2 = \rho_1 \left(\frac{P'_2}{P'_1}\right)^{1/K_1}$$ per Ref. (b)

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

where K_1 = Ratio of specific heats

P' = Pressure PSIA

T = Absolute temperature °R

Flow equations

<u>In pipe</u>

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

where Q = Flow SCFH

D = Diameter in^2

<u>In valve</u>

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

where C_V = Valve coefficient

$X = \Delta P/P'$

ΔP = Pressure drop across valve PSI

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

F_K = Ratio of specific heat factors

X_T = Rated pressure drop ratio factor

G = Specific gravity

Z = Compressibility factor

For choke flow in valve

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

ΔP choked $= F_K\, X_T\, P_1'$

Sonic Velocity Equation

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

Determination of the flow conditions will be performed as follows:

1. Calculate density at the end condition

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

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

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

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

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

For I = 1 to N

$\rho = \rho(I)$

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

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

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

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

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

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

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:

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

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.

$T_{inertia}$ = Torque due to the inertia of the disc assembly.

$T_{bearing}$ = 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:

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

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

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

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

$T_L = C_L \; L_L \; \rho \frac{V^2 A}{2}$ 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.

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

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

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

$$T_F = T_{4F} \, \Delta P$$

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

Pneumatic Torque (T_{air})

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

Where A = Area of piston

$= \frac{T_{running}\ P}{R}$ $T_{running}$ = Running Torque of actuator

P = Working Pressure of Actuator

R = Radius of Scotch yoke (See Figure 3)

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

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

V = Specific Volume

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.

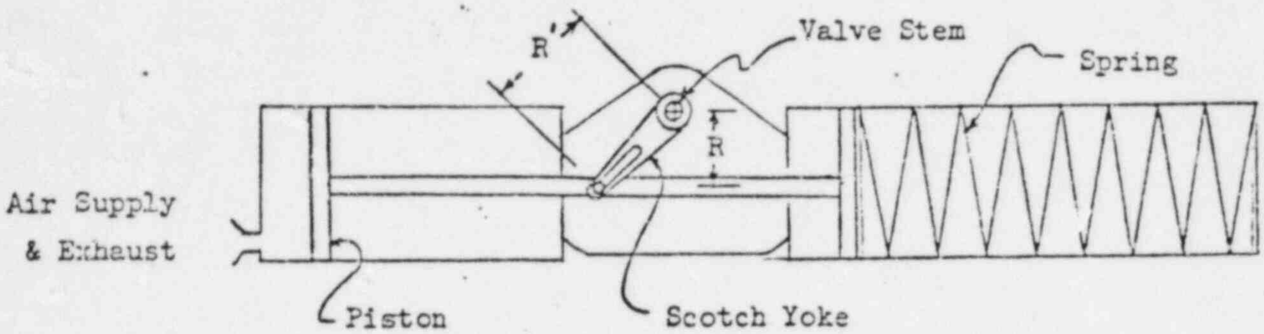


Figure 2

Forces acting on Scotch Yoke Pin

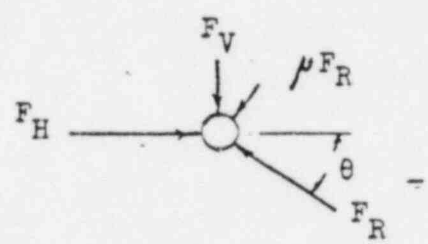


Figure 3

Summing forces in the horizontal direction

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

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

F_R = Resultant Force

F_H = Horizontal Force

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

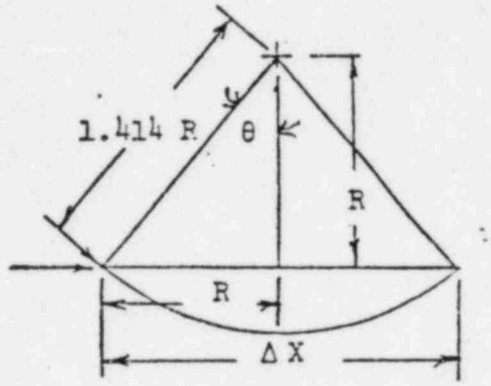
$$\therefore \quad T_R = \frac{T}{\cos\theta\,(\cos\theta + \mu \sin\theta)}$$

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

Spring Torque (T_{spring})

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

Figure 4



$\theta = 45°$

$\Delta X = 2R$

K = Springrate

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

$$T_{spring\ beginning} = T_{breakaway} - T_{spring\ ending}$$

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

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

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

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

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

Bearing Torque ($T_{bearing}$)

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

where μ = Coefficient of friction

= .059 for bronze bearings

D = Disc gage diameter

d = Stem diameter

Inertia Torque $= \frac{I \alpha}{C2}$

I = Inertia of Disc

α = Angular acceleration

$= \frac{W}{dt}$

W = Angular velocity

$= \frac{\Delta\theta}{dt}$

$\Delta\theta$ = Change in angle

$= \theta_{old} - \theta_{new}$

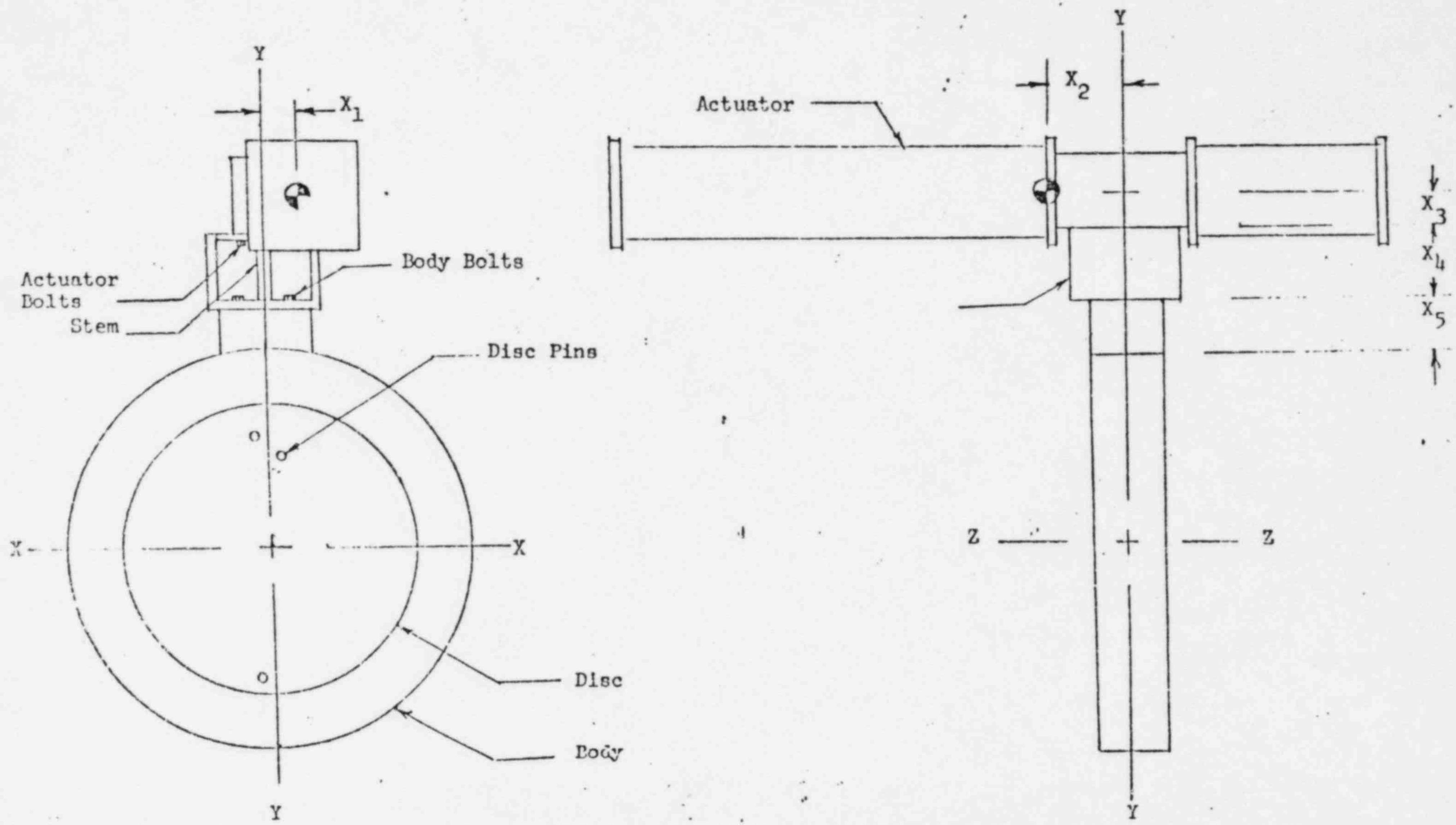
$\theta_{new} = \tan^{-1} \frac{X}{R}$

$X = X_{old} - \Delta X$

$\Delta X = 2 R \quad \Delta V \quad .68\bar{V}$

.68 = Percent of total volume over which the actuator will stroke.

The torque equations are formulated into the computer program "FLOW-CL". As part of this program, the closing times and the angular velocities of the disc assembly are calculated.



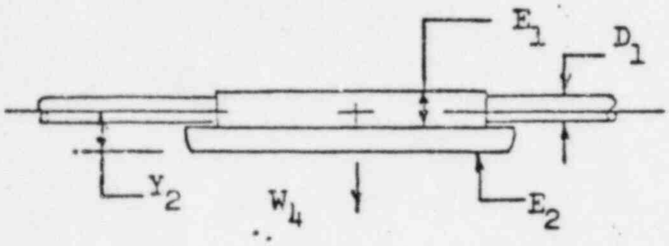
PICTORAL MODEL OF VALVE ASSEMBLY

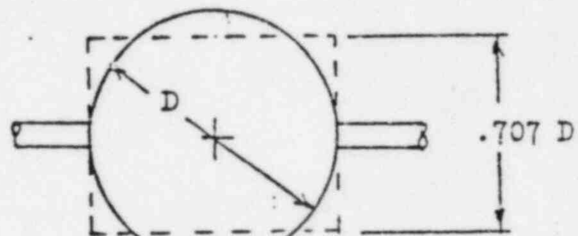
Figure 5

A. NATURAL FREQUENCIES:

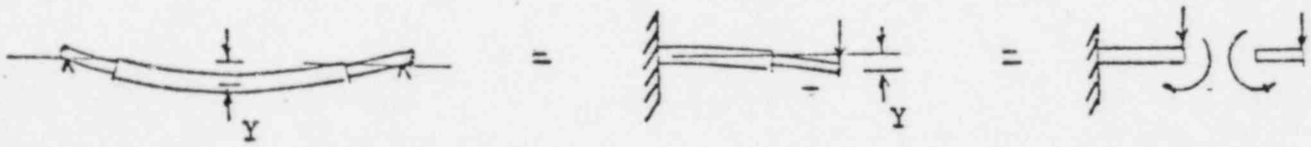
LATERAL - Disc/Stem (By Rayleigh's Method) Ref. (c)

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





$$N_C = 3.125 \sqrt{\frac{1}{Y}} \text{ Hz}$$ NATURAL FREQUENCY Per Ref. (b)



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

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

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

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

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

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

$${}_D = \frac{.707\ DE_2^3}{12} + .707\ DE_2\left[\frac{E_2}{2} - \bar{Y}\right]^2 + \frac{\pi E_1^4}{64} + \frac{\pi E_1^2}{4}\left[Y_2 - \bar{Y}\right]^2$$ Moment of Inertia of Disc (in^4)

$${} = \frac{.3535\ DE_2^2 + .7854\ E_1^2 Y_2}{.707\ DE_2 + .7854\ E_1^2}$$ Distanct to Neutral Axis (in)

WHERE: W_4 = DISC WEIGHT (LBS.)

D_1 = STEM DIA. (IN.)

D = DISC GAGE DIA. (IN.)

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

L_2 = THRUST WASHER THICKNESS (IN.)

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

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

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

VALVE NECK AND FLANGE DIMENSIONS

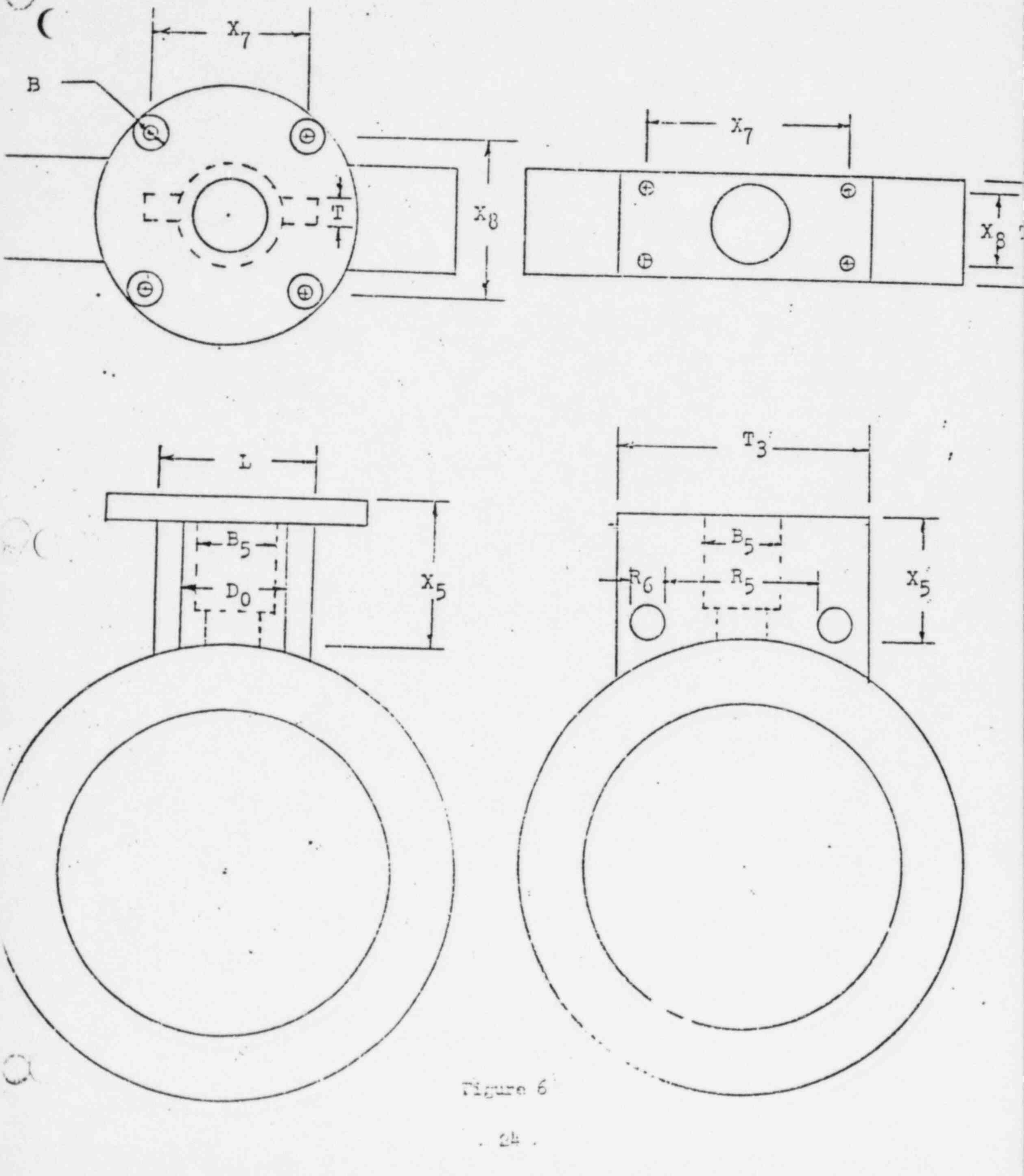


Figure 6

ACTUATOR MOUNTING BRACKET DIMENSIONS

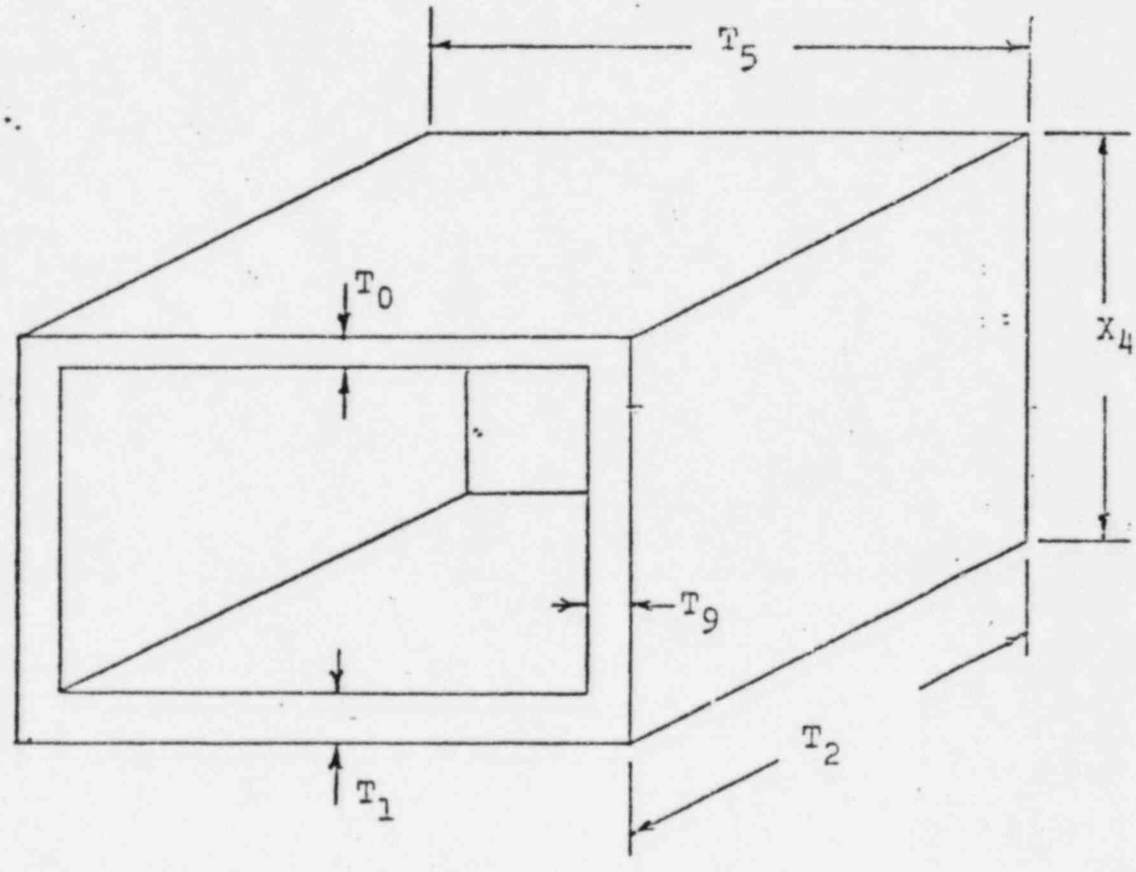


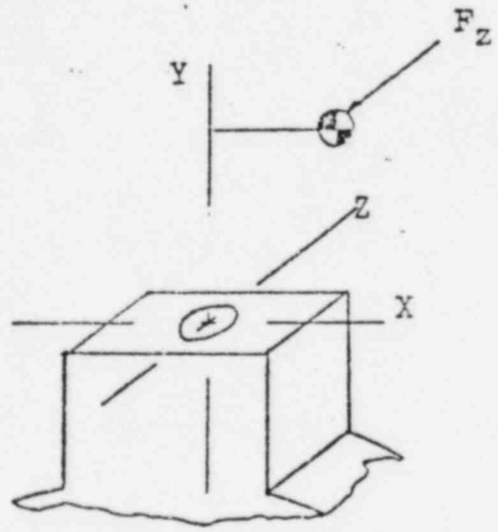
Figure 7

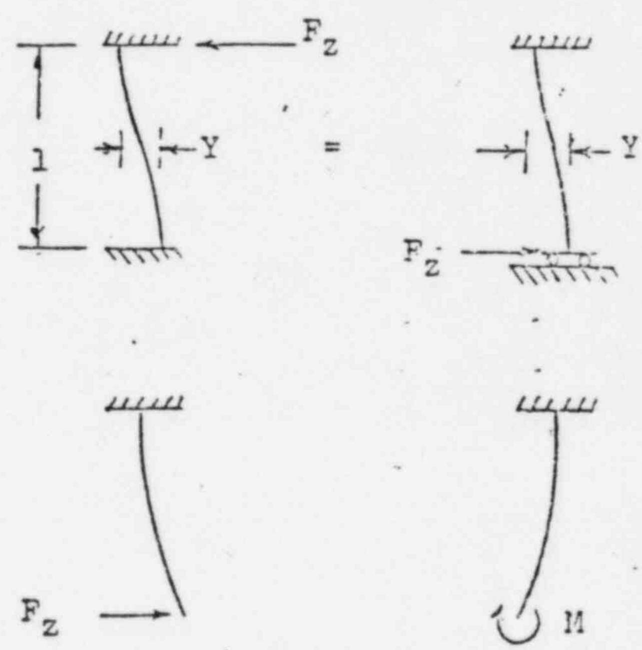
LONGITUDINAL (Z) NATURAL FREQUENCY

DETERMINATION OF LONGITUDINAL SPRINGRATE

Springrate of the Neck

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





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

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

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

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

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

LONGITUDINAL SPRINGRATE OF NECK

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

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

Circular Cross Section

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

Rectangular Cross Section

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

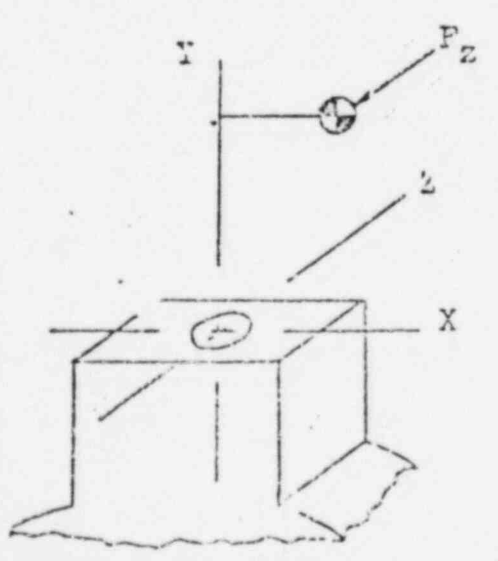
With Gussets

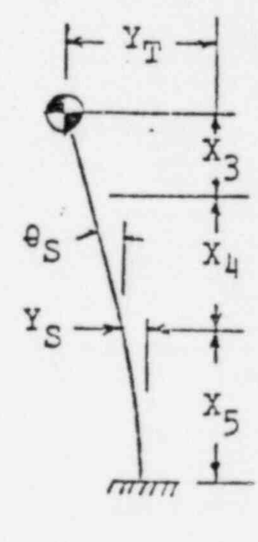
$$I_x = I_x + \frac{(L - D_0)T^3}{12}$$

For the Neck $l = \bar{X}_5$

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

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





LONGITUDINAL SPRINGRATE OF NECK

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

$$\theta_S = \theta_F + \theta_M$$

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

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

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

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

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

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

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

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

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

LONGITUDINAL SPRINGRATE OF BRACKET

Springrate of Bracket

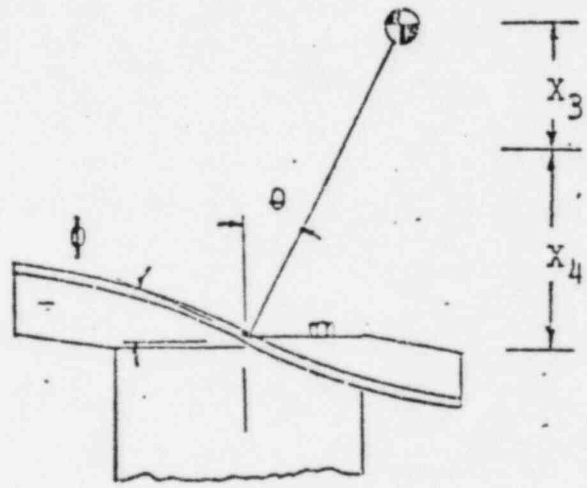
Springrate due to twisting of the bottom plates of bracket per Seely and Smith, Page 271, Ref. (d).

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

Looking at one side of bracket

Assume the width of the bracket that resists the twist of the plate is the average of the valve neck width and distance between bolts

$$\therefore b = \frac{T_4 + X_8}{2}$$



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

$$\phi = \frac{3}{(T_4+X_8)\ T_1^{\ 3}}\left[\frac{F_z\ (X_4 - T_1 + X_3)}{2\ (12\ X\ 10^6)}\right] = \frac{F_z\ (X_4 - T_1 + X_3)}{(T_4 + X_8)\ 4\ X\ 10^6}$$

$$\theta = \phi\ d \quad \text{where d is assumed to be} = \frac{T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}}{2}$$

$$\theta = \frac{F_z\ (X_4 - T_1 + X_3)\ \left(T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}\right)}{(T_4 + X_8)\ \ 8\ X\ 10^6\ \ T_1^{\ 3}}$$

LONGITUDINAL SPRINGRATE OF BRACKET

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

$$Y = \frac{F_z\ (X_4 - T_1 + X_3)^2\ \left(T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}\right)}{(T_4 + X_8)\ \ 8 \times 10^6\ T_1^{\ 3}}$$

$$K_{\frac{BBM}{2}x} = \frac{(T_4 + X_8)\ \ T_1^{\ 3}\ \ 8 \times 10^6}{(X_4 - T_1 + X_3)^2\ \ \left(T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}\right)}$$

The total springrate for the bottom of the bracket is

$$\boxed{K_{BBM_x} = \frac{(T_4 + X_8)\ T_1^{\ 3}\ \ 16 \times 10^6}{(X_4 - T_1 + X_3)^2\ \left(T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}\right)}}$$

for a valve with a flanged neck $b = \frac{B}{2} + X_8$

$$K_{BBM_x} = \frac{(\frac{B}{2} + X_8)\ \ T_1^{\ 3}\ \ 32 \times 10^6}{(X_4 - T_1 + X_3)^2\ \left(T_5 - 2T_9 - (\frac{B}{2} + X_7)\right)}$$

Springrate due to the twisting of the top plate of the bracket

$b = X_6$ - DBC of Actuator

$$\boxed{K_{BTM_x} = \frac{X_6\ T_0^{\ 3}\ \ 32 \times 10^6}{X_3^{\ 2}\ (T_5 - 2T_9 - X_6)}}$$

LONGITUDINAL SPRINGRATE OF BRACKET

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

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

per Page 27 · $K_{Shear} = \dfrac{12\ EI_x}{l^3}$

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

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

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

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

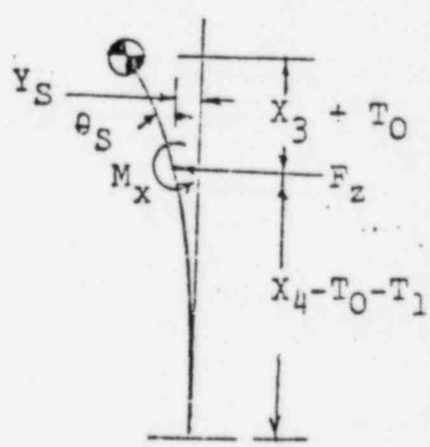
$$Y_T = Y_S + \theta_S\ (X_3 + T_0)$$

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

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

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

$$M = F_z\ (X_3 + T_0)$$



LONGITUDINAL SPRINGRATE OF BRACKET

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

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

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

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

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

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

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

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

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

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

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

LONGITUDINAL (Z) NATURAL FREQUENCY

$$M = \frac{W_1 + W_2}{386}$$

Where W_1 = Weight of Actuator
W_2 = Weight of Bracket

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

VERTICAL (Y) NATURAL FREQUENCY

DETERMINATION OF VERTICAL SPRINGRATE

Springrate of Neck

Stretch of Valve Neck

$K_{NF_y} = \frac{AE}{l}$

$\boxed{K_{NF_y} = \frac{AE}{X_5}}$

$A = \frac{\pi}{4}(D_0^2 - B_5^2)$ Circular Section

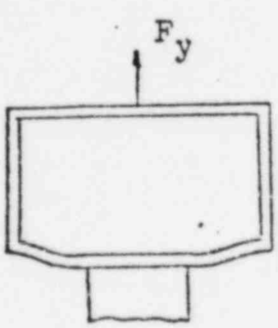
$A = T_3 T_4 - \frac{\pi}{4} B_5^2$ Rectangular Section

$A = A + (L - D_0) T$ with Gussets

Springrate of Bracket

Springrate of Bottom Plate

$Y = \frac{F l^3}{12EI}$ for fixed - fixed per Page 27



For one side

$$l = \frac{T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}}{2}$$

$$I_z = \frac{T_2 T_1^3}{.12}$$

VERTICAL SPRINGRATE OF BRACKET

$$K_{\frac{BBF}{2}y} = \frac{12\ EI_z}{l^3} = \frac{12\ (30X10^6)\ T_2\ T_1^{\ 3}}{12\ \left(\frac{T_5-2\ T_9-\left(\frac{T_3+X_7}{2}\right)}{2}\right)^3}$$

$$K_{\frac{BBF}{2}y} = \frac{T_2\ T_1^{\ 3}\ 2.4\ X\ 10^8}{\left(T_5 - 2T_9 - \left(\frac{T_3 + X_7}{2}\right)\right)^3}$$

For Both Sides

$$\boxed{K_{BBF_y} = \frac{T_2\ T_1^{\ 3}\ \ 4.8\ X\ 10^8}{\left(T_5-2\ T_9- \left(\frac{T_3 + X_7}{2}\right)\right)^3}}$$

For Flanged Neck

$$= \frac{T_2\ T_1^{\ 3}\ \ 4.8\ X\ 10^8}{T_5 - 2T_9 - \left(\frac{B}{2} + X_7\right)^3}$$

Springrate of Top Plate

$$\boxed{K_{BTF_y} = \frac{T_2\ T_0^{\ 3}\ 4.8\ X\ 10^8}{(T_5 - 2T_9 - X_6)^3}}$$

Springrate of Side Plates

$$K_{SF_y} = \frac{AE}{l} \qquad l = X_4 - T_0 - T_1 \qquad A = 2\ T_2\ T_9$$

$$\boxed{K_{BSF_y} = \frac{T_2\ T_9\ 60\ X\ 10^6}{X_4 - T_0 - T_1}}$$

VERTICAL NATURAL FREQUENCY

$$K_{B_y} = \frac{K_{BBF_y} \quad K_{BTF_y} \quad K_{BSF_y}}{K_{BBF_y} \quad K_{BTF_y} + K_{BBF_y} \quad K_{BSF_y} + K_{BTF_y} \quad K_{BSF_y}}$$

$$K_y = \frac{K_{NF_y} \quad K_{B_y}}{K_{NF_y} + K_{B_y}}$$

$$\boxed{fn_y = \frac{1}{2\pi} \sqrt{\frac{K_y}{M}}} \qquad H_z$$

TRANSVERSE (X) NATURAL FREQUENCY

DETERMINATION OF TRANSVERSE SPRINGRATE

Springrate of Neck

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

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

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

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

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

with Gusset

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

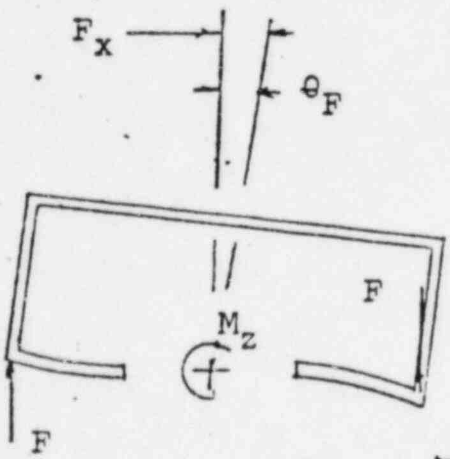
$$\boxed{K_{NM_z} = \frac{3\ EI_z}{X_5^3 + 3\ (X_3 + X_4)\ X_5^2 + 3\ (X_3 + X_4)^2\ X_5}}$$

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

TRANSVERSE SPRINGRATE OF BRACKET

SPRINGRATE OF BRACKET

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



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

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

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

$$\theta_F = \frac{F\,l^2}{2\,EI} = \frac{F\left[(T_5 - 2T_9 - (T_3 + X_7))\,/2\right]^2}{2\,EI_z}$$

$$\theta_F = \frac{F_x\,(X_4 - T_1 + X_3)\,\left[(T_5 - 2T_9 - (T_3 + X_7))\,/2\right]^2}{2EI_z\,(T_5 - T_9)}$$

$$Y = \frac{F_x\,(X_4 - T_1 + X_3)^2\,(T_5 - 2T_9 - (T_3 + X_7))^2}{8\,EI_z\,(T_5 - T_9)}$$

$$K_{BBM_z} = \frac{8\,EI_z\,(T_5 - T_9)}{(X_4 - T_1 + X_3)^2\,\left(T_5 - 2T_9 - \frac{(T_3 + X_7)}{2}\right)^2} \qquad I_z = \frac{T_1^{\,3}\,T_2}{12}$$

TRANSVERSE SPRINGRATE OF BRACKET

$$\boxed{K_{BBM_z} = \frac{20 \times 10^6 \; T_2 \, T_1^{\,3} \, (T_5 - T_3)}{(X_4 - T_1 + X_3)^2 \left(T_5 - 2T_9 - \left(\frac{T_3 + X_7}{2}\right)\right)^2}}$$

For a valve with a flanged neck

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

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

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

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

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

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

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

TRANSVERSE SPRINGRATE OF BRACKET

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

$$K_{BSM_z} = K_{BSM_x} \quad \text{except} \quad I_z = \frac{T_9^3\, T_2}{6} + 2T_9\, T_2 \frac{(T_5 - T_9)^2}{2}$$

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

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

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

$$K_x = \frac{K_{B_x}\; K_{N_x}}{K_{B_x} + K_{N_x}}$$

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

1. ACTUATOR/BRACKET BOLTING.

OPERATING STRESSES -

$$S_{Sox} = \frac{1.414T}{N_1 A_1 X_6}$$ WHERE: T= VALVE TORQUE (Packing + Bearing + Aerodynamic) (in LBS)

N_1= NO. OF ACTUATOR BOLTS

A_1= TENSILE STRESS AREA OF ACTUATOR BOLTS (IN^2)

$$S_{SOZ} = S_{SOX}$$

X_6= D_{BC} OF ACTUATOR BOLTS (IN.)

SEISMIC STRESSES -

G_1= Transverse Seismic Acceleration

G_2= Vertical Seismic Acceleration

G_3= Longitudinal Seismic Acceleration

A. VERTICAL DIRECTION (Fy)

$Fy = W_1 * G_2$ $\quad M_Z = FyX_1$ $\quad M_X = FyX_2$

W_1= Actuator Weight

W_2= Bracket Weight

$$F_X = \left[\frac{4}{3X_6N_1}\left(1 + \cos\frac{\pi}{N_1}\right)\right] M_X$$ MAXIMUM BOLT LOAD (LBS.) Per Ref (e)

$$F_Z = \left[\frac{4}{3X_6N_1}\left(1 + \cos\frac{\pi}{N_1}\right)\right] M_Z$$

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

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

B. TRANSVERSE DIRECTION (F_X)

$F_X = W_1 * G_1$ $\quad Ty = F_X X_2$ $\quad M_Z = F_X X_3$

$$S_{SSX} = \frac{1.414Ty}{N_1A_1X_6} + \frac{Fx}{N_1A_1}$$ (PSI) SHEAR STRESS

$$F_{RZ} = \left[\frac{4}{3X_6N_1}\left(1 + \cos\frac{\pi}{N_1}\right)\right] M_Z$$ MAXIMUM BOLT LOAD (LBS.)

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

C. LONGITUDINAL DIRECTION (F_Z)

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

$$S_{SSZ} = \frac{1.414Ty}{N_1A_1X_6} + \frac{F_Z}{N_1A_1}$$

$$F_{RX} = \left[\frac{4}{3X_6N_1}\left(1 + \cos\frac{\pi}{N_1}\right)\right] M_X$$ MAXIMUM BOLT LOAD (LBS.)

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

ROOT SUM SQUARE STRESSES:

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

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

MAXIMUM STRESS: MAX. STRESS THEORY

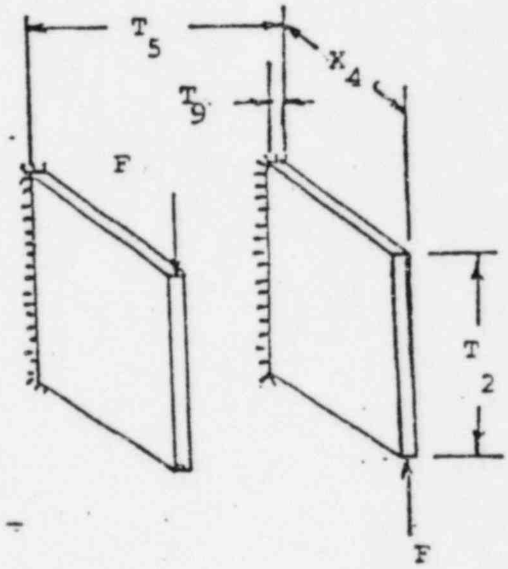
$$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^2}$$

2. BRACKET

OPERATING STRESSES -

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

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



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

$$S_S = \frac{F}{A} \qquad A = T_9\ T_2$$

$$S_S = \frac{T}{T_9\ T_2\ T_5} \qquad \text{SHEAR (PSI)}$$

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$$Fy = (W_1 + .5W_2) G_2 \quad M_Z = FyX_1 \quad M_X = FyX_2$$

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

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

B. TRANSVERSE DIRECTION (F_X)

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

$$S_{SX} = \frac{Ty}{T_9\ T_2\ T_5} + \frac{F_X}{T_9 T_2} \qquad \text{SHEAR (PSI)}$$

$$S_{TZ} = \frac{6\ X_4\ Ty}{T_5 T_9 T_2^2} + \frac{M_Z\ T_5}{2\ J_3} \qquad \text{TENSILE (PSI)}$$

C. LONGITUDINAL DIRECTION (F_Z)

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

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

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

ROOT SUM SQUARE STRESSES:

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

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

MAXIMUM STRESS: MAX. STRESS THEORY

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

3. BRACKET/VALVE BOLTING

OPERATING STRESSES -

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

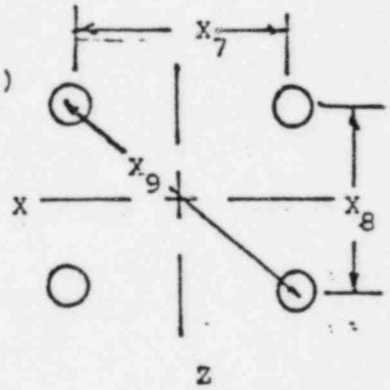
WHERE" T= VALVE TORQUE (IN-LBS)

N_2= NO. OF BRACKET BOLTS= 4

A_2= TENSILE STRESS AREA OF BOLTS (IN.)

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

= EQUIVALENT BOLT DIA. (IN.)



SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

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

$$F_{RX} = \frac{M_X}{2X_8} \quad F_{RZ} = \frac{M_Z}{2X_7} \qquad F_T = \frac{Fy}{N_2} + F_{RX} + F_{RZ}$$

TOTAL TENSILE LOAD ON BOLT (LBS.)

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

B. TRANSVERSE DIRECTION (F_X)

$$F_X = (W_1 + W_2) * G_1 \qquad Ty = F_X X_2 \quad M_Z = F_X (X_3 + X_4)$$

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

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

C. LONGITUDINAL DIRECTION (F_Z)

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

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

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

ROOT SUM SQUARE STRESSES:

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

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

MAXIMUM STRESS: MAX. STRESS THEORY

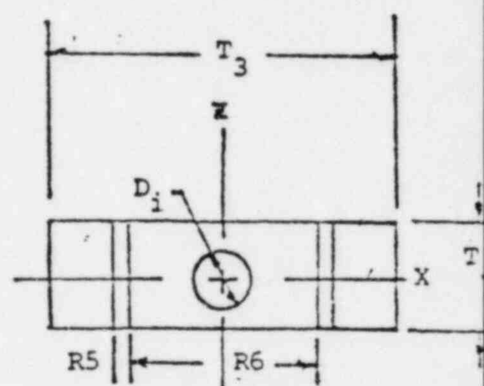
$$S_T = \frac{S_{TS}}{2} + \sqrt{\left[\frac{S_{TS}}{2}\right]^2 + S_{SS}^2}$$

4. VALVE NECK -

OPERATING STRESSES -

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

$$J_1 = \frac{8(T3/2)^2(T4/2)^3}{3\,T3/2 + 1.8\,T4/2} - \frac{8(R5/2 + R6)^2(T4/2)^3}{3(R5/2 + R6) + 1.8\,T4/2} + \frac{8(R5/2)^2(T4/2)^3}{3(R5/2) + 1.8\,T4/2} - \frac{\pi}{32}\,Di^4$$



OR

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

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

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

SEISMIC STRESSES -

A. VERTICAL DIRECTION (Fy)

$Fy = (W_1 + W_2 + W_3) * G_2$ $M_Z = FyX_1$ $M_X = FyX_2$ W_3= Weight of Valve Neck (LBS)

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

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

OR

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

$$J_2 = \frac{(T3 - 2R_5)T_4^3}{12} - \frac{\pi}{64} Di^4 \text{ OR } \frac{\pi}{64}(d_3 4 - Di^4)$$

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

B. TRANSVERSE DIRECTION (F_X)

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

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

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

C. LONGITUDINAL DIRECTION (F_Z)

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

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

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

ROOT SUM SQUARE STRESSES:

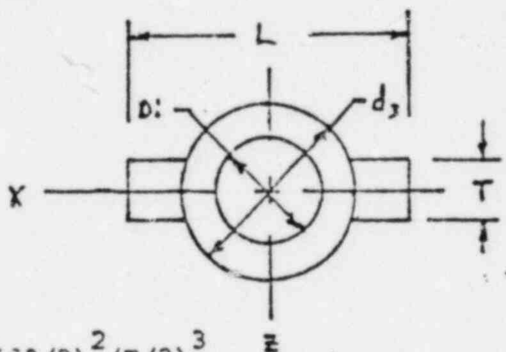
$S_{SS} = \sqrt{S_{SX}^2 + S_{SZ}} + S_S$ SHEAR (PSI)

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

MAXIMUM STRESS: MAX. STRESSTHEORY

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

Valve with Gussets



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

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

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

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

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

$S_{Ty} = \frac{Fy}{A} + \frac{Mz\ L}{2J_3} + \frac{Mx\ d_3}{2J_2}$

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

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

5. VALVE STEM:

OPERATING STRESSES -

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

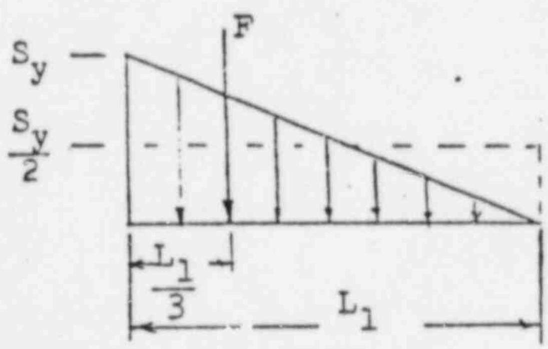
$$F = \tfrac{1}{2}\frac{P}{A} = \frac{\pi P D^2}{8} \quad \tfrac{1}{2} \text{ APPLIED FORCE ON DISC (LBS.)}$$

THE EFFECTIVE BEARING LENGTH IS DERIVED AS FOLLOWS:

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

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

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



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

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

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

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

SEISMIC STRESSES -

$$M = \frac{W4g}{2}\left[\frac{L1}{3} + L_2\right] \qquad \varepsilon = \sqrt{\varepsilon_x^{\,2} + \varepsilon_z^{\,2}}$$

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

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

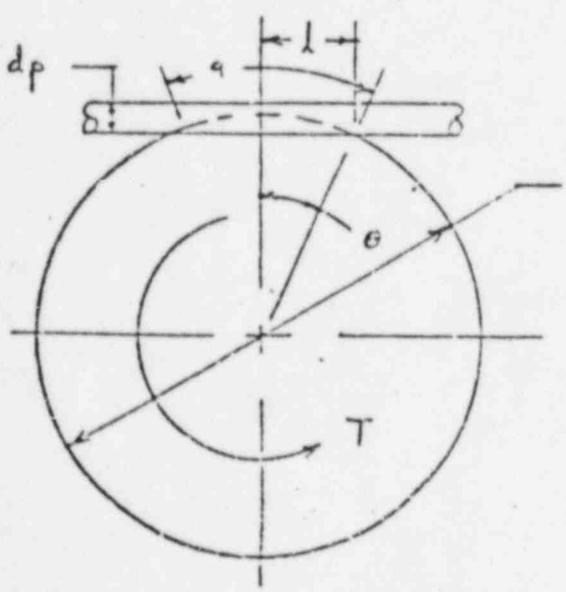
MAXIMUM STRESS: <u>MAX. STRESS THEORY</u>

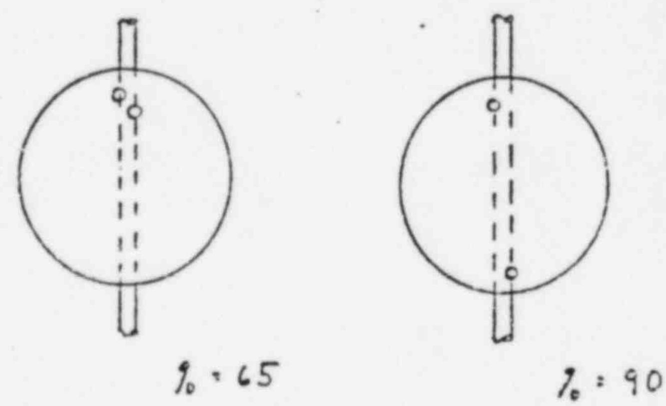
$$S_t = \frac{Sbs}{2} + \sqrt{\left[\frac{Sbs}{2}\right]^2 + Ss^2}$$

6. <u>VALVE DISC PIN:</u> (NO. SEISMIC STRESSES)

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

T = Torque due to seal torque and hydrostatic torque.





$As = .7854\ adp$ SHEAR AREA (IN^2)

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

$\theta = SIN^{-1}(\frac{21}{D_1})$

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

C. VALVE AND PIPING SECTION MODULUS:

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

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

$Zv > 1.1Zp$

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

R_7= VALVE BODY WATERWAY DIA. (IN.)

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

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

D. DEFLECTIONS:

$\Delta_{X,Y,Z} = \frac{Wg,x,y,z}{K_{L,V}}$ WHERE: W= WEIGHT OF ACTUATOR + 1/2 WEIGHT OF BRACKET (LBS.)

g= G LOAD = $\sqrt{gx2 + gy2 + gz2}$

K= SPRINGRATE (LATERAL OR VERTICAL) LBS/IN

E. VALVE BODY BOLTING:

$F = \frac{4}{3X_0N_3}\left[(1 + Cos\frac{\pi}{N_3})\right] M_4$ MAXIMUM BOLT LOAD (LBS)

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

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

N_3= NO. OF BODY BOLTS

X_0= D_{BC} OF BODY BOLTS (IN)

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

NOTE: NOT APPLICABLE IF BODY IS WAFER STYLE OR IF SECTION MODULUS AND ALLOWABLE MATERIAL STRENGTH OF VALVE EXCEEDS THAT OF ADJACENT PIPING. PIPING MAT'L ASSUMED SA106 GR.B S ALLOW= 15,000

DETAILED ANALYSIS

Per Reference (f) upon a LOCA the containment and drywell will be pressurized to 9 and 30 psi above atmospheric, respectively. The media flowing through these valves is steam/air at 100% R.H. and 330°F.

To perform the analyses the media is first assumed to be super heated steam with its density obtained from Reference (g), based on the corresponding pressure and temperature (condition 1). The media is then assumed to be air with its density being obtained using the ideal gas law and the corresponding temperature and pressure (condition 2). For conservatism, the analyses are also performed assuming the temperature to be the temperature for saturated steam (condition 3 being steam and condition 4 being air).

The above translates into the following conditions:

LOCA CONDITIONS

	Drywell CASES 1 thru 5				Containment CASE 6			
	Condition				Condition			
	1	2	3	4	1	2	3	4
Media	Steam	Air	Steam	Air	Steam	Air	Steam	Air
Upstream Pressure	44.7	44.7	44.7	44.7	23.7	23.7	23.7	23.7
Initial Density	.0995	.153	.106	.164	.0509	.0810	.0564	.0918
Initial Temperature	330	330	274	274	330	330	237	237
Final Pressure	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7

To determine which condition results in the largest aerodynamic torque for those systems connected to the drywell, the computer program "FLOW-GAS" is run for Case 1 using all four conditions. The same is performed for Case 6 to determine which is the worst condition for the piping system in containment.

For Case 1, condition 2 was the worst, for Case 6, condition 4, although in both cases the variation was less than 1.0%. Using condition 2, the flow and the aerodynamic torque were calculated for Cases 1A through 5A. For Case 6A, condition 4 was used. The computer input sheets and results of these calculations are given in Appendix B.

The flow conditions for all cases were then used for input into the computer program "FLOW-CL" to determine the closing times. This was performed for both flow in the preferred direction and the nonpreferred direction. The computer input sheets and results for these calculations are given in Appendix C.

Shown in Appendix D is a comparison of the calculated closing times under no flow conditions to the actual closing times of the subject valves when tested at Posi-Seal. Posi-Seal believes the relatively good correlation between the closing times demonstrates the accuracy of the computer program "FLOW-CL."

The largest aerodynamic torques for each of the unique valve sizes (10", 24" and 36") along with their corresponding bearing torques are then inputted into the computer program "LOCA-SMC." This program then calculates the combined seismic, operational and LOCA stresses of the critical areas of the valve assembly. These stresses are then showed to be less than the allowable. If they are not, then a material change is made to ensure the stresses are less. These calculations can be found in Appendix E.

As can be seen on Page E-3, the stresses for the actuator bolts based on an aerodynamic torque of 122,133 in.lbs exceed the allowable stress for bolt material A193 Gr B7. Consequently, the bolt material is changed to A354 Gr BD for all 36" valves.

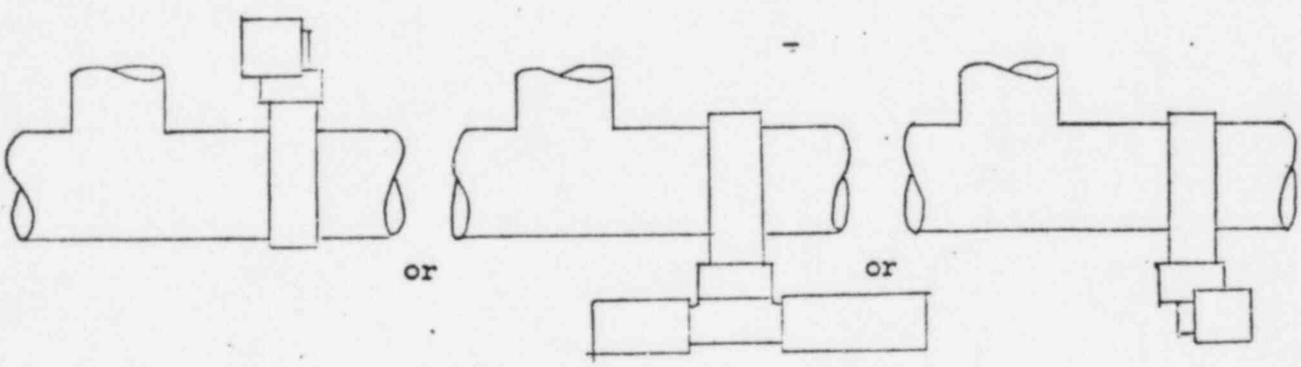
INFLUENCE OF BENDS AND TEES

The piping systems where bends and tees could have an influence on the aerodynamic torque of the valves are:

1. Cases 2 and 3 where valve 1VQ004B is downstream of a 24" X 36" reducing tee.

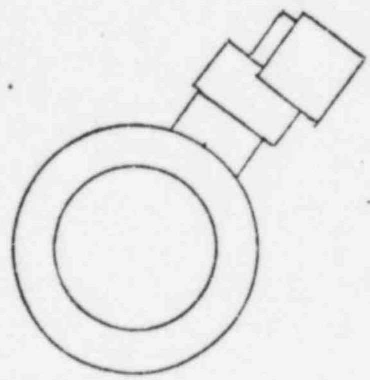
2. Cases 4 and 5 where valve 1VQ003 is downstream of a 124° bend.

For valve 1VQ004B if it is to be cycled the same time or before the other valves in the system, it is recommended that the valve be orientated as shown below.

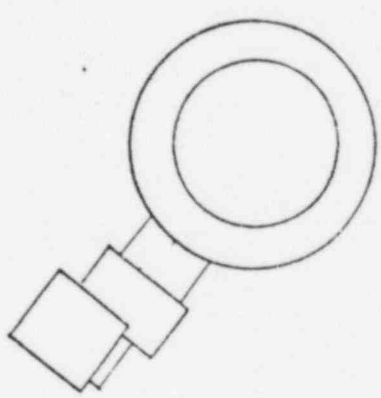


The reason being that the flow from the tee will impact evenly on either side of the valve stem.

For valves 1VQ003A, Reference (h) shows the valve to be oriented as such:

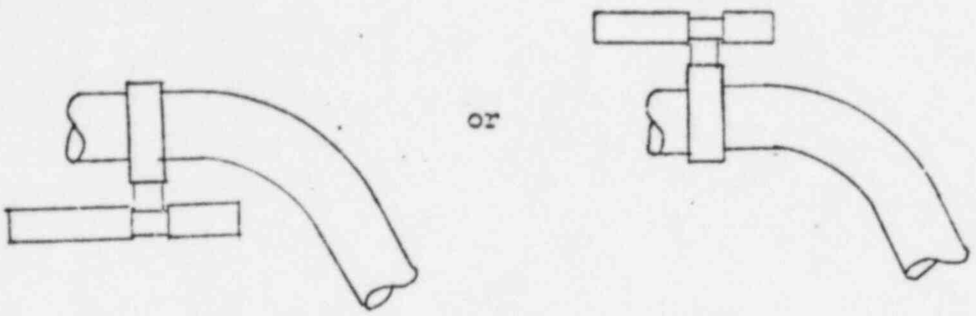


If this valve has to be cycled the same time as, or before the valve upstream, and has to be placed on a forty-five degree angle for space considerations, then it should be oriented as shown below:



This is done such that the flow will impact the disc on the side of the disc that will tend to close the valve.

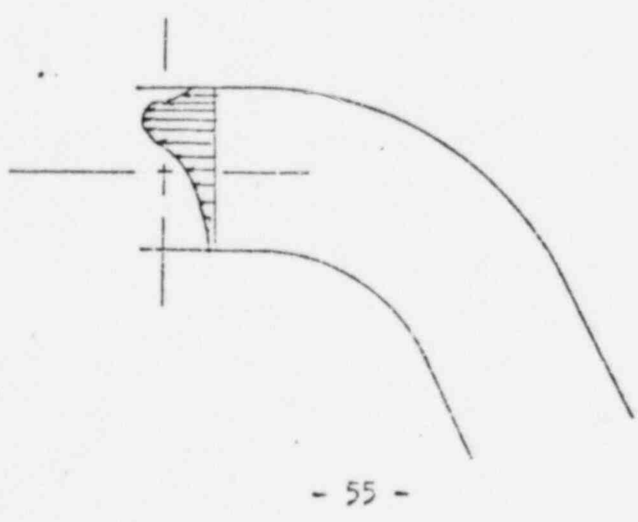
If space consideration allows, then valve 1VQ003 should be orientated as shown below:



NOTE: ASCO 8211 solenoid valves have to be mounted upright to operate properly. Therefore, for the valve assemblies rotated from the vertical, the type of solenoid should be changed or the 8211 solenoid reorientated to be upright.

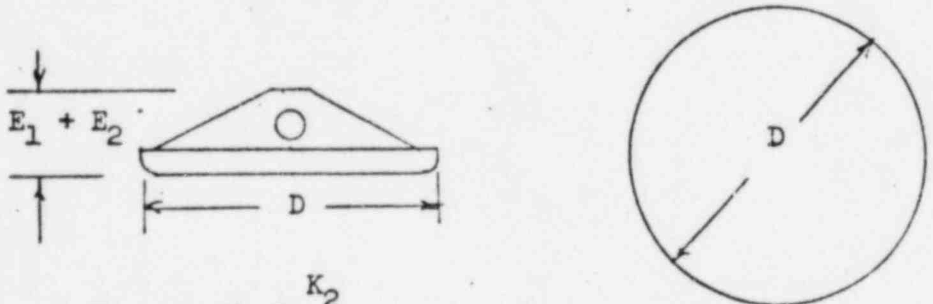
Posi-Seal has performed an investigation to determine what effect a pipe bend upstream from a valve will have on aerodynamic torque. To date this investigation has not revealed anything that Posi-Seal can use with confidence. Consequently Posi-Seal has taken the following approach to analyzing the valve 1VQ003.

If the valve were located such that it's stem layed in the plane of the bend, the flow would impact evenly on each side of the stem with the resultant of the velocity profile acting out board of the valve center line.



To obtain a feel for what effect this would have, it is assumed that this resultant acts at the halfway point between the disc center line and the end of the disc, and that the density of the flow is doubled.

Posi-Seal has determined that the hydrodynamic torque factor, T_{4W}, is a function of the shape factor $(E_1 + E_2)/D$.



$$T_{4W} = K_1 D^{K_2}$$

$$K_1 = (E_1 + E_2)/D$$

$$K_2 = 4.6098 - 5.915\ K_1$$

The hydrodynamic torque factor for a 36" valve at 90° equals 89607 in.lbs/psi. If D equals .707 D (24.591") based on the assumption above, the hydrodynamic torque factor equals 11,134 in.lbs/psi. (Note, this is approximately equal to the hydrodynamic torque factor (12758) for a 24" valve where D = 22.352). Since aerodynamic torque is directly proportional to the density and the hydrodynamic torque per Page 16, the resulting aerodynamic torque for the case assumed above is approximately one quarter that for flow going directly through the valve.

If the valve was located such that the stem is perpendicular to the bend, a term has to be added to the aerodynamic torque that takes into consideration flow impacting the disc outboard of the stem.

The magnitude of this force can be determined by using the principles of impulse and momentum.

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

$$V_2 = 0$$

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

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

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

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

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

where Q = Flow - SCFH

$$F = \frac{.0764\ Q\ V}{323\ (3600)} = \frac{Q\ V}{1.517 \times 10^6}$$

Taking the flows and velocities which resulted in the largest aerodynamic torques for this valve (Case 5) assuming flow directly through the valve, the forces are determined for the various valve angles.

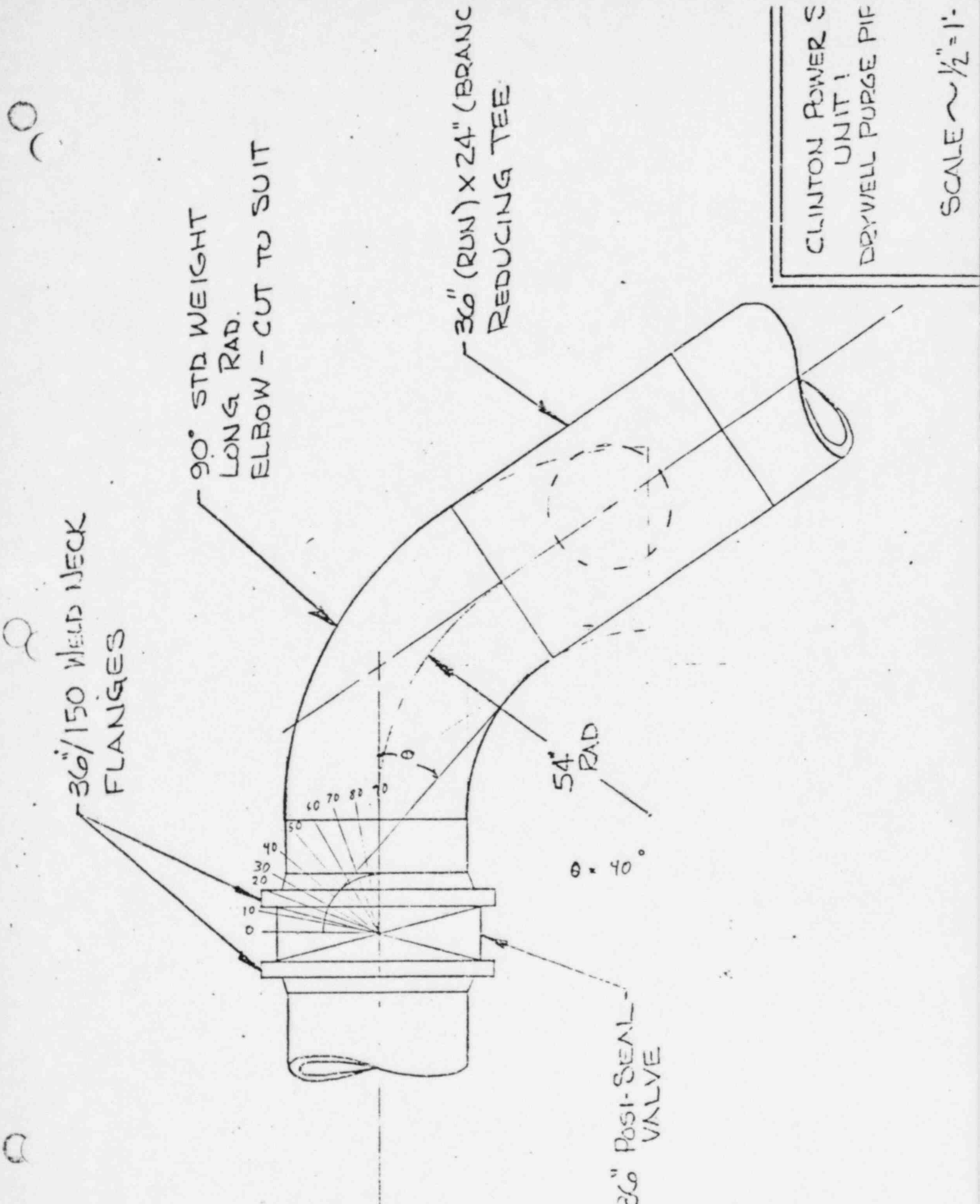
Deg.	Q	V	F
10	1,597,000	69.4	73
20	3,195,000	138.6	291
30	6,480,000	281.6	1203
40	9,360,000	401.4	2476
50	11,360,000	493.6	3695
60	12,100,000	526.2	4196
70	12,100,000	513.6	4095
80	12,100,000	513.6	4095
90	12,100,000	513.6	4095

Again, assuming the resultant force acts at the midpoint between the center and the end of the discs, and that the worst angle of attack for the subject valve is 40° (See Figure 8), the resulting torques are calculated.

$$R = \frac{D}{4} \left| \cos (40 - \Theta) \right| \qquad T_R = R\,F \quad \text{in.lbs}$$

Deg.	R	T_R
10	7,524	549
20	8,164	2,370
30	8,556	10,290
40	8,688	21,510
50	8,556	31,610
60	8,164	34,260
70	7,524	30,810
80	6,655	27,250
90	5,584	22,870

If the above torque at 80° is added to the aerodynamic torque calculated for Case 5 at 80°, the maximum resulting torque based on the assumptions for this orientation is obtained. This torque is 115,900 in.lbs.



36"/150 WELD NECK FLANGES
90° STD WEIGHT LONG RAD. ELBOW - CUT TO SUIT
36" (RUN) X 24" (BRANC
REDUCING TEE
CLINTON POWER S
UNIT 1
DRYWELL PURGE PIF
SCALE ~ 1/2" = 1'
54" RAD
θ = 40°
36" POSI-SEAL VALVE
0
10
20
30
40
50
60
70
80
90

Figure 8

Since the valve 1VQ003 will be orientated on a 45° angle, halfway between the two orientations described above, Posi-Seal believes that the aerodynamic torque value will be subject to less than that calculated for flow going straight through the valve. However, for conservatism the combined seismic and LOCA stress analysis for this valve will be based on an aerodynamic torque of 122,000 in.lbs. This torque being the torque that valves 1VR001A&B will experience.

APPENDIX A

Schematics of the Piping Systems

CASE 1

DRYWELL

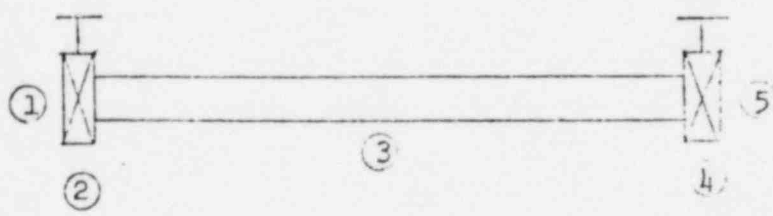
24" Valves 1VQ001A & 1VQ001B

Worst condition

Upstream flange of 1VQ001A breaks off

Downstream flange of 1VQ001B breaks off

The resulting system is as shown below:



per Ref. (h)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	$K = .5$ $D_{IN} = 24"$
2	Valve (7)	$C_V = 23412$
3	Straight Pipe (4)	$L = 9.6'$
4	Valve (7)	$C_V = 23412$
5	Exit (8)	$K = 1$ $D_{OUT} = 24"$

Valve 1VQ001B (4) is cycled close.

CASE 1A

Valve 1VQ001 A(2) is cycled close.

CASE 2

DRYWELL

10" Valve 1VQ005 and

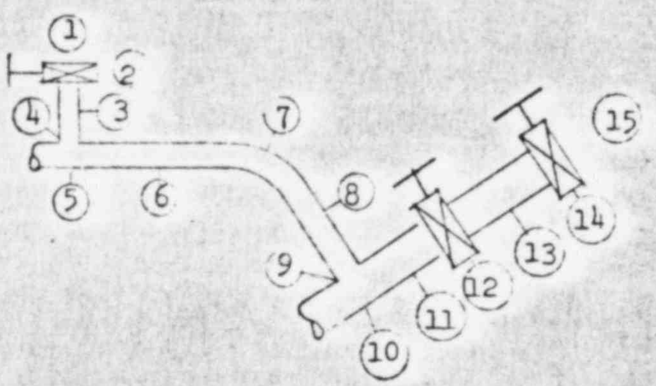
36" Valves 1VQ004A & 1VQ004B

Worst Condition

Upstream flange of 1VQ005 breaks off

Downstream flange of 1VQ004A breaks off

The resulting system is as shown below



per Ref. (h)

Station No.	Type of Resistance	(No.)	
1	Entrance	(1)	$K = .5 \quad D_{IN} = 10$
2	Valve	(7)	$C_V = 3178$
3	Straight Pipe	(4)	$L = 2.2'$
4	Tee	(6)	$K = 60\ f_t = .84$
5	Expander	(3)	$D_{OUT} = 24$

Station No.	Type of Resistance (No.)	
6	Straight Pipe (4)	L = 11.7'
7	Bend 110° (5)	$K = 5 f_t = .06$
8	Straight Pipe (4)	L = 11.7'
9	Tee (6)	$K = 60 f_t = .72$
10	Expander (3)	$D_{OUT} = 36"$
11	Straight Pipe (4)	L = 3'
12	Valve (7)	$C_V = 60648$
13	Straight Pipe (4)	L = 20.6'
14	Valve (7)	$C_V = 60648$
15	Exit (8)	$K = 1$ $D_{OUT} = 36"$

36" Valve 1VQ004B (14) is cycled close.

CASE 2A

10" Valve 1VQ005(2) is cycled close.

CASE 2B

36" Valve 1VQ004A(12) is cycled close.

CASE 3

DRYWELL

24" Valve 1VQ002 and

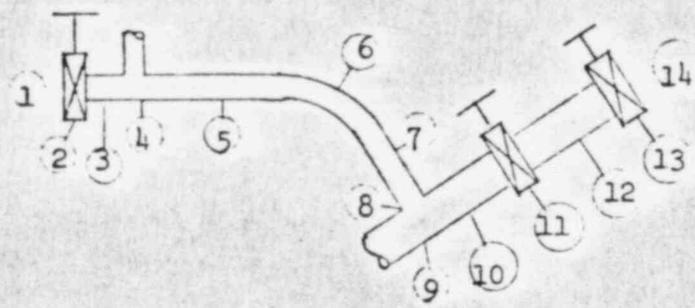
36" Valves 1VQ004A & 1VQ004B

Worst Condition

Upstream flange of 1VQ002 breaks off

Downstream flange of 1VQ004A breaks off

The resulting system is as shown below



per Ref. (h)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	K = .5 D_{IN} = 24"
2	Valve (7)	C_V = 23412
3	Straight Pipe (4)	L = 1.8'
4	Tee (6)	K = 20 f_t = .24
5	Straight Pipe (4)	L = 11.7'
6	Bend 110° (5)	K = 5 ft. = .06

Station No.	Type of Resistance (No.)	
7	Straight Pipe (4)	$L = 11.7'$
8	Tee (6)	$K = 60\ f_t = .72$
9	Expander (3)	$D_{OUT} = 36"$
10	Straight Pipe (4)	$L = 3'$
11	Valve (7)	$C_V = 60648$
12	Straight Pipe (4)	$L = 20.6'$
13	Valve (7)	$C_V = 60648$
14	Exit (8)	$K = 1 \quad D_{OUT} = 36"$

36" Valve 1VQ004B (13) is cycled close.

CASE 3A

24" Valve 1VQ002 (2) is cycled close.

CASE 3B

36" Valve 1VQ004A(11) is cycled close.

CASE 4

DRYWELL

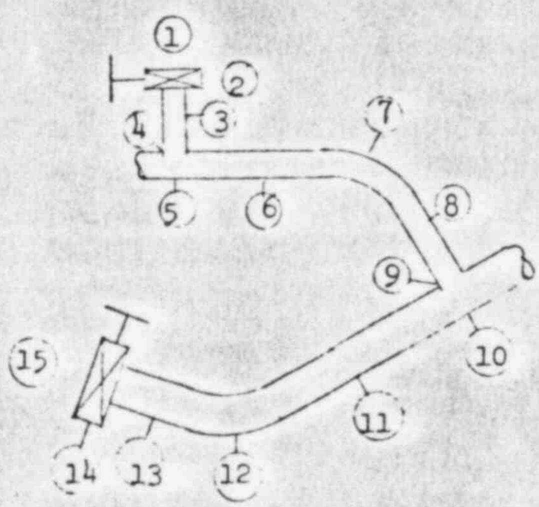
10" Valve 1VQ005 and 36" Valve 1VQ003

Worst Condition

Upstream flange of 1VQ005 breaks off

Downstream flange of 1VQ003 breaks off

The resulting system is as shown below:



per Ref. (h)

Station No.	Type of Resistance (No.)		
1	Entrance (1)	K = .5	D_{IN} = 10"
2	Valve (7)	C_V = 3178	
3	Straight Pipe (4)	L = 2.2'	
4	Tee (6)	K = 60 f_t = .84	
5	Expander (3)		D_{OUT} = 24"

Station No.	Type of Resistance (No.)		
6	Straight Pipe (4)		L = 11.7'
7	Bend 110°	(5)	K = 5 f_t = .06
8	Straight Pipe (4)		L = 11.7'
9	Tee	(6)	K = 60 f_t = .72
10	Expander	(3)	D_{OUT} = 36"
11	Straight Pipe (4)		L = 4.6'
12	Bend 124°	(5)	K = 10 f_t = .12
13	Straight Pipe (4)		L = 3.9'
14	Valve	(7)	C_V = 60648
15	Exit	(8)	K = 1.0 D_{OUT} = 36"

36" Valve 1VQ003 (14) is cycled close.

CASE 4A

10" Valve 1VQ005 (2) is cycled close.

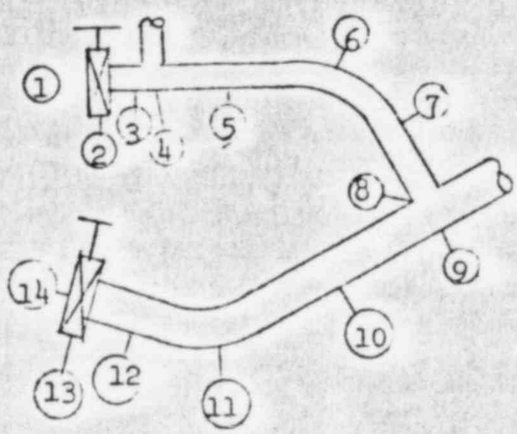
<u>CASE 5</u>

24" Valve 1VQ002 & 36" Valve 1VQ003

Worst Condition

Upstream flange of 1VQ002 breaks off

Downstream flange of 1VQ003 breaks off



Per Ref. (h)

Station No.	Type of Resistance (No.)	
1	Entrance (1)	$K = .5 \quad D_{IN} = 24"$
2	Valve (7)	$C_V = 23412$
3	Straight Pipe (4)	$L = 1.8'$
4	Tee (6)	$K = 20\ f_t = .24$
5	Straight Pipe (4)	$L = 11.7'$
6	Bend 110° (5)	$K = 5\ f_t = .06$
7	Straight Pipe (4)	$L = 11.7'$
8	Tee (6)	$K = 60\ f_t = .72$

Station No.	Type of Resistance (No.)		
9	Expander (3)		D_{OUT} = 36"
10	Straight Pipe (4)	L = 4.6'	
11	Bend 124° (5)	K = 10 f_t = .12	
12	Straight Pipe (4)	L = 3.9'	
13	Valve (7)	C_V = 60648	
14	Exit (8)	K = 1.0	D_{OUT} = 36"

36" Valve 1VQ003 (13) is cycled close.

CASE 5A

24" Valve 1VQ002(2) is cycled close.

CASE 6

CONTAINMENT

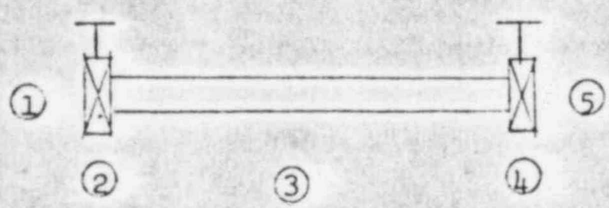
36" Valves 1VR001A & 1VR001B

Worst Condition

Upstream flange to 1VR001B breaks off

Downstream flange to 1VR001A breaks off

The resulting system is shown below:



per Ref. (i)

Station No.	Type of Resistance (No.)		
1	Entrance (1)	K = .5	D_{IN} = 36"
2	Valve (7)	C_V = 60648	
3	Straight Pipe (4)	L = 9.7'	
4	Valve (7)	C_V = 60648	
5	Exit (8)	K = 1	D_{OUT} = 36"

Valve 1VR001B(4) is cycled close.

CASE 6A

Valve 1VR001A(2) is cycled close.

APPENDIX B

Determination of Flow Conditions

CASE 1

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .0995 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	9.95	330	14.7	44.7

	SP. HEAT	GRAVITY		@90 DEG
STEAM	1.329	.62	1	12758

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	9.6	0.072	0.072000
4	VALVE	24.0	0.0	0.541	0.541140
5	EXIT	24.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW=14,484,845 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	640.1
2	39.1	0.0900	319.3	703.7
3	36.1	0.0848	313.1	747.3
4	35.5	0.0838	311.9	751.7
5	33.4	0.0799	307.1	796.1
6	14.7	0.0430	250.5	1478.0

NOTE: THERE IS CHOKE FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 8,161 IN.LBS

DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	14,484,845	2.14	37,553	126

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	640.1
2	39.1	0.0900	319.3	703.7
3	36.1	0.0848	313.1	747.3
4	35.5	0.0838	311.9	751.7
5	33.4	0.0799	307.1	796.1
6	14.7	0.0430	250.5	1478.0

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	14,484,845	2.14	45,439	126

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	640.1
2	39.1	0.0900	319.3	703.7
3	36.1	0.0848	313.1	747.3
4	35.5	0.0838	311.9	751.7
5	33.4	0.0799	307.1	796.1
6	14.7	0.0430	250.5	1478.0

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	13,183,576	9.72	32,011	573

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	582.6
2	40.3	0.0921	321.7	626.7
3	38.0	0.0881	317.0	655.2
4	37.5	0.0873	316.1	659.0
5	27.8	0.0696	293.5	825.6
6	14.7	0.0432	250.8	1316.9

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	10,560,121	18.84	13,417	1,111

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	466.6
2	42.3	0.0955	325.6	483.6
3	40.9	0.0932	323.0	495.6
4	40.8	0.0929	322.6	495.6
5	21.9	0.0593	276.7	796.3
6	14.7	0.0430	250.5	1077.5

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	7,883,826	24.52	4,215	1,446

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	348.4
2	43.5	0.0975	327.9	353.7
3	42.8	0.0963	326.5	358.1
4	42.7	0.0962	326.3	358.1
5	18.2	0.0506	264.2	684.1
6	14.7	0.0430	250.5	804.4

0110 NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	5,350,315	27.70	1,327	1,633

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	236.4
2	44.2	0.0987	329.1	237.6
3	43.9	0.0982	328.5	238.9
4	43.8	0.0981	328.5	238.9
5	16.1	0.0463	256.6	507.8
6	14.7	0.0430	250.5	545.9

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	3,306,721	29.20	282	1,721

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	146.1
2	44.5	[illegible]	329.7	146.1
3	44.4	0.0991	329.5	146.4
4	44.4	0.0990	329.5	146.4
5	15.2	0.0442	252.8	328.3
6	14.7	0.0430	250.5	337.4

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,658,262	29.80	45	1,757

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	73.2
2	44.6	0.0994	329.9	73.2
3	44.6	0.0994	329.8	73.3
4	44.6	0.0993	329.8	73.3
5	14.8	0.0433	251.1	168.0
6	14.7	0.0430	250.5	169.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	835,650	29.95	4	1,765

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.0995	330.0	36.9
2	44.6	0.0994	329.9	36.9
3	44.6	0.0994	329.9	36.9
4	44.6	0.0994	329.9	36.9
5	14.7	0.0431	250.7	85.1
6	14.7	0.0430	250.5	85.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

CASE 1

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

UPSTREAM PRESSURE 44.7 PSIA	INITIAL DENSITY .153 LBS/FT^3
INITIAL TEMPERATURE 330 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 44.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1.4
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2 IN.	GAGE DIA. 22.352 IN
PACKING TORQUE 1210 IN.LBS.	SEAL TORQUE 4316 IN.LBS
DIRECTION Preferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7
	SP. HEAT	GRAVITY		890 DEG
AIR	1.4	1	1	12755

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	9.6	0.072	0.072000
4	VALVE	24.0	0.0	0.541	0.541140
5	EXIT	24.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW=11,936,931 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	35.7	0.1305	309.7	616.3
4	35.0	0.1286	307.8	623.4
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.4

NOTE: THERE IS CHOKE FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 8,161 IN.LBS

DELTA P=30.00 PSI

0115

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	11,936,931	2.47	39,525	146

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	35.7	0.1305	309.7	616.3
4	35.0	0.1286	307.8	623.4
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.4

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	11,936,931	2.47	47,825	146

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	35.7	0.1305	309.7	616.3
4	35.0	0.1286	307.8	623.4
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.4

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	10,795,461	9.80	32,991	578

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	476.6
2	40.4	0.1425	320.7	509.9
3	38.0	0.1362	315.0	533.3
4	37.4	0.1349	313.8	537.3
5	27.6	0.1086	287.7	671.3
6	14.7	0.0691	240.1	1054.8

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	8,520,213	19.27	13,299	1,136

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	376.5
2	42.3	0.1471	324.8	390.5
3	40.9	0.1436	321.7	400.2
4	40.7	0.1431	321.3	400.2
5	21.4	0.0905	267.5	636.1
6	14.7	0.0691	240.1	833.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	6,372,954	24.64	4,124	1,452

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	261.6
2	43.5	0.1501	327.4	286.3
3	42.7	0.1482	325.8	289.8
4	42.6	0.1480	325.6	289.8
5	18.0	0.0800	254.6	538.5
6	14.7	0.0691	240.1	623.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	4,330,358	27.79	1,289	1,636

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	191.3
2	44.2	0.1520	329.1	191.9
3	43.9	0.1511	328.4	193.0
4	43.9	0.1510	328.3	193.0
5	16.1	0.0738	246.5	396.4
6	14.7	0.0691	240.1	423.5

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,674,615	29.22	273	1,722

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	118.1
2	44.5	0.1527	329.7	118.1
3	44.4	0.1524	329.4	118.4
4	44.4	0.1523	329.4	118.4
5	15.2	0.0708	242.5	255.1
6	14.7	0.0691	240.1	261.5

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,351,520	29.80	44	1,757

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	59.7
2	44.6	0.1529	329.9	59.7
3	44.6	0.1528	329.8	59.7
4	44.6	0.1528	329.8	59.7
5	14.8	0.0695	240.7	131.3
6	14.7	0.0691	240.1	132.1

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	686,745	29.94	4	1,765

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	30.3
2	44.6	0.1529	329.9	30.3
3	44.6	0.1529	329.9	30.3
4	44.6	0.1529	329.9	30.3
5	14.7	0.0692	240.3	67.0
6	14.7	0.0691	240.1	67.1

NOTE: THERE IS CHOKE FLOW AT STATION 4

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CASE 1

CONDITION 3

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

UPSTREAM PRESSURE 447 PSIA

INITIAL TEMPERATURE 274 °F

SHUT OFF PRESSURE 447 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .106 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2.0 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	10.6	274	14.7	44.7
	SP. HEAT	GRAVITY		@90 DEG
STEAM	1.329	.62	1	12758

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	9.6	0.072	0.072000
4	VALVE	24.0	0.0	0.541	0.541140
5	EXIT	24.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW=15,028,941 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	617.0
2	39.2	0.0960	265.2	677.8
3	36.2	0.0904	260.0	719.7
4	35.4	0.0891	258.8	727.7
5	33.1	0.0847	254.5	772.2
6	14.7	0.0459	208.0	1424.8

NOTE: THERE IS CHOKE FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 8,161 IN.LBS

DELTA P=30.00 PSI

0123

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	15,028,941	2.32	37,407	136

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	617.0
2	39.2	0.0960	265.2	677.8
3	36.2	0.0904	260.0	719.7
4	35.4	0.0891	258.8	727.7
5	33.1	0.0847	254.5	772.2
6	14.7	0.0459	208.0	1424.8

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	15,028,941	2.32	45,262	136

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	617.0
2	39.2	0.0960	265.2	677.8
3	36.2	0.0904	260.0	719.7
4	35.4	0.0891	258.8	727.7
5	33.1	0.0847	254.5	772.2
6	14.7	0.0459	208.0	1424.8

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	13,764,069	8.97	31,972	529

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	565.1
2	40.3	0.0981	267.1	608.1
3	37.9	0.0937	263.1	636.4
4	37.5	0.0929	262.3	639.8
5	28.5	0.0756	245.2	791.9
6	14.7	0.0459	208.0	1304.9

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	10,922,255	18.96	13,278	1,117

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	448.4
2	42.2	0.1016	270.2	466.0
3	40.9	0.0992	268.1	477.5
4	40.7	0.0988	267.8	477.5
5	21.8	0.0617	229.3	769.8
6	14.7	0.0459	208.0	1035.5

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	8,177,799	24.63	4,183	1,452

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	335.7
2	43.6	0.1040	272.3	340.6
3	42.8	0.1027	271.2	344.8
4	42.7	0.1025	271.0	344.8
5	18.1	0.0538	219.2	661.2
6	14.7	0.0459	208.0	775.3

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	5,547,236	27.74	1,313	1,635

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	227.7
2	44.2	0.1052	273.3	228.8
3	43.9	0.1046	272.8	230.0
4	43.8	0.1045	272.7	230.0
5	16.1	0.0492	212.9	489.7
6	14.7	0.0459	208.0	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	3,431,132	29.21	280	1,72[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	140.8
2	44.5	0.1057	273.8	140.8
3	44.4	0.1055	273.6	141.1
4	44.4	0.1055	273.6	141.1
5	15.2	0.0471	209.9	316.6
6	14.7	0.0459	208.0	325.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,720,637	29.80	44	1,757

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	70.6
2	44.6	0.1059	273.9	70.6
3	44.6	0.1058	273.9	70.6
4	44.6	0.1058	273.9	70.6
5	14.8	0.0462	208.5	162.0
6	14.7	0.0459	208.0	163.1

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	867,099	29.95	4	1,765

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1060	274.0	35.6
2	44.6	0.1059	273.9	35.6
3	44.6	0.1059	273.9	35.6
4	44.6	0.1059	273.9	35.6
5	14.7	0.0459	208.1	82.0
6	14.7	0.0459	208.0	82.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

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CASE 1

CONDITION 4

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 274 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .164 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2.0 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	16.4	274	14.7.	44.7
	SP. HEAT	GRAVITY		890 DEG
AIR	1.4	1	1	12758

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	9.6	0.072	0.072000
4	VALVE	24.0	0.0	0.541	0.541140
5	EXIT	24.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN

FLOW=12,409,306 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	509.5
2	39.1	0.1490	263.7	558.9
3	35.7	0.1398	257.0	595.6
4	34.9	0.1375	255.3	604.3
5	32.6	0.1309	250.3	638.3
6	14.7	0.0741	199.4	1127.6

NOTE: THERE IS CHOKE FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT

VALVE TORQUE= 8,161 IN.LBS

DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,409,306	2.32	39,498	137

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	509.5
2	39.1	0.1490	263.7	558.9
3	35.7	0.1398	257.0	595.6
4	34.9	0.1375	255.3	604.3
5	32.6	0.1309	250.3	638.3
6	14.7	0.0741	199.4	1127.6

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,409,306	2.32	47,793	137

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	509.5
2	39.1	0.1490	263.7	558.9
3	35.7	0.1398	257.0	595.6
4	34.9	0.1375	255.3	604.3
5	32.6	0.1309	250.3	638.3
6	14.7	0.0741	199.4	1127.6

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	11,131,062	10.60	32,719	625

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	457.0
2	40.5	0.1530	266.4	488.3
3	38.0	0.1462	261.7	510.7
4	37.5	0.1448	260.7	514.2
5	26.9	0.1143	237.1	651.6
6	14.6	0.0738	199.1	1002.3

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	8,839,321	19.28	13,257	1,137

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	362.9
2	42.3	0.1576	269.7	376.7
3	40.8	0.1538	267.1	386.0
4	40.7	0.1533	266.7	386.0
5	21.4	0.0969	222.0	613.8
6	14.7	0.0741	199.4	803.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	6,606,988	24.68	4,103	1,455

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	271.2
2	43.5	0.1610	271.9	275.4
3	42.8	0.1590	270.6	278.9
4	42.7	0.1587	270.4	278.9
5	18.0	0.0857	211.3	518.9
6	14.7	0.0741	199.4	600.3

n002 NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	4,490,358	27.71	1,283	1,633

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	184.3
2	44.2	0.1627	273.1	185.5
3	43.8	0.1618	272.5	186.5
4	43.8	0.1617	272.4	186.5
5	16.1	0.0791	204.7	382.0
6	14.7	0.0741	199.4	408.0

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,769,633	29.22	271	1,723

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	113.7
2	44.5	0.1637	273.7	113.7
3	44.4	0.1633	273.5	113.9
4	44.4	0.1633	273.5	113.9
5	15.2	0.0759	201.3	245.5
6	14.7	0.0741	199.4	251.6

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,400,097	29.80	44	1,757

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	57.4
2	44.6	0.1639	273.9	57.4
3	44.6	0.1638	273.8	57.5
4	44.6	0.1638	273.8	57.5
5	14.8	0.0745	199.9	126.4
6	14.7	0.0741	199.4	127.2

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	711,189	29.94	4	1,765

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	29.2
2	44.6	0.1639	273.9	29.2
3	44.6	0.1639	273.9	29.2
4	44.6	0.1639	273.9	29.2
5	14.7	0.0742	199.5	64.5
6	14.7	0.0741	199.4	64.6

NOTE: THERE IS CHOKE FLOW AT STATION 4

CASE 1 A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-5880

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1.4

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10+2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	12758

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	9.6	0.072	0.072000
4	VALVE	24.0	0.0	0.541	0.541140
5	EXIT	24.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=11,936,377 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	35.8	0.1305	309.7	616.2
4	35.0	0.1286	307.8	623.4
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.3

NOTE: THERE IS CHOKE FLOW AT STATION 5

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 8,161 IN.LBS
DELTA P=30.00 PSI

0425

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	11,936,377	3.31	36,721	195

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	35.8	0.1305	309.7	616.2
4	35.0	0.1286	307.8	623.4
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.3

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	11,936,377	5.63	46,611	331

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	527.5
2	39.1	0.1390	317.6	578.5
3	33.4	0.1244	303.8	646.4
4	32.5	0.1221	301.5	657.0
5	32.5	0.1220	301.4	661.2
6	14.7	0.0691	240.1	1167.3

NOTE: THERE IS CHOKE FLOW AT STATION 5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	10,822,539	8.79	30,120	518

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	478.2
2	40.3	0.1422	320.4	513.5
3	31.5	0.1193	298.7	612.0
4	30.8	0.1174	296.8	619.8
5	27.2	0.1075	286.6	677.0
6	14.7	0.0680	238.6	1062.1

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	8,796,643	16.89	12,622	995

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	388.7
2	42.1	0.1466	324.4	404.6
3	25.2	0.1017	280.2	504.8
4	24.7	0.1003	278.8	592.4
5	22.0	0.0923	269.6	643.9
6	14.7	0.0691	240.1	860.3

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	6,474,248	23.83	4,001	1,405

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	286.1
2	43.5	0.1500	327.4	290.8
3	19.6	0.0851	250.9	514.3
4	19.4	0.0843	240.1	518.7
5	18.1	0.0804	255.1	544.3
6	14.7	0.0691	240.1	633.1

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	4,363,022	27.46	1,269	1,619

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	192.8
2	44.2	0.1520	329.1	193.4
3	16.8	0.0761	249.6	387.3
4	16.7	0.0758	249.2	388.8
5	16.1	0.0739	246.6	399.0
6	14.7	0.0691	240.1	426.7

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,671,671	29.09	269	1,715

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	118.0
2	44.5	0.1527	329.7	118.0
3	15.4	0.0717	243.7	251.7
4	15.4	0.0716	243.6	252.1
5	15.2	0.0709	242.5	254.8
6	14.7	0.0691	240.1	261.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,352,657	29.74	44	1,753

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	59.7
2	44.6	0.1529	329.9	59.7
3	14.9	0.0698	241.2	130.8
4	14.9	0.0698	241.1	130.9
5	14.8	0.0695	240.7	131.4
6	14.7	0.0691	240.1	132.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	683,896	29.93	4	1,764

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	30.2
2	44.6	0.1529	329.9	30.2
3	14.7	0.0693	240.4	66.6
4	14.7	0.0693	240.4	66.7
5	14.7	0.0692	240.3	66.7
6	14.7	0.0691	240.1	66.8

NOTE: THERE IS CHOKE FLOW AT STATION 2

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CASE 2

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 -9R80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1.4

HYDRODYNAMIC FACTOR
@ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7
	SP. HEAT	GRAVITY		@90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	10.0	0.0	0.500	0.500000
2	VALVE	10.0	0.0	0.885	0.885186
3	STRAIGHT PIPE	10.0	2.2	0.039	0.039600
4	TEE	10.0	0.0	0.840	0.840000
5	EXPANDER	10.0	0.0	0.682	0.682918
6	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
7	PIPE BEND	24.0	0.0	0.060	0.001808
8	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
9	TEE	24.0	0.0	0.720	0.021701
10	EXPANDER	24.0	0.0	0.308	0.009302
11	STRAIGHT PIPE	36.0	3.0	0.015	0.000069
12	VALVE	36.0	0.0	0.408	0.002430
13	STRAIGHT PIPE	36.0	20.6	0.103	0.000613
14	VALVE	36.0	0.0	0.408	0.002430
15	EXIT	36.0	0.0	1.000	0.005953

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 2,113,075 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0684	239.2	208.6
7	14.5	0.0684	239.2	208.6
8	14.5	0.0684	239.2	208.6
9	14.5	0.0684	239.2	208.6
10	14.4	0.0684	239.2	208.7
11	14.7	0.0693	240.4	91.6
12	14.7	0.0693	240.4	91.6
13	14.7	0.0692	240.2	91.7
14	14.7	0.0692	240.2	91.7
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,889 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	2,113,075	0.03	2,208	6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0685	239.3	208.5
7	14.5	0.0685	239.3	208.5
8	14.5	0.0685	239.3	208.5
9	14.5	0.0685	239.2	208.5
10	14.5	0.0684	239.2	208.6
11	14.7	0.0693	240.4	91.5
12	14.7	0.0693	240.4	91.5
13	14.7	0.0692	240.3	91.7
14	14.7	0.0692	240.3	91.7
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	2,113,075	0.04	2,769	9

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1307.3
6	14.5	0.0685	239.3	208.3
7	14.5	0.0695	239.3	208.3
8	14.5	0.0685	239.3	208.3
9	14.5	0.0695	239.3	208.3
10	14.5	0.0685	239.3	208.4
11	14.7	0.0694	240.5	91.4
12	14.7	0.0694	240.5	91.4
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	2,113,075	0.08	2,082	16

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0686	239.5	208.0
7	14.5	0.0686	239.5	208.0
8	14.5	0.0686	239.5	208.0
9	14.5	0.0686	239.5	208.0
10	14.5	0.0686	239.4	208.1
11	14.8	0.0695	240.6	91.3
12	14.8	0.0695	240.6	91.3

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
13	14.7	0.0694	240.5	91.4
14	14.7	0.0694	240.5	91.4
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	2,113,075	0.17	1,121	37

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.6	0.0689	239.9	207.1
7	14.6	0.0689	239.9	207.1
8	14.6	0.0689	239.9	207.1
9	14.6	0.0689	239.9	207.1
10	14.6	0.0689	239.9	207.2
11	14.9	0.0698	241.1	90.9
12	14.9	0.0698	241.1	90.9
13	14.8	0.0697	240.9	91.0
14	14.8	0.0697	240.9	91.0
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	2,113,075	0.35	549	70

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.8	0.0696	240.8	205.2
7	14.8	0.0696	240.8	205.2
8	14.9	0.0695	240.8	205.2
9	14.8	0.0695	240.8	205.2
10	14.8	0.0695	240.7	205.3
11	15.0	0.0704	241.9	90.1
12	15.0	0.0704	241.9	90.1
13	15.0	0.0703	241.8	90.2
14	15.0	0.0703	241.8	90.2
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	2,113,075	0.92	343	162

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	15.4	0.0714	243.4	199.8
7	15.4	0.0714	243.4	199.8
8	15.4	0.0714	243.4	199.8
9	15.4	0.0714	243.4	199.8

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10	15.3	0.0714	243.3	199.9
11	15.6	0.0723	244.5	87.7
12	15.6	0.0723	244.5	87.7
13	15.6	0.0722	244.4	87.9
14	15.6	0.0722	244.4	87.9
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,113,075	3.26	183	64[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.1
4	31.3	0.1188	298.2	687.9
5	14.0	0.0669	237.0	1229.6
6	17.7	0.0790	253.3	180.7
7	17.7	0.0790	253.3	180.7
8	17.7	0.0790	253.3	180.7
9	17.7	0.0790	253.3	180.7
10	17.7	0.0790	253.3	180.9
11	17.9	0.0798	254.4	79.4
12	17.9	0.0798	254.4	79.4
13	17.9	0.0797	254.3	79.5
14	17.9	0.0797	254.3	79.5
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	2,002,925	11.47	102	2,252

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	509.8
2	39.5	0.1401	318.6	555.2
3	33.8	0.1254	304.8	620.2
4	33.5	0.1246	304.0	622.7
5	23.0	0.0951	272.9	811.6
6	25.9	0.1037	282.4	128.8
7	25.9	0.1037	282.4	128.8
8	25.9	0.1037	282.4	128.8
9	25.9	0.1037	282.4	128.8
10	25.9	0.1037	282.4	128.8
11	26.1	0.1044	283.2	56.7
12	26.1	0.1044	283.2	56.7
13	26.1	0.1044	283.2	56.7
14	26.1	0.1044	283.2	56.7
15	14.7	0.0691	240.1	87.0
16	14.7	0.0691	240.1	87.0

NOTE: THERE IS CHOKE FLOW AT STATION 14

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	1,003,845	27.24	10	5,347

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	255.5
2	43.7	0.1506	327.9	258.9
3	42.7	0.1401	325.8	263.2
4	42.7	0.1480	325.7	263.2
5	40.9	0.1438	321.9	270.5
6	41.7	0.1456	323.5	46.2

7	41.7	0.1456	323.5	46.2
8	41.7	0.1456	323.5	46.2
9	41.7	0.1456	323.5	46.2
10	41.7	0.1456	323.5	46.2
11	41.9	0.1462	324.0	20.4
12	41.9	0.1462	324.0	20.4
13	41.9	0.1461	324.0	20.4
14	41.9	0.1461	324.0	20.4
15	14.7	0.0691	240.1	43.6
16	14.7	0.0691	240.1	43.6

NOTE: THERE IS CHOKE FLOW AT STATION 14

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CASE 2 A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 10"

VALVE CLASS: 150

ACTUATOR: Matryx 20002-SK50

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 330 IN.LBS/PSI

STEM DIA. 1.125 IN.

PACKING TORQUE 680 IN.LBS.

DIRECTION Preferred

GAGE DIA. 9.85 IN

SEAL TORQUE 839 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=10   VALVE CLASS=150   FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	16.4	274	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	330

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.125	9.85	680	839

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	10.0	0.0	0.500	0.500000
2	VALVE	10.0	0.0	0.885	0.885186
3	STRAIGHT PIPE	10.0	2.2	0.039	0.039600
4	TEE	10.0	0.0	0.840	0.840000
5	EXPANDER	10.0	0.0	0.682	0.682918
6	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
7	PIPE BEND	24.0	0.0	0.060	0.001808
8	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
9	TEE	24.0	0.0	0.720	0.021701
10	EXPANDER	24.0	0.0	0.308	0.009302
11	STRAIGHT PIPE	36.0	3.0	0.015	0.000089
12	VALVE	36.0	0.0	0.408	0.002430
13	STRAIGHT PIPE	36.0	20.6	0.103	0.000613
14	VALVE	36.0	0.0	0.408	0.002430
15	EXIT	36.0	0.0	1.000	0.005963

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 2,191,068 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	518.2
2	38.7	0.1481	263.0	572.2
3	31.7	0.1285	248.5	659.7
4	31.3	0.1271	247.4	664.9
5	12.8	0.0672	191.7	1264.1
6	14.4	0.0733	198.6	201.0
7	14.4	0.0733	198.6	201.0
8	14.4	0.0733	198.6	201.0
9	14.4	0.0733	198.6	201.0
10	14.4	0.0733	198.5	201.1
11	14.7	0.0742	199.5	88.2
12	14.7	0.0742	199.5	88.2
13	14.7	0.0741	199.5	88.3
14	14.7	0.0741	199.5	88.3
15	14.7	0.0741	199.4	88.4
16	14.7	0.0741	199.4	88.4

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TOSQUE= 1,806 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	2,191,068	7.00	1,752	45

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	510.2
2	38.7	0.1481	263.0	572.2
3	31.7	0.1285	249.5	659.7
4	31.3	0.1271	247.4	664.9
5	12.8	0.0672	191.7	1264.1
6	14.5	0.0734	198.7	200.8
7	14.5	0.0734	198.7	200.8
8	14.5	0.0734	198.6	200.8
9	14.5	0.0734	198.6	200.8
10	14.5	0.0734	198.6	200.9
11	14.7	0.0743	199.6	88.2
12	14.7	0.0743	199.6	88.2
13	14.7	0.0742	199.5	88.3
14	14.7	0.0742	199.5	88.3
15	14.7	0.0741	199.4	88.4
16	14.7	0.0741	199.4	88.4

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	2,057,491	11.72	2,048	75

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	486.6
2	39.7	0.1506	264.8	528.5
3	27.9	0.1173	239.6	678.5
4	27.5	0.1160	238.5	684.4
5	12.0	0.0642	188.3	1241.2
6	14.5	0.0734	198.7	188.5
7	14.5	0.0734	198.7	188.5
8	14.5	0.0734	198.7	188.5
9	14.5	0.0734	198.7	188.5
10	14.5	0.0734	198.7	188.5
11	14.7	0.0742	199.5	82.9
12	14.7	0.0742	199.5	82.9
13	14.7	0.0741	199.5	82.9
14	14.7	0.0741	199.5	82.9
15	14.7	0.0741	199.4	83.0
16	14.7	0.0741	199.4	83.0

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	1,717,069	20.02	1,299	128

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	406.0
2	41.5	0.1556	268.3	426.9
3	21.5	0.0973	222.3	684.3
4	21.2	0.0963	221.5	691.0
5	12.4	0.0659	190.3	1010.0
6	14.5	0.0736	198.9	156.9
7	14.5	0.0735	198.9	156.9
8	14.5	0.0736	198.9	156.9
9	14.5	0.0736	198.9	156.9
10	14.5	0.0736	198.9	157.0
11	14.7	0.0742	199.5	69.2
12	14.7	0.0742	199.5	69.2

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
13	14.7	0.0741	199.4	69.2
14	14.7	0.0741	199.4	69.2
15	14.7	0.0741	199.4	69.3
16	14.7	0.0741	199.4	69.3

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	1,267,528	25.82	444	166

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	299.7
2	43.2	0.1600	271.3	306.3
3	17.3	0.0835	209.2	588.3
4	17.2	0.0831	208.7	591.3
5	13.5	0.0699	194.8	702.7
6	14.6	0.0738	199.1	115.5
7	14.6	0.0738	199.1	115.5
8	14.6	0.0738	199.1	115.5
9	14.6	0.0738	199.1	115.5
10	14.6	0.0738	199.1	115.5
11	14.7	0.0741	199.4	51.1
12	14.7	0.0741	199.4	51.1
13	14.7	0.0741	199.4	51.1
14	14.7	0.0741	199.4	51.1
15	14.7	0.0741	199.4	51.1
16	14.7	0.0741	199.4	51.1

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	921,862	28.06	122	180

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	218.0
2	43.9	0.1621	272.7	220.0
3	15.9	0.0784	204.0	455.5
4	15.8	0.0782	203.7	457.0
5	14.1	0.0719	197.1	496.6
6	14.6	0.0739	199.2	83.9
7	14.6	0.0739	199.2	83.9
8	14.6	0.0739	199.2	83.9
9	14.6	0.0739	199.2	83.9
10	14.6	0.0739	199.2	83.9
11	14.7	0.0741	199.4	37.2
12	14.7	0.0741	199.4	37.2
13	14.7	0.0741	199.4	37.2
14	14.7	0.0741	199.4	37.2
15	14.7	0.0741	199.4	37.2
16	14.7	0.0741	199.4	37.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	616,718	29.30	35	188

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	145.8
2	44.5	0.1635	273.6	145.8
3	15.2	0.0759	201.3	315.0
4	15.1	0.0758	201.2	315.5
5	14.4	0.0731	198.4	326.8
6	14.6	0.0740	199.3	56.0
7	14.6	0.0740	199.3	56.0
8	14.6	0.0740	199.3	56.0
9	14.6	0.0740	199.3	56.0

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10	14.6	0.0740	199.3	56.0
11	14.7	0.0741	199.4	24.9
12	14.7	0.0741	199.4	24.9
13	14.7	0.0741	199.4	24.9
14	14.7	0.0741	199.4	24.9
15	14.7	0.0741	199.4	24.9
16	14.7	0.0741	199.4	24.9

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANCLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	376,968	29.74	7	191

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	89.1
2	44.6	0.1638	273.8	89.1
3	14.8	0.0747	200.1	195.5
4	14.8	0.0747	200.0	195.6
5	14.6	0.0737	199.0	198.2
6	14.6	0.0740	199.3	34.2
7	14.6	0.0740	199.3	34.2
8	14.6	0.0740	199.3	34.2
9	14.6	0.0740	199.3	34.2
10	14.6	0.0740	199.3	34.2
11	14.7	0.0741	199.4	15.2
12	14.7	0.0741	199.4	15.2
13	14.7	0.0741	199.4	15.2
14	14.7	0.0741	199.4	15.2
15	14.7	0.0741	199.4	15.2
16	14.7	0.0741	199.4	15.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANCLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	190,497	29.93	1	192

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	45.0
2	44.6	0.1639	273.9	45.0
3	14.7	0.0742	199.5	99.4
4	14.7	0.0742	199.5	99.4
5	14.6	0.0740	199.3	99.8
6	14.6	0.0741	199.4	17.3
7	14.6	0.0741	199.4	17.3
8	14.6	0.0741	199.4	17.3
9	14.6	0.0741	199.4	17.3
10	14.6	0.0741	199.4	17.3
11	14.7	0.0741	199.4	7.6
12	14.7	0.0741	199.4	7.6
13	14.7	0.0741	199.4	7.6
14	14.7	0.0741	199.4	7.6
15	14.7	0.0741	199.4	7.6
16	14.7	0.0741	199.4	7.6

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANCLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	96,308	29.98	0	193

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	22.7
2	44.6	0.1639	273.9	22.7
3	14.7	0.0741	199.4	50.3
4	14.7	0.0741	199.4	50.3
5	14.6	0.0740	199.3	50.4
6	14.6	0.0741	199.4	8.7

7	14.6	0.0741	199.4	8.7
8	14.6	0.0741	199.4	8.7
9	14.6	0.0741	199.4	8.7
10	14.6	0.0741	199.4	8.7
11	14.7	0.0741	199.4	3.8
12	14.7	0.0741	199.4	3.8
13	14.7	0.0741	199.4	3.8
14	14.7	0.0741	199.4	3.8
15	14.7	0.0741	199.4	3.8
16	14.7	0.0741	199.4	3.8

NOTE: THERE IS CHOKE FLOW AT STATION 2

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CASE 2 B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1.1

HYDRODYNAMIC FACTOR
@ 90 DEG 89607 IN.LBS / PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE-36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	10.0	0.0	0.500	0.500000
2	VALVE	10.0	0.0	0.885	0.885186
3	STRAIGHT PIPE	10.0	2.2	0.039	0.039600
4	TEE	10.0	0.0	0.840	0.840000
5	EXPANDER	10.0	0.0	0.682	0.682918
6	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
7	PIPE BEND	24.0	0.0	0.060	0.001808
8	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
9	TEE	24.0	0.0	0.720	0.021701
10	EXPANDER	24.0	0.0	0.308	0.009302
11	STRAIGHT PIPE	36.0	3.0	0.015	0.000089
12	VALVE	36.0	0.0	0.408	0.002430
13	STRAIGHT PIPE	36.0	20.6	0.103	0.000613
14	VALVE	36.0	0.0	0.408	0.002430
15	EXIT	36.0	0.0	1.000	0.005953

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 2,112,751 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.4	0.0684	239.2	208.7
7	14.4	0.0684	239.2	208.7
8	14.4	0.0684	239.1	208.7
9	14.4	0.0684	239.1	208.7
10	14.4	0.0684	239.1	208.8
11	14.7	0.0692	240.3	91.6
12	14.7	0.0692	240.3	91.6
13	14.7	0.0692	240.2	91.7
14	14.7	0.0692	240.2	91.7
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,959 IN.LBS
DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	2,112,751	0.03	2,284	6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0685	239.3	208.4
7	14.5	0.0685	239.3	208.5
8	14.5	0.0685	239.3	208.5
9	14.5	0.0685	239.2	208.5
10	14.5	0.0684	239.2	208.5
11	14.7	0.0693	240.4	91.5
12	14.7	0.0693	240.4	91.5
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	2,112,751	0.04	2,764	9

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0685	239.3	208.3
7	14.5	0.0685	239.3	208.3
8	14.5	0.0685	239.3	208.3
9	14.5	0.0685	239.3	208.3
10	14.5	0.0685	239.3	208.4
11	14.7	0.0694	240.5	91.4
12	14.7	0.0694	240.5	91.4
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	2,112,751	0.08	2,078	16

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0686	239.5	207.9
7	14.5	0.0686	239.5	207.9
8	14.5	0.0686	239.5	208.0
9	14.5	0.0686	239.5	208.0
10	14.5	0.0686	239.4	208.0
11	14.8	0.0695	240.6	91.3
12	14.8	0.0695	240.6	91.3

13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	2,112,751	0.17	1,119	33

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.6	0.0689	239.9	207.0
7	14.6	0.0689	239.9	207.0
8	14.6	0.0689	239.9	207.0
9	14.6	0.0689	239.9	207.1
10	14.6	0.0689	239.9	207.1
11	14.9	0.0698	241.1	90.9
12	14.9	0.0698	241.1	90.9
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	2,112,751	0.35	548	69

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	14.8	0.0696	240.8	205.2
7	14.8	0.0696	240.8	205.2
8	14.8	0.0695	240.8	205.2
9	14.8	0.0695	240.8	205.2
10	14.8	0.0695	240.7	205.3
11	15.0	0.0704	241.9	90.1
12	15.0	0.0704	241.9	90.1
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	2,112,751	0.92	342	181

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	12.8	0.0628	231.1	1309.3
6	15.4	0.0714	243.4	199.8
7	15.4	0.0714	243.4	199.8
8	15.4	0.0714	243.4	199.8
9	15.4	0.0714	243.3	199.8

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
10	15.3	0.0714	243.3	199.9
11	15.6	0.0723	244.5	87.7
12	15.6	0.0723	244.5	87.7
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,112,751	3.25	182	638

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	684.9
4	31.3	0.1188	298.2	687.8
5	14.0	0.0668	237.0	1230.0
6	17.7	0.0790	253.3	180.8
7	17.7	0.0790	253.3	180.8
8	17.7	0.0790	253.3	180.8
9	17.7	0.0790	253.3	180.8
10	17.7	0.0789	253.3	180.8
11	17.9	0.0798	254.4	79.5
12	17.9	0.0798	254.4	79.5
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	2,001,181	12.54	98	2,461

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	509.4
2	39.6	0.1405	318.9	552.7
3	34.7	0.1277	307.0	607.9
4	34.4	0.1269	306.2	610.3
5	24.1	0.0985	276.7	783.0
6	27.0	0.1069	285.9	124.7
7	27.0	0.1069	285.9	124.7
8	27.0	0.1069	285.9	124.7
9	27.0	0.1069	285.9	124.7
10	27.0	0.1069	285.9	124.7
11	27.3	0.1076	286.7	54.9
12	27.3	0.1076	286.7	54.9
13	14.7	0.0694	240.5	85.1
14	14.7	0.0694	240.5	85.1
15	14.7	0.0693	240.4	85.2
16	14.7	0.0693	240.4	85.2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	996,367	27.26	10	5,351

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	253.6
2	43.7	0.1506	327.9	256.9
3	42.7	0.1482	325.8	261.1
4	42.7	0.1481	325.7	261.1
5	41.0	0.1438	322.0	268.4
6	41.7	0.1457	323.6	45.8
7	41.7	0.1457	323.6	45.8

8	41.7	0.1457	323.6	45.8
9	41.7	0.1457	323.6	45.8
10	41.7	0.1457	323.6	45.8
11	41.9	0.1462	324.1	20.2
12	41.9	0.1462	324.1	20.2
13	14.7	0.0691	240.2	43.2
14	14.7	0.0691	240.2	43.2
15	14.7	0.0691	240.1	43.3
16	14.7	0.0691	240.1	43.3

NOTE: THERE IS CHOKE FLOW AT STATION 12

CASE 3

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	1.8	0.013	0.013500
4	TEE	24.0	0.0	0.240	0.240000
5	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
6	PIPE BEND	24.0	0.0	0.060	0.060000
7	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
8	TEE	24.0	0.0	0.720	0.720000
9	EXPANDER	24.0	0.0	0.308	0.308641
10	STRAIGHT PIPE	36.0	3.0	0.015	0.002962
11	VALVE	36.0	0.0	0.408	0.080640
12	STRAIGHT PIPE	36.0	20.6	0.103	0.020345
13	VALVE	36.0	0.0	0.408	0.080640
14	EXIT	36.0	0.0	1.000	0.197530

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=12,099,300 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	16.7	0.0758	249.1	479.5
11	16.7	0.0758	249.1	479.6
12	15.9	0.0733	245.9	495.5
13	15.9	0.0732	245.7	496.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,889 IN.LBS
DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,099,300	1.09	73,285	214

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.3	0.0778	251.8	466.9
11	17.3	0.0778	251.8	467.0
12	16.3	0.0745	247.4	487.9
13	16.2	0.0743	247.3	488.8
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,099,300	1.74	88,675	343

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.9	0.0798	254.3	455.5
11	17.9	0.0797	254.3	455.6
12	16.9	0.0766	250.2	474.4
13	16.9	0.0765	250.1	475.2
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	12,099,300	3.44	66,689	675

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	19.6	0.0847	260.8	427.8
11	19.6	0.0849	260.8	427.9
12	18.6	0.0820	257.1	443.3
13	18.6	0.0818	257.0	443.9
14	15.1	0.0707	242.4	513.6

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15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tcp
60	12,060,832	6.85	33,626	1,345

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	533.0
2	38.9	0.1386	317.2	586.6
3	35.5	0.1298	308.9	626.4
4	35.4	0.1296	308.8	626.4
5	32.0	0.1207	300.2	670.4
6	30.9	0.1177	297.2	684.6
7	30.2	0.1158	295.2	693.4
8	29.0	0.1124	291.7	711.8
9	15.0	0.0704	242.0	1128.2
10	22.8	0.0946	272.3	372.1
11	22.8	0.0946	272.3	372.1
12	22.0	0.0924	269.8	380.9
13	22.0	0.0924	269.7	380.9
14	15.2	0.0708	242.5	496.8
15	14.7	0.0694	240.5	504.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tcp
50	11,280,159	13.42	15,344	2,634

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	498.5
2	39.9	0.1410	319.4	539.0
3	37.0	0.1338	312.8	568.0
4	37.0	0.1337	312.7	568.0
5	34.4	0.1269	306.2	597.0
6	33.5	0.1245	303.9	606.5
7	32.9	0.1231	302.5	611.4
8	32.1	0.1208	300.2	621.5
9	23.7	0.0973	275.3	767.7
10	29.0	0.1124	291.8	294.3
11	29.0	0.1124	291.7	294.3
12	28.5	0.1110	290.3	298.0
13	28.5	0.1110	290.2	298.0
14	15.1	0.0705	242.0	480.6
15	14.7	0.0691	240.1	490.3

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tcp
40	9,303,585	21.09	6,570	4,141

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	411.1
2	41.7	0.1456	323.5	430.8
3	39.9	0.1413	319.6	444.1
4	39.9	0.1412	319.5	444.1
5	38.5	0.1377	316.4	453.8
6	38.2	0.1367	315.5	455.4
7	38.0	0.1363	315.0	455.4
8	37.6	0.1353	314.2	457.1
9	33.2	0.1238	303.2	497.5
10	36.3	0.1319	311.0	206.9
11	36.3	0.1319	311.0	206.9
12	36.0	0.1312	310.3	208.0
13	36.0	0.1312	310.3	208.0
14	14.9	0.0700	241.3	399.2
15	14.7	0.0691	240.1	404.3

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	6,460,352	26.57	1,701	5,216

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	285.5
2	43.5	0.1500	327.4	290.2
3	42.7	0.1481	325.7	293.9
4	42.7	0.1481	325.7	293.9
5	42.1	0.1467	324.5	295.9
6	42.0	0.1464	324.3	295.9
7	41.9	0.1462	324.1	295.9
8	41.8	0.1459	323.8	295.9
9	40.0	0.1415	319.8	304.2
10	41.5	0.1451	323.1	131.5
11	41.5	0.1451	323.1	131.5
12	41.3	0.1448	322.8	131.8
13	41.3	0.1448	322.8	131.8
14	14.9	0.0695	240.7	279.2
15	14.7	0.0691	240.1	280.8

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	3,184,353	29.52	259	5,795

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	140.7
2	44.5	0.1526	329.6	140.7
3	44.3	0.1521	329.2	141.1
4	44.3	0.1521	329.2	141.1
5	44.2	0.1519	329.1	141.1
6	44.2	0.1518	329.0	141.1
7	44.2	0.1518	328.9	141.1
8	44.1	0.1517	328.9	141.1
9	43.8	0.1509	328.2	141.5
10	44.2	0.1519	329.1	62.3
11	44.2	0.1519	329.1	62.3
12	44.2	0.1519	329.0	62.4
13	44.2	0.1519	329.0	62.4
14	14.7	0.0692	240.3	138.2
15	14.7	0.0691	240.1	138.4

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	1,624,705	30.06	27	5,900

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	71.8
2	44.6	0.1528	329.9	71.8
3	44.6	0.1527	329.8	71.8
4	44.6	0.1527	329.8	71.8
5	44.5	0.1527	329.7	71.8
6	44.5	0.1527	329.7	71.8
7	44.5	0.1526	329.7	71.8
8	44.5	0.1526	329.7	71.8
9	44.5	0.1525	329.5	71.8
10	44.7	0.1531	330.1	31.6
11	44.7	0.1531	330.1	31.6
12	44.7	0.1531	330.1	31.6
13	44.7	0.1531	330.1	31.6
14	14.7	0.0691	240.2	70.5
15	14.7	0.0691	240.1	70.6

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NOTE: THERE IS CHOKE FLOW AT STATION 13

CASE 3A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SK80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2.0 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR €90 DEG
AIR	1.4	1	1	12758

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	1.8	0.013	0.013500
4	TEE	24.0	0.0	0.240	0.240000
5	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
6	PIPE BEND	24.0	0.0	0.060	0.060000
7	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
8	TEE	24.0	0.0	0.720	0.720000
9	EXPANDER	24.0	0.0	0.308	0.308641
10	STRAIGHT PIPE	36.0	3.0	0.015	0.002962
11	VALVE	36.0	0.0	0.408	0.080640
12	STRAIGHT PIPE	36.0	20.6	0.103	0.020345
13	VALVE	36.0	0.0	0.408	0.080640
14	EXIT	36.0	0.0	1.000	0.197530

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=12,099,300 SCFM

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	16.7	0.0759	249.1	479.5
11	16.7	0.0758	249.1	479.6
12	15.9	0.0733	245.9	495.5
13	15.9	0.0732	245.7	496.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 8,161 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,099,300	3.44	37,975	203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.3	0.0778	251.8	466.9
11	17.3	0.0778	251.8	467.0
12	16.3	0.0745	247.4	487.9
13	16.2	0.0743	247.3	488.8
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,099,300	5.90	48,376	348

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	32.9	0.1231	302.5	662.0
4	32.9	0.1229	302.3	662.0
5	29.2	0.1131	292.4	717.4
6	27.9	0.1092	288.4	740.3
7	27.0	0.1068	285.8	754.1
8	25.6	0.1028	281.5	779.7
9	13.2	0.0643	233.3	1272.1
10	17.2	0.0776	251.5	468.3
11	17.2	0.0776	251.5	468.4
12	16.2	0.0744	247.3	488.5
13	16.2	0.0742	247.1	489.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	11,098,386	9.87	32,607	581

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	490.4
2	40.1	0.1416	319.9	528.4
3	30.2	0.1157	295.1	646.6
4	30.1	0.1155	294.9	646.6
5	27.2	0.1075	286.6	691.5
6	26.2	0.1046	283.4	707.9
7	25.6	0.1027	281.4	718.2
8	24.5	0.0997	278.1	736.1
9	13.6	0.0656	235.2	1143.0
10	16.6	0.0754	248.7	442.0
11	16.6	0.0754	248.7	442.1
12	15.8	0.0730	245.5	456.3
13	15.8	0.0729	245.4	457.0
14	15.0	0.0704	242.0	473.2

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
15	14.7	0.0691	240.1	482.4

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	8,790,500	19.89	13,797	1,172

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	308.4
2	42.1	0.1466	324.4	404.3
3	22.2	0.0929	270.3	639.7
4	22.1	0.0927	270.1	640.8
5	20.2	0.0870	263.3	682.7
6	19.5	0.0848	260.6	700.4
7	19.1	0.0834	258.9	712.2
8	18.3	0.0811	256.0	732.6
9	12.0	0.0601	227.1	908.2
10	15.7	0.0727	245.0	363.1
11	15.7	0.0727	245.0	363.2
12	15.3	0.0713	243.2	370.1
13	15.3	0.0713	243.1	370.4
14	14.9	0.0699	241.2	377.8
15	14.7	0.0691	240.1	382.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	6,470,967	25.56	4,268	1,506

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	285.9
2	43.5	0.1500	327.4	290.7
3	17.9	0.0797	254.2	548.9
4	17.9	0.0795	254.0	549.6
5	17.0	0.0767	250.4	569.9
6	16.7	0.0757	249.1	577.3
7	16.5	0.0750	248.2	582.7
8	16.1	0.0739	246.7	591.3
9	13.5	0.0650	234.4	672.1
10	15.2	0.0708	242.4	274.5
11	15.2	0.0708	242.4	274.5
12	15.0	0.0701	241.6	277.0
13	15.0	0.0701	241.5	277.1
14	14.8	0.0695	240.7	279.6
15	14.7	0.0691	240.1	281.2

NOTE: THERE IS CHOKE FLOW AT STATION 2 .

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	4,361,360	28.31	1,316	1,669

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	192.7
2	44.2	0.1520	329.1	193.3
3	15.9	0.0733	245.9	401.8
4	15.9	0.0733	245.8	402.1
5	15.6	0.0721	244.2	408.7
6	15.4	0.0717	243.7	410.9
7	15.4	0.0714	243.4	412.4
8	15.2	0.0711	242.8	414.6
9	14.2	0.0675	237.9	436.6
10	14.9	0.0699	241.2	187.4
11	14.9	0.0699	241.2	187.4
12	14.8	0.0696	240.8	188.2
13	14.8	0.0696	240.8	188.2
14	14.7	0.0693	240.4	189.0

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15	14.7	0.0691	240.1	189.5

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,670,844	29.42	273	1,734

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	118.0
2	44.5	0.1527	329.7	118.0
3	15.1	0.0706	242.2	255.5
4	15.1	0.0706	242.2	255.6
5	15.0	0.0702	241.6	257.0
6	14.9	0.0700	241.4	257.6
7	14.9	0.0699	241.3	258.0
8	14.9	0.0698	241.1	258.5
9	14.5	0.0685	239.3	263.3
10	14.7	0.0694	240.5	115.5
11	14.7	0.0694	240.5	115.5
12	14.7	0.0693	240.4	115.7
13	14.7	0.0693	240.4	115.7
14	14.7	0.0692	240.2	115.9
15	14.7	0.0691	240.1	116.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,352,244	29.84	44	1,759

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	59.7
2	44.6	0.1529	329.9	59.7
3	14.8	0.0695	240.7	131.4
4	14.8	0.0695	240.7	131.4
5	14.7	0.0694	240.5	131.6
6	14.7	0.0694	240.5	131.7
7	14.7	0.0693	240.5	131.7
8	14.7	0.0693	240.4	131.8
9	14.6	0.0690	240.0	132.4
10	14.7	0.0692	240.3	58.6
11	14.7	0.0692	240.3	58.6
12	14.7	0.0691	240.2	58.7
13	14.7	0.0691	240.2	58.7
14	14.7	0.0691	240.1	58.7
15	14.7	0.0691	240.1	58.7

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	683,690	29.96	4	1,766

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	30.2
2	44.6	0.1529	329.9	30.2
3	14.7	0.0692	240.3	66.7
4	14.7	0.0692	240.3	66.7
5	14.7	0.0692	240.2	66.7
6	14.7	0.0692	240.2	66.7
7	14.7	0.0691	240.2	66.8
8	14.7	0.0691	240.2	66.8
9	14.6	0.0691	240.1	66.8
10	14.7	0.0691	240.2	29.7
11	14.7	0.0691	240.2	29.7
12	14.7	0.0691	240.1	29.7
13	14.7	0.0691	240.1	29.7
14	14.7	0.0691	240.1	29.7

15	14.7	0.069:	240.1	29.7

NOTE: THERE IS CHOKE FLOW AT STATION 2

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CASE 3 B

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	39607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	1.8	0.013	0.013500
4	TEE	24.0	0.0	0.240	0.240000
5	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
6	PIPE BEND	24.0	0.0	0.060	0.060000
7	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
8	TEE	24.0	0.0	0.720	0.720000
9	EXPANDER	24.0	0.0	0.308	0.308641
10	STRAIGHT PIPE	36.0	3.0	0.015	0.002962
11	VALVE	36.0	0.0	0.408	0.080640
12	STRAIGHT PIPE	36.0	20.6	0.103	0.020345
13	VALVE	36.0	0.0	0.408	0.080640
14	EXIT	36.0	0.0	1.000	0.197530

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=12,099,300 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	16.7	0.0758	249.1	479.5
11	16.7	0.0758	249.1	479.6
12	15.9	0.0733	245.9	495.5
13	15.9	0.0732	245.7	496.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,889 IN.LBS
DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,099,300	1.03	69,620	202

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.6
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.3	0.0778	251.8	466.9
11	17.3	0.0778	251.8	467.0
12	16.3	0.0745	247.4	487.9
13	16.2	0.0743	247.3	488.8
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,099,300	1.60	84,344	314

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.9	0.0795	254.0	456.8
11	17.8	0.0795	254.0	456.9
12	16.2	0.0744	247.3	488.5
13	16.2	0.0742	247.1	489.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	12,099,300	3.07	63,426	602

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	19.3	0.0842	259.8	431.7
11	19.3	0.0841	259.8	431.8
12	16.2	0.0744	247.3	488.5
13	16.2	0.0742	247.1	489.3
14	15.1	0.0707	242.4	513.6

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15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	12,060,832	4.02	31,372	1,181

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	533.0
2	38.9	0.1386	317.2	586.6
3	35.5	0.1298	308.9	626.4
4	35.4	0.1296	308.8	626.4
5	32.0	0.1207	300.2	670.4
6	30.9	0.1177	297.2	684.6
7	30.2	0.1158	295.2	693.4
8	29.0	0.1124	291.7	711.8
9	15.0	0.0704	242.0	1128.2
10	22.8	0.0946	272.3	372.1
11	22.8	0.0946	272.3	372.1
12	16.8	0.0760	249.5	463.1
13	16.7	0.0759	249.3	463.1
14	15.7	0.0726	244.9	484.3
15	14.7	0.0712	243.0	491.1

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	11,358,749	12.79	14,954	2,511

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	501.9
2	39.8	0.1410	319.3	542.7
3	37.0	0.1336	312.6	572.5
4	36.9	0.1335	312.4	572.5
5	34.3	0.1266	305.9	601.8
6	33.4	0.1242	303.6	611.4
7	32.8	0.1228	302.2	616.4
8	31.9	0.1204	299.9	626.6
9	23.3	0.0961	274.0	782.5
10	28.7	0.1116	290.9	298.5
11	28.7	0.1116	290.9	298.5
12	15.9	0.0733	245.9	465.2
13	15.9	0.0732	245.7	465.9
14	15.1	0.0705	242.1	483.8
15	14.7	0.0691	240.1	493.7

NOTE: THERE IS CHOKE FLOW AT STATION 11

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	9,365,389	20.65	6,500	4,053

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	413.8
2	41.7	0.1456	323.5	433.7
3	39.9	0.1411	319.5	447.3
4	39.9	0.1410	319.4	447.3
5	38.4	0.1373	316.0	458.7
6	38.0	0.1363	315.1	460.4
7	37.8	0.1358	314.6	460.4
8	37.4	0.1348	313.7	462.1
9	32.9	0.1229	302.3	505.1
10	36.1	0.1314	310.5	209.3
11	36.1	0.1314	310.5	209.3
12	15.4	0.0717	243.7	392.4
13	15.4	0.0716	243.6	392.8
14	14.9	0.0700	241.4	401.8
15	14.7	0.0691	240.1	407.0

NOTE: THERE IS CHOKE FLOW AT STATION 11

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	6,470,662	26.46	1,688	5,195

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	285.9
2	43.5	0.1500	327.4	290.7
3	42.7	0.1481	325.7	294.4
4	42.7	0.1481	325.7	294.4
5	42.1	0.1467	324.5	296.4
6	42.0	0.1464	324.3	296.4
7	41.9	0.1462	324.1	296.4
8	41.8	0.1459	323.8	296.4
9	40.0	0.1414	319.8	304.7
10	41.5	0.1451	323.0	131.7
11	41.5	0.1451	323.0	131.7
12	15.0	0.0702	241.7	276.6
13	15.0	0.0702	241.7	276.7
14	14.8	0.0695	240.7	279.6
15	14.7	0.0691	240.1	281.2

NOTE: THERE IS CHOKE FLOW AT STATION 11

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	3,183,788	29.48	258	5,786

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	140.7
2	44.5	0.1526	329.6	140.7
3	44.3	0.1521	329.2	141.1
4	44.3	0.1521	329.2	141.1
5	44.2	0.1519	329.1	141.1
6	44.2	0.1518	329.0	141.1
7	44.2	0.1518	328.9	141.1
8	44.1	0.1517	328.9	141.1
9	43.8	0.1509	328.2	141.5
10	44.2	0.1519	329.1	62.3
11	44.2	0.1519	329.1	62.3
12	14.8	0.0694	240.6	137.7
13	14.7	0.0694	240.6	137.7
14	14.7	0.0692	240.3	138.2
15	14.7	0.0691	240.1	138.3

NOTE: THERE IS CHOKE FLOW AT STATION 11

ANGLE	FLOW	DP ACSOSS VALVE	Taero	Tdp
10	1,604,339	30.05	26	5,899

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	70.9
2	44.6	0.1528	329.9	70.9
3	44.6	0.1527	329.8	70.9
4	44.6	0.1527	327.8	70.9
5	44.5	0.1527	329.7	70.9
6	44.5	0.1527	329.7	70.9
7	44.5	0.1527	329.7	70.9
8	44.5	0.1526	329.7	70.9
9	44.5	0.1525	329.6	70.9
10	44.7	0.1531	330.1	31.2
11	44.7	0.1531	330.1	31.2
12	14.7	0.0692	240.2	69.6
13	14.7	0.0692	240.2	69.6
14	14.7	0.0691	240.2	69.7
15	14.7	0.0691	240.1	69.7

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NOTE: THERE IS CHOKE FLOW AT STATION 11

CASE 4

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36

VALVE CLASS: 150/150

ACTUATOR: Rotryx 45102-SL80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 4.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	10.0	0.0	0.500	0.500000
2	VALVE	10.0	0.0	0.885	0.885186
3	STRAIGHT PIPE	10.0	2.2	0.039	0.039600
4	TEE	10.0	0.0	0.840	0.840000
5	EXPANDER	10.0	0.0	0.682	0.682918
6	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
7	PIPE BEND	24.0	0.0	0.060	0.001808
8	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
9	TEE	24.0	0.0	0.720	0.021701
10	EXPANDER	24.0	0.0	0.308	0.009302
11	STRAIGHT PIPE	36.0	4.6	0.023	0.000136
12	PIPE BEND	36.0	0.0	0.120	0.000714
13	STRAIGHT PIPE	36.0	3.9	0.019	0.000116
14	VALVE	36.0	0.0	0.408	0.002430
15	EXIT	36.0	0.0	1.000	0.005953

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 2,112,955 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1178	299.2	685.0
4	31.3	0.1189	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.4	0.0683	239.1	208.9
7	14.4	0.0683	239.1	208.9
8	14.4	0.0683	239.1	208.9
9	14.4	0.0683	239.1	208.9
10	14.4	0.0683	239.0	209.0
11	14.7	0.0692	240.2	91.7
12	14.7	0.0692	240.2	91.7
13	14.7	0.0692	240.2	91.7
14	14.7	0.0692	240.2	91.7
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,889 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	2,112,955	0.03	2,288	6

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.4	0.0684	239.1	208.8
7	14.4	0.0684	239.1	208.8
8	14.4	0.0684	239.1	208.8
9	14.4	0.0684	239.1	208.8
10	14.4	0.0683	239.1	208.9
11	14.7	0.0692	240.3	91.7
12	14.7	0.0692	240.3	91.7
13	14.7	0.0692	240.3	91.7
14	14.7	0.0692	240.3	91.7
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	2,112,955	0.04	2,768	9

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0684	239.2	208.6
7	14.5	0.0684	239.2	208.6
8	14.4	0.0684	239.2	208.6
9	14.4	0.0684	239.2	208.6
10	14.4	0.0684	239.1	208.7
11	14.7	0.0692	240.3	91.6
12	14.7	0.0692	240.3	91.6
13	14.7	0.0692	240.3	91.6
14	14.7	0.0692	240.3	91.6
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	2,112,955	0.08	2,082	16

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.5	0.0685	239.3	208.3
7	14.5	0.0685	239.3	208.3
8	14.5	0.0685	239.3	208.3
9	14.5	0.0685	239.3	208.3
10	14.5	0.0685	239.3	208.4
11	14.7	0.0694	240.5	91.4
12	14.7	0.0694	240.5	91.4

13	14.7	0.0694	240.5	91.4
14	14.7	0.0694	240.5	91.4
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	2,112,955	0.17	1,121	33

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.6	0.0688	239.8	207.4
7	14.6	0.0688	239.8	207.4
8	14.6	0.0688	239.8	207.4
9	14.6	0.0688	239.8	207.4
10	14.6	0.0688	239.7	207.5
11	14.8	0.0697	240.9	91.0
12	14.8	0.0697	240.9	91.0
13	14.8	0.0697	240.9	91.0
14	14.8	0.0697	240.9	91.0
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	2,112,955	0.35	549	70

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	14.8	0.0695	240.6	205.5
7	14.8	0.0694	240.6	205.5
8	14.8	0.0694	240.6	205.5
9	14.8	0.0694	240.6	205.5
10	14.8	0.0694	240.6	205.6
11	15.0	0.0703	241.8	90.2
12	15.0	0.0703	241.8	90.2
13	15.0	0.0703	241.8	90.2
14	15.0	0.0703	241.8	90.2
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	2,112,955	0.92	343	182

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	12.8	0.0628	231.1	1309.3
6	15.3	0.0713	243.2	200.1
7	15.3	0.0713	243.2	200.1
8	15.3	0.0713	243.2	200.1
9	15.3	0.0713	243.2	200.1

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10	15.3	0.0713	243.2	200.1
11	15.6	0.0722	244.4	87.9
12	15.6	0.0722	244.4	87.9
13	15.6	0.0722	244.4	87.9
14	15.6	0.0722	244.4	87.9
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,112,955	3.26	183	640

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	537.8
2	38.7	0.1381	316.7	594.1
3	31.7	0.1198	299.2	685.0
4	31.3	0.1188	298.2	687.9
5	14.0	0.0668	236.9	1231.3
6	17.7	0.0789	253.2	180.9
7	17.7	0.0789	253.2	180.9
8	17.7	0.0789	253.2	180.9
9	17.7	0.0789	253.2	180.9
10	17.6	0.0789	253.2	181.0
11	17.9	0.0797	254.3	79.5
12	17.9	0.0797	254.3	79.5
13	17.9	0.0797	254.3	79.5
14	17.9	0.0797	254.3	79.5
15	14.7	0.0691	240.1	91.8
16	14.7	0.0691	240.1	91.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	2,001,181	11.80	102	2,317

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	509.4
2	39.6	0.1405	318.9	552.7
3	34.0	0.1259	305.2	616.7
4	33.7	0.1250	304.4	619.1
5	23.3	0.0961	274.0	801.8
6	26.2	0.1046	283.4	127.3
7	26.2	0.1046	283.4	127.3
8	26.2	0.1046	283.4	127.3
9	26.2	0.1046	283.4	127.3
10	26.2	0.1046	283.4	127.3
11	26.5	0.1053	284.2	56.0
12	26.5	0.1053	284.2	56.0
13	26.5	0.1053	284.2	56.0
14	26.5	0.1053	284.2	56.0
15	14.7	0.0691	240.1	86.9
16	14.7	0.0691	240.1	86.9

NOTE: THERE IS CHOKE FLOW AT STATION 14

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	1,001,769	27.25	10	5,349

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	255.0
2	43.7	0.1506	327.9	258.3
3	42.7	0.1482	325.8	262.6
4	42.7	0.1481	325.7	262.6
5	40.9	0.1438	321.9	269.9
6	41.7	0.1456	323.6	46.1

7	41.7	0.1456	323.6	46.1
8	41.7	0.1456	323.6	46.1
9	41.7	0.1456	323.6	46.1
10	41.7	0.1456	323.6	46.1
11	41.9	0.1462	324.0	20.3
12	41.9	0.1462	324.0	20.3
13	41.9	0.1462	324.0	20.3
14	41.9	0.1462	324.0	20.3
15	14.7	0.0691	240.1	43.5
16	14.7	0.0691	240.1	43.5

NOTE: THERE IS CHOKE FLOW AT STATION 14

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CASE 4A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 10"

VALVE CLASS: 150

ACTUATOR: Matryx 26062-SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 330 IN.LBS/PSI

STEM DIA. 1.125 IN.

PACKING TORQUE 680 IN.LBS.

DIRECTION Preferred

GAGE DIA. 9.85 IN

SEAL TORQUE - 839 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=10	VALVE CLASS=150			FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	16.4	274	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR 890 DEG
AIR	1.4	1	1	330

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
1.125	9.85	680	839

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	10.0	0.0	0.500	0.500000
2	VALVE	10.0	0.0	0.885	0.885186
3	STRAIGHT PIPE	10.0	2.2	0.039	0.039600
4	TEE	10.0	0.0	0.840	0.840000
5	EXPANDER	10.0	0.0	0.682	0.68291[illegible]
6	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
7	PIPE BEND	24.0	0.0	0.060	0.001808
8	STRAIGHT PIPE	24.0	11.7	0.087	0.002644
9	TEE	24.0	0.0	0.720	0.021701
10	EXPANDER	24.0	0.0	0.308	0.009302
11	STRAIGHT PIPE	36.0	4.6	0.023	0.000136
12	PIPE BEND	36.0	0.0	0.120	0.000714
13	STRAIGHT PIPE	36.0	3.9	0.019	0.000116
14	VALVE	36.0	0.0	0.408	0.002430
15	EXIT	36.0	0.0	1.000	0.005953

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW= 2,191,068 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	518.2
2	38.7	0.1481	263.0	572.2
3	31.7	0.1285	248.5	659.7
4	31.3	0.1271	247.4	664.9
5	12.8	0.0672	191.7	1264.1
6	14.4	0.0732	198.5	201.2
7	14.[illegible]	0.0732	198.5	201.2
8	14.4	0.0732	198.5	201.3
9	14.4	0.0732	198.5	201.3
10	14.4	0.0732	198.5	201.3
11	14.7	0.0741	199.5	88.3
12	14.7	0.0741	199.5	88.3
13	14.7	0.0741	199.5	88.3
14	14.7	0.0741	199.5	88.3
15	14.7	0.0741	199.4	88.4
16	14.7	0.0741	199.4	88.4

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 1,806 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	2,191,068	7.00	1,752	45

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	518.2
2	38.7	0.1481	263.0	572.2
3	31.7	0.1285	248.5	659.7
4	31.3	0.1271	247.4	664.9
5	12.8	0.0672	191.7	1264.1
6	14.4	0.0733	198.5	201.1
7	14.4	0.0733	198.5	201.2
8	14.4	0.0733	198.5	201.2
9	14.4	0.0733	198.5	201.2
10	14.4	0.0733	198.5	201.2
11	14.7	0.0742	199.5	88.3
12	14.7	0.0742	199.5	88.3
13	14.7	0.0742	199.5	88.3
14	14.7	0.0742	199.5	88.3
15	14.7	0.0741	199.4	88.4
16	14.7	0.0741	199.4	88.4

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	2,057,456	11.72	2,048	75

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	486.6
2	39.7	0.1506	264.8	528.4
3	27.9	0.1173	239.6	678.5
4	27.5	0.1160	238.5	684.3
5	12.0	0.0642	188.3	1241.2
6	14.5	0.0734	198.6	188.6
7	14.5	0.0734	198.6	188.6
8	14.5	0.0734	198.6	188.6
9	14.5	0.0734	198.6	188.7
10	14.5	0.0733	198.6	188.7
11	14.7	0.0742	199.5	82.9
12	14.7	0.0742	199.5	82.9
13	14.7	0.0742	199.5	82.9
14	14.7	0.0742	199.5	82.9
15	14.7	0.0741	199.4	83.0
16	14.7	0.0741	199.4	83.0

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	1,718,775	19.98	1,300	128

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	406.5
2	41.5	0.1556	268.3	427.3
3	21.5	0.0974	222.5	684.0
4	21.2	0.0965	221.6	690.7
5	12.4	0.0658	190.2	1012.2
6	14.5	0.0736	198.8	157.2
7	14.5	0.0736	198.8	157.2
8	14.5	0.0736	198.8	157.2
9	14.5	0.0736	198.8	157.2
10	14.5	0.0735	198.8	157.2
11	14.7	0.0741	199.4	69.3
12	14.7	0.0741	199.4	69.3

13	14.7	0.0741	199.4	69.3
14	14.7	0.0741	199.4	69.3
15	14.7	0.0741	199.4	69.4
16	14.7	0.0741	199.4	69.4

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	1,267,200	25.82	443	166

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	299.7
2	43.2	0.1600	271.3	306.2
3	17.3	0.0835	209.2	588.3
4	17.2	0.0831	208.7	591.3
5	13.5	0.0699	194.8	702.6
6	14.6	0.0738	199.1	115.5
7	14.6	0.0738	199.1	115.5
8	14.6	0.0738	199.1	115.5
9	14.6	0.0738	199.1	115.5
10	14.6	0.0738	199.1	115.5
11	14.7	0.0741	199.4	51.1
12	14.7	0.0741	199.4	51.1
13	14.7	0.0741	199.4	51.1
14	14.7	0.0741	199.4	51.1
15	14.7	0.0741	199.4	51.1
16	14.7	0.0741	199.4	51.1

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	921,754	28.06	122	180

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	218.0
2	43.9	0.1621	272.7	220.0
3	15.9	0.0784	204.0	455.5
4	15.8	0.0782	203.7	456.9
5	14.1	0.0719	197.1	496.6
6	14.6	0.0739	199.2	83.9
7	14.6	0.0739	199.2	83.9
8	14.6	0.0739	199.2	83.9
9	14.6	0.0739	199.2	83.9
10	14.6	0.0739	199.2	83.9
11	14.7	0.0741	199.4	37.2
12	14.7	0.0741	199.4	37.2
13	14.7	0.0741	199.4	37.2
14	14.7	0.0741	199.4	37.2
15	14.7	0.0741	199.4	37.2
16	14.7	0.0741	199.4	37.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	618,372	29.30	35	188

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	146.2
2	44.5	0.1635	273.6	146.2
3	15.2	0.0759	201.3	315.8
4	15.1	0.0758	201.2	316.3
5	14.4	0.0731	198.3	327.8
6	14.6	0.0740	199.3	56.2
7	14.6	0.0740	199.3	56.2
8	14.6	0.0740	199.3	56.2
9	14.6	0.0740	199.3	56.2

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10	14.6	0.0740	199.3	56.2
11	14.7	0.0741	199.4	24.9
12	14.7	0.0741	199.4	24.9
13	14.7	0.0741	199.4	24.9
14	14.7	0.0741	199.4	24.9
15	14.7	0.0741	199.4	24.9
16	14.7	0.0741	199.4	24.9

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	376,735	29.74	7	191

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	89.1
2	44.6	0.1638	273.8	89.1
3	14.8	0.0747	200.1	195.4
4	14.8	0.0747	200.0	195.5
5	14.6	0.0737	199.0	198.1
6	14.6	0.0740	199.3	34.2
7	14.6	0.0740	199.3	34.2
8	14.6	0.0740	199.3	34.2
9	14.6	0.0740	199.3	34.2
10	14.6	0.0740	199.3	34.2
11	14.7	0.0741	199.4	15.2
12	14.7	0.0741	199.4	15.2
13	14.7	0.0741	199.4	15.2
14	14.7	0.0741	199.4	15.2
15	14.7	0.0741	199.4	15.2
16	14.7	0.0741	199.4	15.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	190,270	29.93	1	192

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	45.0
2	44.6	0.1639	273.9	45.0
3	14.7	0.0742	199.5	99.3
4	14.7	0.0742	199.5	99.3
5	14.6	0.0740	199.3	99.7
6	14.6	0.0740	199.4	17.2
7	14.6	0.0740	199.4	17.2
8	14.6	0.0740	199.4	17.2
9	14.6	0.0740	199.4	17.2
10	14.6	0.0740	199.4	17.2
11	14.7	0.0741	199.4	7.6
12	14.7	0.0741	199.4	7.6
13	14.7	0.0741	199.4	7.6
14	14.7	0.0741	199.4	7.6
15	14.7	0.0741	199.4	7.6
16	14.7	0.0741	199.4	7.6

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	94,623	29.98	0	193

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1640	274.0	22.3
2	44.6	0.1639	273.9	22.3
3	14.7	0.0741	199.4	49.4
4	14.7	0.0741	199.4	49.5
5	14.6	0.0740	199.3	49.5
6	14.5	0.0741	199.4	8.5

7	14.6	0.0741	199.4	8.5
8	14.6	0.0741	199.4	8.5
9	14.6	0.0741	199.4	8.5
10	14.6	0.0741	199.4	8.5
11	14.7	0.0741	199.4	3.8
12	14.7	0.0741	199.4	3.8
13	14.7	0.0741	199.4	3.8
14	14.7	0.0741	199.4	3.8
15	14.7	0.0741	199.4	3.8
16	14.7	0.0741	199.4	3.8

NOTE: THERE IS CHOKE FLOW AT STATION 2

CASE 5

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102-SR80

UPSTREAM PRESSURE	44.7 PSIA	INITIAL DENSITY	.153 LBS/FT^3
INITIAL TEMPERATURE	330 °F	FINAL PRESSURE	14.7 PSIA
SHUT OFF PRESSURE	44.7 PSIA	MEDIA	Air
RATIO OF SP. HEAT	1.4	SPECIFIC GRAVITY	1
COMPRESSIBILITY	1	HYDRODYNAMIC FACTOR @ 90 DEG	79607 IN.LBS/PSI

STEM DIA.	2.75 IN.	GAGE DIA.	34.782 IN
PACKING TORQUE	1663 IN.LBS.	SEAL TORQUE	10452 IN.LBS
DIRECTION	Preferred		

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	1.8	0.013	0.013500
4	TEE	24.0	0.0	0.240	0.240000
5	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
6	PIPE BEND	24.0	0.0	0.060	0.060000
7	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
8	TEE	24.0	0.0	0.720	0.720000
9	EXPANDER	24.0	0.0	0.308	0.308641
10	STRAIGHT PIPE	36.0	4.6	0.023	0.004543
11	PIPE BEND	36.0	0.0	0.120	0.023703
12	STRAIGHT PIPE	36.0	3.9	0.019	0.003851
13	VALVE	36.0	0.0	0.408	0.080640
14	EXIT	36.0	0.0	1.000	0.197530

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=12,099,300 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	15.9	0.0734	246.0	495.0
11	15.9	0.0734	246.0	495.2
12	15.9	0.0732	245.8	496.2
13	15.9	0.0732	245.7	496.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 20,889 IN.LBS
DELTA P=30.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,099,300	1.09	73,285	214

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	16.3	0.0745	247.5	487.5
11	16.3	0.0745	247.5	487.6
12	16.2	0.0744	247.3	488.6
13	16.2	0.0743	247.3	488.8
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,099,300	1.74	88,675	343

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	17.0	0.0767	250.3	474.0
11	16.9	0.0766	250.3	474.1
12	16.9	0.0765	250.1	475.0
13	16.9	0.0765	250.1	475.2
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	12,099,300	3.44	66,689	675

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	18.6	0.0820	257.2	443.0
11	18.6	0.0820	257.1	443.1
12	18.6	0.0819	257.0	443.8
13	18.6	0.0818	257.0	443.9
14	15.1	0.0707	242.4	513.6

15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	12,106,089	6.50	35,948	1,275

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	535.0
2	38.9	0.1385	317.1	588.8
3	35.4	0.1296	308.8	629.2
4	35.3	0.1294	308.6	629.2
5	32.0	0.1205	300.0	673.4
6	30.7	0.1172	296.6	690.6
7	30.0	0.1152	294.6	699.6
8	28.8	0.1118	291.1	718.3
9	12.9	0.0632	231.8	1293.5
10	21.7	0.0914	268.5	397.8
11	21.7	0.0914	268.5	397.9
12	21.7	0.0913	268.4	398.4
13	21.6	0.0912	268.4	398.5
14	15.1	0.0707	242.4	513.9
15	14.7	0.0691	240.1	526.2

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tc
50	11,357,038	13.61	15,549	2,673

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	501.8
2	39.8	0.1410	319.4	542.6
3	37.0	0.1336	312.6	572.4
4	36.9	0.1335	312.4	572.4
5	34.3	0.1266	305.9	601.7
6	33.4	0.1242	303.6	611.3
7	32.8	0.1228	302.2	616.3
8	31.9	0.1204	299.9	626.5
9	23.3	0.0961	274.0	782.4
10	28.7	0.1116	290.9	298.5
11	28.7	0.1116	290.9	298.5
12	28.7	0.1116	290.8	298.5
13	28.7	0.1116	290.8	298.5
14	15.1	0.0705	242.1	483.7
15	14.7	0.0691	240.1	493.6

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tc
40	9,356,762	21.14	6,644	4,15[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	413.5
2	41.7	0.1456	323.5	433.3
3	39.9	0.1412	319.5	446.9
4	39.9	0.1411	319.4	446.9
5	38.4	0.1373	316.0	458.2
6	38.0	0.1363	315.1	459.9
7	37.8	0.1358	314.6	457.9
8	37.4	0.1349	313.7	461.6
9	32.9	0.1230	302.4	504.6
10	36.1	0.1314	310.5	209.1
11	36.1	0.1314	310.5	209.1
12	36.1	0.1313	310.5	209.1
13	36.1	0.1313	310.5	209.1
14	14.9	0.0700	241.4	401.4

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
15	14.7	0.0691	240.1	406.7

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	6,480,646	26.68	1,712	5,237

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	286.3
2	43.4	0.1500	327.4	291.1
3	42.7	0.1481	325.7	294.8
4	42.7	0.1481	325.7	294.8
5	42.1	0.1467	324.5	296.8
6	42.0	0.1464	324.2	296.8
7	41.9	0.1462	324.1	296.8
8	41.8	0.1459	323.8	296.8
9	40.0	0.1414	319.8	305.2
10	41.5	0.1451	323.0	131.9
11	41.5	0.1451	323.0	131.9
12	41.4	0.1450	323.0	131.9
13	41.4	0.1450	323.0	131.9
14	14.8	0.0695	240.7	280.1
15	14.7	0.0691	240.1	281.6

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	3,195,102	29.54	261	5,800

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	141.2
2	44.5	0.1525	329.6	141.2
3	44.3	0.1521	329.2	141.6
4	44.3	0.1521	329.2	141.6
5	44.2	0.1519	329.0	141.6
6	44.2	0.1518	329.0	141.6
7	44.2	0.1518	328.9	141.6
8	44.1	0.1517	328.9	141.6
9	43.8	0.1509	323.2	142.0
10	44.2	0.1519	329.1	62.5
11	44.2	0.1519	329.1	62.5
12	44.2	0.1519	329.1	62.5
13	44.2	0.1519	329.1	62.5
14	14.7	0.0692	240.3	138.6
15	14.7	0.0691	240.1	138.8

NOTE: THERE IS CHOKE FLOW AT STATION 13

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	1,597,551	30.07	26	5,902

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	70.6
2	44.6	0.1528	329.9	70.6
3	44.6	0.1527	329.8	70.6
4	44.6	0.1527	329.8	70.6
5	44.5	0.1527	329.7	70.6
6	44.5	0.1527	329.7	70.6
7	44.5	0.1527	329.7	70.6
8	44.5	0.1526	329.7	70.6
9	44.5	0.1525	329.6	70.6
10	44.7	0.1531	330.1	31.1
11	44.7	0.1531	330.1	31.1
12	44.7	0.1531	330.1	31.1
13	44.7	0.1531	330.1	31.1
14	14.7	0.0691	240.2	69.4
15	14.7	0.0691	240.1	69.4

NOTE: THERE IS CHOKE FLOW AT STATION 13

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CASE 5 A

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

UPSTREAM PRESSURE 44.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 44.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .153 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 12758 IN.LBS/PSI

STEM DIA. 2 IN.

PACKING TORQUE 1210 IN.LBS.

DIRECTION Preferred

GAGE DIA. 22.352 IN

SEAL TORQUE 4316 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=24 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
44.7	15.3	330	14.7	44.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	12758

STEM DIA.	CAGE DIA.	PACKING TORQUE	SEAL TORQUE
2	22.352	1210	4316

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	24.0	0.0	0.500	0.500000
2	VALVE	24.0	0.0	0.541	0.541140
3	STRAIGHT PIPE	24.0	1.8	0.013	0.013500
4	TEE	24.0	0.0	0.240	0.240000
5	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
6	PIPE BEND	24.0	0.0	0.060	0.060000
7	STRAIGHT PIPE	24.0	11.7	0.087	0.087750
8	TEE	24.0	0.0	0.720	0.720000
9	EXPANDER	24.0	0.0	0.308	0.308641
10	STRAIGHT PIPE	36.0	4.6	0.023	0.004543
11	PIPE BEND	36.0	0.0	0.120	0.023703
12	STRAIGHT PIPE	36.0	3.9	0.019	0.003851
13	VALVE	36.0	0.0	0.408	0.080640
14	EXIT	36.0	0.0	1.000	0.197530

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=12,099,300 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	15.9	0.0734	246.0	495.0
11	15.9	0.0734	246.0	495.2
12	15.9	0.0732	245.8	496.2
13	15.9	0.0732	245.7	496.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 9,161 IN.LBS
DELTA P=30.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	12,099,300	3.44	37,975	203

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	35.4	0.1296	308.8	628.8
4	35.3	0.1294	308.6	628.8
5	32.0	0.1206	300.0	673.0
6	30.8	0.1172	296.7	690.2
7	30.0	0.1153	294.7	699.1
8	28.8	0.1119	291.1	717.8
9	12.9	0.0632	231.7	1293.6
10	16.3	0.0745	247.5	487.5
11	16.3	0.0745	247.5	487.6
12	16.2	0.0744	247.3	488.6
13	16.2	0.0743	247.3	488.8
14	15.1	0.0707	242.4	513.6
15	14.7	0.0691	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	12,099,300	5.90	48,376	348

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	534.7
2	38.9	0.1385	317.1	588.5
3	32.9	0.1231	302.5	662.0
4	32.9	0.1229	302.3	662.0
5	29.2	0.1131	292.4	717.4
6	27.9	0.1092	288.4	740.3
7	27.0	0.1068	285.8	754.1
8	25.6	0.1028	281.5	779.7
9	13.2	0.0643	233.3	1272.1
10	16.3	0.0744	247.4	488.1
11	16.3	0.0744	247.4	488.2
12	16.2	0.0743	247.2	489.2
13	16.2	0.0742	247.1	489.4
14	15.1	0.0707	242.4	513.6
15	14.7	0.0671	240.1	525.9

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	11,096,871	9.86	32,594	581

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	490.4
2	40.1	0.1416	319.9	528.3
3	30.2	0.1157	295.1	646.4
4	30.1	0.1155	294.9	646.4
5	27.3	0.1075	286.6	691.3
6	26.2	0.1046	283.5	707.7
7	25.6	0.1027'	281.4	718.0
8	24.5	0.0997	278.1	735.9
9	13.6	0.0655	235.0	1145.0
10	15.7	0.0725	244.8	459.4
11	15.7	0.0725	244.8	459.6
12	15.6	0.0724	244.6	460.4
13	15.6	0.0723	244.6	460.5
14	15.0	0.0704	242.0	473.1

15	14.7	0.0691	240.1	189.5

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	2,670,128	29.44	273	1,735

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	118.0
2	44.5	0.1527	329.7	118.0
3	15.1	0.0706	242.1	255.7
4	15.1	0.0705	242.1	255.7
5	15.0	0.0701	241.6	257.2
6	14.9	0.0700	241.4	257.7
7	14.9	0.0699	241.2	258.1
8	14.8	0.0697	241.0	258.7
9	14.5	0.0685	239.3	263.4
10	14.7	0.0693	240.5	115.6
11	14.7	0.0693	240.5	115.6
12	14.7	0.0693	240.4	115.6
13	14.7	0.0693	240.4	115.6
14	14.7	0.0692	240.2	115.9
15	14.7	0.0691	240.1	116.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,350,903	29.85	44	1,760

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	59.7
2	44.6	0.1529	329.9	59.7
3	14.8	0.0695	240.6	131.4
4	14.8	0.0695	240.6	131.4
5	14.7	0.0693	240.5	131.6
6	14.7	0.0693	240.4	131.6
7	14.7	0.0693	240.4	131.7
8	14.7	0.0692	240.3	131.8
9	14.6	0.0689	239.9	132.4
10	14.7	0.0691	240.2	58.6
11	14.7	0.0691	240.2	58.6
12	14.7	0.0691	240.2	58.6
13	14.7	0.0691	240.2	58.6
14	14.7	0.0691	240.1	58.7
15	14.7	0.0691	240.1	58.7

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	684,588	29.96	4	1,766

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	30.2
2	44.6	0.1529	329.9	30.2
3	14.7	0.0692	240.3	66.8
4	14.7	0.0692	240.3	66.8
5	14.7	0.0692	240.2	66.8
6	14.7	0.0691	240.2	66.8
7	14.7	0.0691	240.2	66.9
8	14.7	0.0691	240.2	66.9
9	14.6	0.0690	240.1	66.9
10	14.7	0.0691	240.1	29.7
11	14.7	0.0691	240.1	29.7
12	14.7	0.0691	240.1	29.7
13	14.7	0.0691	240.1	29.7
14	14.7	0.0691	240.1	29.7

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
15	14.7	0.0691	240.1	482.3

NOTE: THERE IS CHOKE FLOW AT STATION 8

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	8,788,794	20.09	13,879	1,184

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	388.4
2	42.1	0.1466	324.4	404.2
3	22.0	0.0923	269.6	643.6
4	21.9	0.0921	269.4	644.8
5	20.0	0.0864	262.6	687.4
6	19.3	0.0842	259.8	705.5
7	18.9	0.0827	258.1	717.7
8	18.1	0.0804	255.1	738.6
9	11.7	0.0590	225.5	1006.0
10	15.5	0.0718	243.8	367.6
11	15.5	0.0718	243.8	367.7
12	15.4	0.0717	243.7	368.1
13	15.4	0.0717	243.7	368.2
14	14.9	0.0699	241.2	377.7
15	14.7	0.0691	240.1	382.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	6,469,403	25.64	4,280	1,511

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	285.9
2	43.5	0.1500	327.4	290.6
3	17.8	0.0794	253.9	550.5
4	17.8	0.0793	253.7	551.3
5	16.9	0.0764	250.0	571.8
6	16.6	0.0755	248.7	579.3
7	16.4	0.0748	247.8	584.7
8	16.0	0.0737	246.3	593.4
9	13.4	0.0647	234.0	675.1
10	15.1	0.0705	242.1	275.5
11	15.1	0.0705	242.1	275.5
12	15.1	0.0704	242.0	275.7
13	15.1	0.0704	242.0	275.8
14	14.8	0.0695	240.7	279.6
15	14.7	0.0691	240.1	281.2

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	4,360,454	23.35	1,318	1,671

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	44.7	0.1530	330.0	192.7
2	44.2	0.1520	329.1	193.3
3	15.9	0.0732	245.7	402.5
4	15.9	0.0731	245.7	402.8
5	15.5	0.0720	244.1	409.4
6	15.4	0.0716	243.5	411.6
7	15.3	0.0713	243.2	413.1
8	15.2	0.0709	242.7	415.4
9	14.1	0.0673	237.7	437.4
10	14.8	0.0697	241.0	187.7
11	14.8	0.0697	241.0	187.7
12	14.8	0.0697	241.0	187.8
13	14.8	0.0697	241.0	187.8
14	14.7	0.0693	240.4	189.0

0467

15 14.7 0.0691 240.1 29.7

NOTE: THERE IS CHOKE FLOW AT STATION 2

0460

CASE 6

CONDITION 1

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102-SR80

UPSTREAM PRESSURE 23.7 PSIA

INITIAL TEMPERATURE 330 °F

SHUT OFF PRESSURE 23.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .0509 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
23.7	5.09	330	14.7	23.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
STEAM	1.329	.62	1	.89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	36.0	0.0	0.500	0.500000
2	VALVE	36.0	0.0	0.408	0.408243
3	STRAIGHT PIPE	36.0	9.7	0.048	0.048500
4	VALVE	36.0	0.0	0.408	0.408243
5	EXIT	36.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=18,410,513 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	682.0
2	21.6	0.0475	322.7	724.7
3	20.3	0.0454	317.9	758.1
4	20.2	0.0452	317.4	758.1
5	18.8	0.0429	311.9	799.0
6	14.6	0.0354	293.0	954.7

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 16,767 IN.LBS
DELTA P= 9.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	18,410,513	1.36	107,533	268

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	682.0
2	21.6	0.0475	322.7	724.7
3	20.3	0.0454	317.9	758.1
4	20.2	0.0452	317.4	758.1
5	18.8	0.0429	311.9	799.0
6	14.6	0.0354	293.0	954.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	17,761,372	2.01	122,072	395

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	657.9
2	21.8	0.0479	323.5	691.9
3	20.7	0.0460	319.2	720.5
4	20.6	0.0458	318.8	720.5
5	18.6	0.0424	310.7	778.5
6	14.7	0.0355	293.3	919.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	16,497,311	3.20	81,592	623

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	611.1
2	22.1	0.0484	324.6	636.1
3	21.2	0.0468	321.1	657.6
4	21.1	0.0466	320.7	657.6
5	17.9	0.0412	307.9	744.1
6	14.6	0.0354	292.9	858.6

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	13,682,069	5.17	32,191	1,015

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	506.8
2	22.6	0.0492	326.3	522.2
3	22.0	0.0481	324.1	533.4
4	21.9	0.0480	323.8	533.4
5	16.7	0.0392	303.0	652.9
6	14.6	0.0353	292.8	716.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	10,560,552	6.88	9,747	1,351

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	391.2
2	23.1	0.0500	328.1	395.0
3	22.8	0.0494	326.9	399.7
4	22.7	0.0494	326.7	399.7
5	15.8	0.0376	298.9	524.0
6	14.6	0.0354	292.9	553.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	7,200,600	8.04	2,925	1,578

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	266.7
2	23.5	0.0505	329.3	266.7
3	23.3	0.0503	328.7	268.1
4	23.3	0.0502	328.6	268.1
5	15.2	0.0365	296.0	368.5
6	14.7	0.0355	293.3	373.6

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	4,397,386	8.62	597	1,692

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	162.9
2	23.6	0.0507	329.7	162.9
3	23.5	0.0506	329.5	163.2
4	23.5	0.0506	329.5	163.2
5	14.9	0.0359	294.3	229.9
6	14.7	0.0355	293.3	229.9

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	2,197,728	8.91	94	1,749

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	81.4
2	23.6	0.0508	329.9	81.4
3	23.6	0.0508	329.8	81.4
4	23.6	0.0508	329.8	81.4
5	14.7	0.0356	293.4	116.3
6	14.7	0.0355	293.1	116.6

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	1,104,696	8.97	9	1,762

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0509	330.0	40.9
2	23.6	0.0508	329.9	40.9
3	23.6	0.0508	329.9	40.9
4	23.6	0.0508	329.9	40.9
5	14.7	0.0355	293.2	58.5
6	14.7	0.0355	293.1	58.6

NOTE: THERE IS CHOKE FLOW AT STATION 4

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CASE 6

CONDITION 2

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 23.7 PSIA	INITIAL DENSITY .081 LBS/FT^3
INITIAL TEMPERATURE 330 °F	FINAL PRESSURE 14.7 PSIA
SHUT OFF PRESSURE 23.7 PSIA	MEDIA Air
RATIO OF SP. HEAT 1.4	SPECIFIC GRAVITY 1
COMPRESSIBILITY 1	HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.	GAGE DIA. 34.752 IN
PACKING TORQUE 1663 IN.LBS.	SEAL TORQUE 10452 IN.LBS
DIRECTION Preferred	

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
23.7	8.1	330	14.7	23.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	36.0	0.0	0.500	0.500000
2	VALVE	36.0	0.0	0.408	0.408243
3	STRAIGHT PIPE	36.0	9.7	0.048	0.048500
4	VALVE	36.0	0.0	0.408	0.408243
5	EXIT	36.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=14,581,579 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	540.1
2	21.7	0.0760	321.8	571.9
3	20.4	0.0728	316.3	596.9
4	20.3	0.0725	315.7	596.9
5	18.9	0.0690	309.5	627.4
6	14.7	0.0578	288.3	746.3

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 16,767 IN.LBS
DELTA P= 9.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	14,581,579	1.36	106,599	267

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	540.1
2	21.7	0.0760	321.8	571.9
3	20.4	0.0728	316.3	596.9
4	20.3	0.0725	315.7	596.9
5	18.9	0.0690	309.5	627.4
6	14.7	0.0578	288.3	746.3

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	14,093,767	2.02	122,090	397

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	522.1
2	21.8	0.0765	322.5	549.2
3	20.7	0.0736	317.6	570.8
4	20.6	0.0732	317.0	570.8
5	18.5	0.0680	307.8	614.5
6	14.7	0.0577	288.2	720.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	13,075,784	3.19	81,721	627

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	484.3
2	22.1	0.0771	323.6	506.2
3	21.1	0.0747	319.5	522.7
4	21.0	0.0744	319.1	522.7
5	17.8	0.0662	304.4	587.8
6	14.6	0.0574	287.5	674.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	10,901,203	5.12	31,871	1,005

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	403.8
2	22.7	0.0785	326.0	414.0
3	22.0	0.0769	323.3	422.5
4	22.0	0.0768	323.0	422.5
5	16.8	0.0635	299.4	510.7
6	14.7	0.0576	288.0	559.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	8,423,712	6.79	9,748	1,334

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	312.0
2	23.1	0.0796	327.7	315.9
3	22.7	0.0787	326.2	319.5
4	22.7	0.0786	326.1	319.5
5	15.9	0.0610	294.6	411.8
6	14.7	0.0576	287.9	433.1

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	5,766,293	8.02	2,935	1,575

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CASE 6

CONDITION 3

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 23.7 PSIA

INITIAL TEMPERATURE 237 °F

SHUT OFF PRESSURE 23.7 PSIA

RATIO OF SP. HEAT 1.329

COMPRESSIBILITY 1

INITIAL DENSITY .0564 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Steam

SPECIFIC GRAVITY .62

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	213.6
2	23.5	0.0805	329.2	213.6
3	23.3	0.0801	328.5	214.6
4	23.3	0.0800	328.4	214.6
5	15.2	0.0592	291.1	290.2
6	14.7	0.0576	288.0	297.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	3,527,294	8.71	603	1,711

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	130.6
2	23.6	0.0808	329.7	130.6
3	23.5	0.0806	329.4	130.9
4	23.5	0.0806	329.4	130.9
5	14.8	0.0579	288.6	182.1
6	14.6	0.0573	287.4	183.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,776,334	8.91	96	1,749

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	65.8
2	23.6	0.0809	329.9	65.8
3	23.6	0.0809	329.8	65.8
4	23.6	0.0809	329.8	65.8
5	14.7	0.0577	288.2	92.3
6	14.7	0.0575	287.9	92.5

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	898,435	8.97	9	1,762

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0810	330.0	33.2
2	23.6	0.0809	329.9	33.2
3	23.6	0.0809	329.9	33.2
4	23.6	0.0809	329.9	33.2
5	14.7	0.0576	287.9	46.7
6	14.7	0.0575	287.9	46.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
23.7	5.64	237	14.7	23.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
STEAM	1.329	.62	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	36.0	0.0	0.500	0.500000
2	VALVE	36.0	0.0	0.408	0.408243
3	STRAIGHT PIPE	36.0	9.7	0.048	0.048500
4	VALVE	36.0	0.0	0.408	0.408243
5	EXIT	36.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=19,651,526 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	642.2
2	21.6	0.0526	231.7	684.7
3	20.3	0.0503	228.2	716.7
4	20.2	0.0500	227.9	716.7
5	18.8	0.0474	223.9	755.8
6	14.6	0.0392	210.3	909.0

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 16,767 IN.LBS
DELTA P= 9.00 PSI

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CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	19,651,526	1.38	106,449	271

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	642.2
2	21.6	0.0526	231.7	684.7
3	20.3	0.0503	228.2	716.7
4	20.2	0.0500	227.9	716.7
5	18.8	0.0474	223.9	755.8
6	14.6	0.0392	210.3	909.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	18,959,435	2.03	121,091	409

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	619.6
2	21.8	0.0530	232.3	654.4
3	20.7	0.0509	229.1	681.8
4	20.5	0.0507	228.8	681.8
5	18.5	0.0468	223.0	737.5
6	14.7	0.0394	210.6	867.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	17,460,206	3.15	79,450	629

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	570.6
2	22.1	0.0536	233.1	597.1
3	21.2	0.0519	230.6	617.1
4	21.1	0.0517	230.3	617.1
5	17.9	0.0457	221.2	697.1
6	14.7	0.0395	210.8	802.2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	14,626,225	5.24	31,691	1,039

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	478.0
2	22.7	0.0546	234.5	491.1
3	22.0	0.0534	232.8	501.6
4	22.0	0.0533	232.6	501.6
5	16.7	0.0434	217.5	615.8
6	14.6	0.0391	210.2	678.2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	11,253,639	6.91	9,544	1,356

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	367.8
2	23.1	0.0554	235.7	371.1
3	22.8	0.0548	234.8	375.4
4	22.7	0.0547	234.7	375.4
5	15.8	0.0417	214.6	492.7
6	14.6	0.0393	210.5	517.5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	7,671,980	8.08	2,870	1,58[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	250.7
2	23.5	0.0560	236.5	250.7
3	23.3	0.0557	236.1	252.0
4	23.3	0.0557	236.0	252.0
5	15.2	0.0404	212.4	347.1
6	14.6	0.0393	210.5	355.9

ANGLE	FLOW	DP ACROSS VALVE	Taero	Td:
30	4,684,594	8.65	585	1,69[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	153.1
2	23.6	0.0562	236.8	153.1
3	23.5	0.0561	236.6	153.4
4	23.5	0.0561	236.6	153.4
5	14.9	0.0397	211.2	216.4
6	14.7	0.0393	210.5	216.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Td:
20	2,341,269	8.91	92	1,74[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	76.5
2	23.6	0.0563	236.9	76.5
3	23.6	0.0563	236.9	76.5
4	23.6	0.0563	236.9	76.5
5	14.7	0.0394	210.7	109.3
6	14.7	0.0393	210.5	109.6

NOTE: THERE IS CHOKE FLOW AT STATION 4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Td:
10	1,191,921	8.97	9	1,76[illegible]

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0564	237.0	38.9
2	23.6	0.0563	236.9	38.9
3	23.6	0.0563	236.9	38.9
4	23.6	0.0563	236.9	38.9
5	14.7	0.0393	210.6	55.7
6	14.7	0.0393	210.5	55.8

NOTE: THERE IS CHOKE FLOW AT STATION 4

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CASE 6

CONDITION 4

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 23.7 PSIA

INITIAL TEMPERATURE 237 °F

SHUT OFF PRESSURE 23.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .0918 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10↑2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
23.7	9.18	237	14.7	23.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	.89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	36.0	0.0	0.500	0.500000
2	VALVE	36.0	0.0	0.408	0.408243
3	STRAIGHT PIPE	36.0	9.7	0.048	0.048500
4	VALVE	36.0	0.0	0.408	0.408243
5	EXIT	36.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=15,487,677 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	506.1
2	21.6	0.0860	230.9	539.4
3	20.3	0.0824	227.0	562.0
4	20.2	0.0820	226.6	562.0
5	18.8	0.0780	222.1	590.8
6	14.7	0.0653	206.8	703.4

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 16,767 IN.LBS
DELTA P= 9.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	15,487,677	1.36	106,930	268

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	506.1
2	21.6	0.0860	230.9	538.4
3	20.3	0.0824	227.0	562.0
4	20.2	0.0820	226.6	562.0
5	18.8	0.0780	222.1	590.8
6	14.7	0.0653	206.8	703.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	14,939,880	2.01	122,133	395

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	488.2
2	21.8	0.0865	231.4	516.4
3	20.6	0.0832	227.9	536.8
4	20.5	0.0829	227.5	536.8
5	18.5	0.0770	220.9	577.9
6	14.7	0.0652	206.7	679.3

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	13,876,580	3.17	81,185	623

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	453.5
2	22.1	0.0874	232.4	474.2
3	21.1	0.0847	229.5	489.5
4	21.0	0.0844	229.2	489.5
5	17.9	0.0751	218.7	550.0
6	14.6	0.0652	206.7	629.6

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	11,545,006	5.04	31,579	991

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	377.3
2	22.6	0.0889	234.0	387.8
3	22.0	0.0872	232.1	395.8
4	21.9	0.0870	231.9	395.8
5	16.9	0.0722	215.3	476.9
6	14.7	0.0655	207.1	524.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	8,971,702	6.81	9,734	1,337

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	293.2
2	23.1	0.0903	235.4	296.4
3	22.7	0.0892	234.3	299.8
4	22.7	0.0891	234.2	299.8
5	15.9	0.0691	211.6	386.6
6	14.7	0.0652	206.7	407.2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	6,118,041	7.95	2,935	1,561

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	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	199.9
2	23.4	0.0911	236.2	201.0
3	23.2	0.0906	235.8	202.0
4	23.2	0.0905	235.7	202.0
5	15.3	0.0671	209.1	272.4
6	14.7	0.0654	206.9	278.6

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	3,751,922	8.68	601	1,704

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	122.6
2	23.6	0.0915	236.7	122.6
3	23.5	0.0914	236.6	122.8
4	23.5	0.0914	236.5	122.8
5	14.8	0.0658	207.4	170.6
6	14.6	0.0651	206.6	171.9

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,738,869	8.87	81	1,742

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	56.8
2	23.6	0.0917	236.9	56.8
3	23.6	0.0917	236.9	56.8
4	23.6	0.0917	236.9	56.8
5	14.7	0.0655	207.1	79.5
6	14.7	0.0654	206.9	79.5

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	886,815	8.98	8	1,762

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	28.9
2	23.6	0.0917	236.9	28.9
3	23.6	0.0917	236.9	28.9
4	23.6	0.0917	236.9	28.9
5	14.7	0.0653	206.8	40.7
6	14.7	0.0652	206.7	40.7

NOTE: THERE IS CHOKE FLOW AT STATION 4

CASE 6A

CONDITION 4

NUCLEAR LOCA ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

UPSTREAM PRESSURE 23.7 PSIA

INITIAL TEMPERATURE 237 °F

SHUT OFF PRESSURE 23.7 PSIA

RATIO OF SP. HEAT 1.4

COMPRESSIBILITY 1

INITIAL DENSITY .0718 LBS/FT^3

FINAL PRESSURE 14.7 PSIA

MEDIA Air

SPECIFIC GRAVITY 1

HYDRODYNAMIC FACTOR @ 90 DEG 89607 IN.LBS/PSI

STEM DIA. 2.75 IN.

PACKING TORQUE 1663 IN.LBS.

DIRECTION Preferred

GAGE DIA. 34.782 IN

SEAL TORQUE 10452 IN.LBS

INPUT STATION NO., K FACTORS, ETC.

(See Appendix A)

CONTROL SYSTEM ANALYSIS

VALVE SIZE=36 VALVE CLASS=150/150 FLOW-GAS

UPSTREAM PRESSURE	INITIAL DENSITY-X10*2	INITIAL TEMPERATURE	FINAL PRESSURE	SHUT-OFF PRESSURE
23.7	9.18	237	14.7	23.7

MEDIA	RATIO OF SP. HEAT	SPECIFIC GRAVITY	COMPRESSIBILITY	HYDRODYNAMIC FACTOR @90 DEG
AIR	1.4	1	1	89607

STEM DIA.	GAGE DIA.	PACKING TORQUE	SEAL TORQUE
2.75	34.782	1663	10452

STATION NO.	TYPE OF RESISTANCE	DIAMETER-(D)	LENGTH-(L)	RESISTANCE-(K)	CORRECTED RESISTANCE-(K)
1	ENTRANCE	36.0	0.0	0.500	0.500000
2	VALVE	36.0	0.0	0.408	0.408243
3	STRAIGHT PIPE	36.0	9.7	0.048	0.048500
4	VALVE	36.0	0.0	0.408	0.408243
5	EXIT	36.0	0.0	1.000	1.000000

FLOW IN PREFERRED DIRECTION

CONDITIONS WITH VALVE OPEN
FLOW=15,484,745 SCFH

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	506.1
2	21.6	0.0860	230.9	538.3
3	20.3	0.0824	227.0	561.9
4	20.2	0.0820	226.6	561.9
5	18.8	0.0780	222.1	590.6
6	14.7	0.0653	206.8	703.3

CONDITIONS WITH VALVE SHUT
VALVE TORQUE= 16,767 IN.LBS
DELTA P= 9.00 PSI

CONDITIONS AS VALVE CLOSES

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
90	15,484,745	1.26	102,174	247

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	506.1
2	21.6	0.0860	230.9	538.3
3	20.3	0.0824	227.0	561.9
4	20.2	0.0820	226.6	561.9
5	18.8	0.0780	222.1	590.6
6	14.7	0.0653	206.8	703.3

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
80	14,940,144	1.86	116,816	365

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	488.3
2	21.8	0.0865	231.4	516.4
3	19.9	0.0812	225.6	550.3
4	19.8	0.0808	225.2	550.3
5	18.5	[illegible]	220.9	577.4
6	14.7	0.0653	206.8	678.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
70	13,876,901	2.93	77,734	575

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	453.5
2	22.1	0.0874	232.4	474.2
3	19.2	0.0790	223.2	524.7
4	19.1	0.0787	222.8	524.7
5	17.9	0.0753	218.9	548.3
6	14.7	0.0654	207.0	627.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
60	11,632,437	4.81	30,984	945

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	380.1
2	22.6	0.0889	234.0	390.8
3	17.8	0.0750	218.6	463.4
4	17.7	0.0747	218.3	463.4
5	16.9	0.0722	215.3	479.6
6	14.7	0.0655	207.0	527.0

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
50	9,022,538	6.62	9,712	1,300

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	294.8
2	23.1	0.0901	235.2	299.7
3	16.4	0.0707	213.6	381.6
4	16.4	0.0706	213.4	381.6
5	15.8	0.0690	211.4	390.6
6	14.6	0.0650	206.5	411.4

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
40	6,143,044	7.87	2,926	1,544

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	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	200.7
2	23.4	0.0911	236.2	201.8
3	15.5	0.0680	210.2	270.3
4	15.5	0.0679	210.1	270.3
5	15.3	0.0671	209.1	273.4
6	14.7	0.0653	206.9	279.7

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
30	3,760,933	8.69	602	1,705

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	122.9
2	23.6	0.0915	236.7	122.9
3	14.9	0.0660	207.7	170.5
4	14.9	0.0659	207.6	170.5
5	14.8	0.0656	207.2	171.3
6	14.6	0.0650	206.4	172.6

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
20	1,893,972	8.90	96	1,747

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	61.9
2	23.6	0.0917	236.9	61.9
3	14.7	0.0655	207.0	86.7
4	14.7	0.0655	207.0	86.7
5	14.7	0.0654	206.9	86.8
6	14.7	0.0652	206.7	87.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

ANGLE	FLOW	DP ACROSS VALVE	Taero	Tdp
10	957,900	8.97	9	1,761

	PRESSURE	DENSITY	TEMPERATURE	VELOCITY
1	23.7	0.0918	237.0	31.3
2	23.6	0.0917	236.9	31.3
3	14.7	0.0653	206.8	43.9
4	14.7	0.0653	206.8	43.9
5	14.7	0.0653	206.8	44.0
6	14.7	0.0652	206.7	44.0

NOTE: THERE IS CHOKE FLOW AT STATION 2

APPENDIX C

Determination of Closing Times

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

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR 33082-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YORE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	67.0	29.94
20	.0695	131.3	29.80
30	.0708	255.1	29.22
40	.0738	396.4	27.79
50	.0800	538.5	24.64
60	.0905	636.1	19.27
70	.109	671.3	9.80
80	.122	661.2	2.47
90	.122	661.2	2.47

Case 1

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33062-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 21195
Tbreak= 37091
Tspring ending= 10210
ACT. VOL.= 4.01
ACT. YOKE RADIUS= 3.38
ACT. PRESS= 80
SOL. VALVE Cv= 8
MEDIA=AIR
VALVE Cv= 23412
HYDRO. TORQUE @ 90= 12758
SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210
SEAL TORQUE= 4316
Dstem= 2
Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2
dt= .1

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0708	.0738	.0800	.0905	.1020	.1220	.1220
VELOCITY	67.0	131.3	255.1	396.4	538.5	636.1	671.3	661.2	661.2
PRES DROP	29.94	29.80	29.22	27.79	24.64	19.27	9.80	2.47	2.47

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

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -47922 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	29062	-12821	-18371	1210	1768	63.00	16.42
0.10	0	6752	-9652	-351	726	1687	31.28	29.03
0.20	0	7586	-9530	-108	726	1754	24.16	29.55
0.30	0	7159	-9599	-28	726	1759	17.30	29.83
0.40	0	7391	-9755	-8	726	1766	11.98	29.91
0.50	0	7511	-9932	-1	726	1767	7.50	29.95
0.60	0	7660	-10083	-0	726	1768	3.78	29.97
0.70	0	3951	-10185	-0	4525	1769	0.67	29.99

Case 1

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR 33082-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF | ACTUATOR YORE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG | SOLENOID VALVE C_V 8

MEDIA Air | VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 | SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. | SEAL TORQUE 4316 IN.LBS.

STEM DIA. 20 IN. | GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 | dt 1.0 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	67.0	29.94
20	.0695	131.3	29.80
30	.0708	255.1	29.22
40	.0738	396.4	27.79
50	.0800	538.5	24.64
60	.0905	636.1	19.27
70	.109	671.3	9.80
80	.122	661.2	2.47
90	.122	661.2	2.47

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33082-S800 ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10210	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.38	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 90= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SEAL TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .5	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0708	.0738	.0800	.0905	.1020	.1220	.1220
VELOCITY	67.0	131.3	255.1	396.4	538.5	636.1	671.3	661.2	661.2
PRES DROP	29.94	29.80	29.22	27.79	24.64	19.27	9.80	2.47	2.47

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	51221	37086	-26857	39604	1210	145	90.00	2.47
0.50	23550	9447	-26857	39604	1210	145	90.00	2.47
1.00	21756	7654	-26857	39604	1210	145	90.00	2.47
1.50	20579	6476	-26857	39604	1210	145	90.00	2.47
2.00	19736	5633	-26857	39604	1210	145	90.00	2.47
2.50	19098	4996	-26857	39604	1210	145	90.00	2.47
3.00	18596	4494	-26857	39604	1210	145	90.00	2.47
3.50	18191	4088	-26857	39604	1210	145	90.00	2.47
4.00	17855	3752	-26857	39604	1210	145	90.00	2.47
4.50	17572	3469	-26857	39604	1210	145	90.00	2.47
5.00	17330	3227	-26857	39604	1210	145	90.00	2.47
5.50	17120	3018	-26857	39604	1210	145	90.00	2.47
6.00	16937	2835	-26857	39604	1210	145	90.00	2.47
6.50	16776	2673	-26857	39604	1210	145	90.00	2.47
7.00	16632	2530	-26857	39604	1210	145	90.00	2.47
7.50	16503	2401	-26857	39604	1210	145	90.00	2.47
8.00	16388	2285	-26857	39604	1210	145	90.00	2.47
8.50	16283	2180	-26857	39604	1210	145	90.00	2.47
9.00	16187	2085	-26857	39604	1210	145	90.00	2.47
9.50	16100	1997	-26857	39604	1210	145	90.00	2.47
10.00	16019	1917	-26857	39604	1210	145	90.00	2.47
10.50	15946	1843	-26857	39604	1210	145	90.00	2.47
11.00	15877	1775	-26857	39604	1210	145	90.00	2.47
11.50	15814	1711	-26857	39604	1210	145	90.00	2.47
12.00	15755	1653	-26857	39604	1210	145	90.00	2.47
12.50	15700	1598	-26857	39604	1210	145	90.00	2.47
13.00	15649	1546	-26857	39604	1210	145	90.00	2.47

Case 1A

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33082-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YORE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0693	66.6	29.93
20	.0698	130.8	29.74
30	.0717	251.7	29.09
40	.0761	387.3	27.46
50	.0851	514.3	23.83
60	.1017	584.8	16.59
70	.1193	612.0	8.79
80	.1244	646.4	5.63
90	.1305	616.2	3.31

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33082-SR80 ACTUATOR

Case 1A

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10210	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.38	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 90= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SEAL TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0693	.0698	.0717	.0761	.0851	.1017	.1193	.1244	.1305
VELOCITY	66.6	130.8	251.7	387.3	514.3	584.8	612.0	646.4	616.2
PRES DROP	29.93	29.74	29.09	27.46	23.83	16.89	8.79	5.63	3.31

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

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -46701 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	29077	-13036	-18852	1210	1768	64.00	13.65
0.10	0	6990	-9699	-437	726	1668	32.60	28.66
0.20	0	7506	-9534	-127	726	1742	25.09	29.40
0.30	0	7171	-9582	-32	726	1756	18.13	29.77
0.40	0	7364	-9731	-10	726	1764	12.66	29.87
0.50	0	7491	-9908	-2	726	1766	8.06	29.94
0.60	0	7643	-10064	-0	726	1768	4.26	29.97
0.70	0	4282	-10174	-0	4185	1769	1.07	29.99

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Case 1A

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33082-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22,352 IN.

INERTIA OF DISC ASS'Y 33.2 LB. IN. SEC^2 dt 0.5 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0693	66.6	29.93
20	.0698	130.8	29.74
30	.0717	251.7	29.09
40	.0761	387.3	27.46
50	.0851	514.3	23.83
60	.1017	594.8	16.89
70	.1193	612.0	8.79
80	.1244	646.4	5.63
90	.1305	616.2	3.31

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33082-SR80 ACTUATOR

Case 1A

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10210	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.38	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA-AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 90= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SEAL TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .5	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0693	.0698	.0717	.0761	.0851	.1017	.1193	.1244	.1305
VELOCITY	66.6	130.8	251.7	387.3	514.3	584.8	612.0	646.4	616.2
PRES DROP	29.93	29.74	29.09	27.46	23.83	16.89	8.79	5.63	3.31

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	48460	37086	-26857	36793	1210	195	90.00	3.31
0.50	20789	9447	-26857	36793	1210	195	90.00	3.31
1.00	18995	7654	-26857	36793	1210	195	90.00	3.31
1.50	17818	6476	-26857	36793	1210	195	90.00	3.31
2.00	16975	5633	-26857	36793	1210	195	90.00	3.31
2.50	16337	4996	-26857	36793	1210	195	90.00	3.31
3.00	15835	4494	-26857	36793	1210	195	90.00	3.31
3.50	15429	4088	-26857	36793	1210	195	90.00	3.31
4.00	15093	3752	-26857	36793	1210	195	90.00	3.31
4.50	14810	3469	-26857	36793	1210	195	90.00	3.31
5.00	14568	3227	-26857	36793	1210	195	90.00	3.31
5.50	14359	3018	-26857	36793	1210	195	90.00	3.31
6.00	14176	2835	-26857	36793	1210	195	90.00	3.31
6.50	14014	2673	-26857	36793	1210	195	90.00	3.31
7.00	13871	2530	-26857	36793	1210	195	90.00	3.31
7.50	13742	2401	-26857	36793	1210	195	90.00	3.31
8.00	13626	2285	-26857	36793	1210	195	90.00	3.31
8.50	13521	2180	-26857	36793	1210	195	90.00	3.31
9.00	13426	2085	-26857	36793	1210	195	90.00	3.31
9.50	13338	1997	-26857	36793	1210	195	90.00	3.31
10.00	13258	1917	-26857	36793	1210	195	90.00	3.31
10.50	13184	1843	-26857	36793	1210	195	90.00	3.31
11.00	13116	1775	-26857	36793	1210	195	90.00	3.31
11.50	13053	1711	-26857	36793	1210	195	90.00	3.31
12.00	12994	1653	-26857	36793	1210	195	90.00	3.31
12.50	12939	1598	-26857	36793	1210	195	90.00	3.31

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR YS102-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YORE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V .8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.6	27.24
20	.0691	82.0	11.43
30	.0691	91.8	3.26
40	.0691	91.8	.92
50	.0691	91.8	.35
60	.0691	91.8	.17
70	.0691	91.8	.08
80	.0691	91.8	.04
90	.0691	91.8	.03

Case 2

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 451::-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530 Ibreak= 76190 Tspring ending= 21250
ACT. VOL.= 10 ACT. YOKE RADIUS= 4.5 ACT. PRESS= 80 SOL. VALVE Cv= 8
MEDIA=AIR VALVE Cv= 60648 HYDRO. TORQUE @ 90= 89607 SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663 SEAL TORQUE= 10452 Dstem= 2.75 Dgage= 34.782
INERTIA OF DISC ASS'Y= 187 dt= .1

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691
VELOCITY	43.6	87.0	91.8	91.8	91.8	91.8	91.8	91.8	91.8
PRES DROP	27.24	11.43	3.26	0.92	0.35	0.17	0.08	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	20720	76167	-54891	-2291	1663	5	90.00	0.03
0.10	16101	71615	-54891	-2291	1663	5	90.00	0.03
0.20	12076	67590	-54891	-2291	1663	5	90.00	0.03
0.30	8491	64006	-54891	-2291	1663	5	90.00	0.03
0.40	5277	60791	-54891	-2291	1663	5	90.00	0.03
0.50	2377	57891	-54891	-2291	1663	5	90.00	0.03
0.60	0	55261	-54891	-2291	1663	5	90.00	0.03
0.70	0	46683	-47200	-2478	997	-0	86.10	0.03
0.80	0	42526	-40973	-2678	997	7	81.94	0.03
0.90	0	37005	-35662	-2582	997	9	77.23	0.05
1.00	0	32540	-31438	-2236	997	13	72.20	0.07
1.10	0	28831	-28152	-1788	997	20	66.92	0.10
1.20	0	25873	-25677	-1268	997	30	61.51	0.15
1.30	0	23737	-23801	-899	997	47	56.10	0.24
1.40	0	22193	-22633	-595	997	66	50.79	0.33
1.50	0	21232	-21829	-460	997	117	45.65	0.59
1.60	0	20191	-20929	-358	997	172	40.74	0.87
1.70	0	19305	-20289	-281	997	359	36.11	1.83
1.80	0	18673	-19902	-212	997	556	31.81	2.83
1.90	0	18010	-19704	-164	997	981	27.87	4.99
2.00	0	17367	-19643	-135	997	1551	24.32	7.89
2.10	0	16870	-19676	-111	997	2060	21.14	10.49
2.20	0	16210	-19770	-77	997	2768	18.30	14.10
2.30	0	15538	-19901	-48	997	3545	15.80	18.06
2.40	0	14973	-20048	-29	997	4230	13.60	21.54
2.50	0	14490	-20201	-17	997	4837	11.64	24.64
2.60	0	14104	-20352	-10	997	5352	9.89	27.26
2.70	0	14147	-20498	-5	997	5438	8.31	27.70
2.80	0	14177	-20638	-3	997	5517	6.84	28.11
2.90	0	14231	-20770	-1	997	5591	5.47	28.48
3.00	0	14279	-20892	-0	997	5661	4.19	28.84
3.10	0	14320	-21001	-0	997	5726	3.00	29.17
3.20	0	7972	-21096	-0	7378	5786	1.88	29.48
3.30	0	6736	-21142	-0	8879	5819	1.29	29.64
3.40	0	5473	-21177	-0	9919	5844	0.81	29.77
3.50	0	4733	-21203	-0	10662	5865	0.43	29.87
3.60	0	4127	-21224	-0	11247	5882	0.11	29.96

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V .8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 Δt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.6	27.24
20	.0691	82.0	11.43
30	.0691	91.8	3.26
40	.0691	91.8	.92
50	.0691	91.8	.35
60	.0691	91.8	.17
70	.0691	91.8	.08
80	.0691	91.8	.04
90	.0691	91.8	.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 451[illegible]-SR80 ACTUATOR

Case 2

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= [illegible]1250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 40648	HYDRO. TORQUE @ [illegible]0= 99607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	7[illegible]	80	90
DENSITY	.0691	.0691	.0691	.0691	.0691	.0691	.0[illegible]1	.0691	.0691
VELOCITY	43.6	87.0	91.8	91.8	91.8	91.8	91.3	91.8	91.8
PRES DROP	27.24	11.43	3.26	0.92	0.35	0.17	0.[illegible]8	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	25302	76167	-54891	2291	1663	5	90.00	0.03
0.10	20683	71615	-54891	2291	1663	5	90.00	0.03
0.20	16659	67590	-54891	2291	1663	5	90.00	0.03
0.30	13074	64006	-54891	2291	1663	5	90.00	0.03
0.40	9859	60791	-54891	2291	1663	5	90.00	0.03
0.50	6959	57891	-54891	2291	1663	5	90.00	0.03
0.60	4329	55261	-54891	2291	1663	5	90.00	0.03
0.70	1933	52865	-54891	2291	1663	5	90.00	0.03
0.80	0	50672	-54891	2291	1663	5	90.00	0.03
0.90	0	43465	-47795	1493	997	0	86.44	0.03
1.00	0	40180	-41936	644	997	6	82.66	0.03
1.10	0	35689	-36823	-87	997	8	78.38	0.04
1.20	0	31948	-32623	-467	997	12	73.77	0.06
1.30	0	28866	-29241	-750	997	17	68.85	0.09
1.40	0	26101	-26587	-620	997	26	63.70	0.13
1.50	0	24003	-24591	-477	997	38	58.46	0.19
1.60	0	22403	-23147	-309	997	57	53.22	0.29
1.70	0	21302	-22166	-188	997	90	48.09	0.45
1.80	0	20423	-21365	-143	997	145	43.14	0.74
1.90	0	19516	-20579	-110	997	252	38.43	1.28
2.00	0	18820	-20076	-100	997	456	34.01	2.32
2.10	0	18341	-19789	-91	997	653	29.92	3.32
2.20	0	17595	-19661	-71	997	1255	26.16	6.39
2.30	0	17057	-19649	-54	997	1793	22.80	9.13
2.40	0	16583	-19713	-39	997	2304	19.80	11.73
2.50	0	15843	-19827	-25	997	3136	17.12	15.97
2.60	0	15251	-19966	-16	997	3867	14.76	19.69
2.70	0	14729	-20117	-10	997	4513	12.68	22.99
2.80	0	14288	-20270	-6	997	5089	10.82	25.92
2.90	0	14119	-20419	-3	997	5392	9.16	27.47
3.00	0	14157	-20562	-2	997	5475	7.63	27.89
3.10	0	14201	-20699	-1	997	5552	6.21	28.28
3.20	0	14253	-20827	-0	997	5624	4.88	28.65
3.30	0	14298	-20943	-0	997	5691	3.64	28.99
3.40	0	10007	-21046	-0	5326	5754	2.48	29.31
3.50	0	7709	-21109	-0	7620	5796	1.72	29.52
3.60	0	6250	-21152	-0	9186	5826	1.15	29.68
3.70	0	5286	-21184	-0	10116	5850	0.71	29.80
3.80	0	4567	-21209	-0	10816	5869	0.35	29.90
3.90	0	4004	-21228	-0	11370	5886	0.04	29.98

Case 2A

DETERMINATION OF CLOSING TIME

VALVE SIZE 10" VALVE CLASS 150

ACTUATOR Matryx 26062-5880

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 9294 BREAK 16264 SPRING ENDING 4640

ACTUATOR VOLUME 1.8 SCF ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 3178

HYDRODYNAMIC TORQUE @90 330 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 680 IN.LBS. SEAL TORQUE 839 IN.LBS.

STEM DIA. 1.125 IN. GAGE DIA. 9.85 IN.

INERTIA OF DISC ASS'Y .406 LB.IN.SEC^2 dt .025 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	50.3	29.98
20	.0742	99.4	29.93
30	.0747	195.5	29.74
40	.0759	315.0	29.30
50	.0784	455.5	28.06
60	.0835	588.3	25.82
70	.0973	684.3	20.02
80	.1173	678.5	11.72
90	.1285	659.7	7.00

DETERMINATION OF CLOSING TIME

10 - 150 CLASS VALVE WITH A 26062-SRHO ACTUATOR

Case 2A

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 9294	Tbreak= 16264	Tspring ending= 4642	
ACT. VOL.= 1.8	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA-AIR	VALVE Cv= 3172	HYDRO. TORQUE @ 90= 330	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 680	SEAL TORQUE= 839	Dstem= 1.125	Dgage= 9.85
INERTIA OF DISC ASS'Y= .406		dt= 2.50000000E-02	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0742	.0747	.0752	.0784	.0835	.0973	.1173	.1285
VELOCITY	50.3	99.4	195.5	315.0	455.5	588.3	684.3	678.2	659.7
PRES DROP	29.98	29.93	29.74	29.30	28.06	25.82	20.02	11.72	7.00

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg+inertia	ANGLE degrees	DELTA P psi
0.00	3630	16262	-11613	-1756	680	45	90.00	7.00
0.02	2266	14912	-11613	-1756	680	45	90.00	7.00
0.05	1131	13777	-11613	-1756	680	45	90.00	7.00
0.07	162	12808	-11613	-1756	680	45	90.00	7.00
0.10	0	11970	-11613	-1756	680	45	90.00	7.00
0.12	0	10763	-9401	-1928	408	-95	84.36	9.66
0.15	0	8884	-7571	-1832	408	49	77.26	13.98
0.17	0	6917	-6256	-1212	408	104	69.20	20.40
0.20	0	5372	-5429	-513	408	161	61.09	25.18
0.22	0	4593	-4955	-213	408	195	53.69	27.23
0.25	0	4193	-4691	-87	408	198	46.85	28.44
0.27	0	3913	-4465	-38	408	202	40.53	29.23
0.30	0	3735	-4310	-16	408	204	34.71	29.53
0.32	0	3649	-4236	-6	408	206	29.41	29.75
0.35	0	3626	-4217	-3	408	206	24.62	29.84
0.37	0	3642	-4235	-1	408	206	20.31	29.92
0.40	0	3684	-4278	-0	408	205	16.46	29.94
0.42	0	3741	-4336	-0	408	204	13.02	29.96
0.45	0	3804	-4399	-0	408	203	9.95	29.98
0.47	0	3868	-4464	-0	408	202	7.22	29.98
0.50	0	3928	-4524	-0	408	201	4.78	29.99
0.52	0	3676	-4578	-0	712	200	2.60	29.99
0.55	0	3306	-4619	-0	1127	203	0.79	29.99

Case 2A

DETERMINATION OF CLOSING TIME

VALVE SIZE 10" VALVE CLASS 150

ACTUATOR Matryx 26062-5880

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 9294 BREAK 16264 SPRING ENDING 4640

ACTUATOR VOLUME 1.8 SCF ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 3178

HYDRODYNAMIC TORQUE @90 330 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 680 IN.LBS. SEAL TORQUE 839 IN.LBS.

STEM DIA. 1.125 IN. GAGE DIA. 9.85 IN.

INERTIA OF DISC ASS'Y .406 LB.IN.SEC^2 dt .025 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	50.3	29.98
20	.0742	99.4	29.93
30	.0747	195.5	29.74
40	.0759	315.0	29.30
50	.0784	455.5	28.06
60	.0835	588.3	25.82
70	.0973	684.3	20.02
80	.1173	6[illegible]5	11.72
90	.1285	559.7	7.00

DETERMINATION OF CLOSING TIME

10 - 150 CLASS VALVE WITH A 26062-SF[) ACTUATOR

Case 2A

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 9294	Tbreak= 16264	Tspring ending= -540	
ACT. VOL.= 1.8	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 3178	HYDRO. TORQUE @ [illegible]= 330	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 680	SEAL TORQUE= 839	Dstem= 1.125	Dgage= 9.85
INERTIA OF DISC ASS'Y= .406		dt= 2.50000000E-02	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0742	.0747	.0759	.0784	.0835	.0923	.1173	.1285
VELOCITY	50.3	99.4	195.5	315.0	455.5	588.3	684.3	678.2	659.7
PRES DROP	29.98	29.93	29.74	29.30	28.06	25.82	20.02	11.72	7.00

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	7144	16262	-11613	1756	680	45	90.00	7.00
0.02	5780	14912	-11613	1756	680	45	90.00	7.00
0.05	4645	13777	-11613	1756	680	45	90.00	7.00
0.07	3676	12808	-11613	1756	680	45	90.00	7.00
0.10	2039	11970	-11613	1756	680	45	90.00	7.00
0.12	2107	11239	-11613	1756	680	45	90.00	7.00
0.15	1462	10594	-11613	1756	680	45	90.00	7.00
0.17	889	10021	-11613	1756	680	45	90.00	7.00
0.20	377	9509	-11613	1756	680	45	90.00	7.00
0.22	0	9047	-11613	1756	680	45	90.00	7.00
0.25	0	8333	-9897	1025	408	-58	85.83	8.94
0.27	0	7727	-8400	180	408	50	80.88	11.30
0.30	0	6857	-7128	-252	408	75	74.95	15.90
0.32	0	6013	-6139	-426	408	114	68.26	21.02
0.35	0	5084	-5428	-231	408	148	61.08	25.18
0.37	0	4491	-4975	-96	408	179	54.09	27.14
0.40	0	4154	-4707	-34	408	191	47.42	28.37
0.42	0	3909	-4486	-14	408	198	41.15	29.15
0.45	0	3737	-4323	-7	408	202	35.32	29.50
0.47	0	3651	-4241	-3	408	205	29.98	29.74
0.50	0	3624	-4217	-1	408	206	25.14	29.83
0.52	0	3638	-4232	-0	408	206	20.78	29.91
0.55	0	3670	-4273	-0	408	205	16.88	29.94
0.57	0	3734	-4329	-0	408	204	13.39	29.96
0.60	0	3797	-4392	-0	408	203	10.29	29.97
0.62	0	3861	-4456	-0	408	202	7.51	29.98
0.65	0	3922	-4518	-0	408	201	5.04	29.98
0.67	0	3782	-4572	-0	601	200	2.84	29.99
0.70	0	3328	-4613	-0	1100	202	0.95	29.99

PAGE

Case 2B

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1163 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.2	27.26
20	.0694	85.1	12.54
30	.0692	91.6	3.25
40	.0692	91.6	.92
50	.0692	91.6	.35
60	.0692	91.6	.17
70	.0692	91.6	.08
80	.0692	91.6	.04
90	.0692	91.6	.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 45102-SR90 ACTUATOR

Case 2B

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60649	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0694	.0692	.0692	.0692	.0692	.0692	.0692	.0692
VELOCITY	43.2	85.1	91.6	91.6	91.6	91.6	91.6	91.6	91.6
PRES DROP	27.26	12.54	3.25	0.92	0.35	0.17	0.08	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	20727	76167	-54891	-2284	1663	5	90.00	0.03
0.10	16108	71615	-54891	-2284	1663	5	90.00	0.03
0.20	12083	67590	-54891	-2284	1663	5	90.00	0.03
0.30	8498	64006	-54891	-2284	1663	5	90.00	0.03
0.40	5283	60791	-54891	-2284	1663	5	90.00	0.03
0.50	2383	57891	-54891	-2284	1663	5	90.00	0.03
0.60	0	55261	-54891	-2284	1663	5	90.00	0.03
0.70	0	46675	-47200	-2471	997	-0	86.10	0.03
0.80	0	42519	-40974	-2670	997	7	81.94	0.03
0.90	0	36999	-35663	-2574	997	9	77.23	0.05
1.00	0	32535	-31440	-2230	997	13	72.20	0.07
1.10	0	28828	-28154	-1783	997	20	66.92	0.10
1.20	0	25872	-25679	-1264	997	30	61.51	0.15
1.30	0	23736	-23882	-897	997	47	56.11	0.23
1.40	0	22193	-22634	-593	997	66	50.79	0.33
1.50	0	21232	-21830	-459	997	117	45.66	0.59
1.60	0	20191	-20930	-358	997	172	40.74	0.87
1.70	0	19306	-20290	-280	997	358	36.11	1.82
1.80	0	18675	-19902	-211	997	555	31.82	2.82
1.90	0	17965	-19704	-163	997	1024	27.88	5.21
2.00	0	17247	-19643	-132	997	1671	24.33	8.51
2.10	0	16683	-19675	-107	997	2246	21.18	11.44
2.20	0	16044	-19768	-75	997	2932	18.37	14.93
2.30	0	15425	-19896	-47	997	3650	15.88	18.59
2.40	0	14907	-20041	-29	997	4284	13.69	21.82
2.50	0	14466	-20193	-17	997	4849	11.73	24.70
2.60	0	14094	-20344	-10	997	5352	9.98	27.26
2.70	0	14139	-20470	-6	997	5437	8.40	27.69
2.80	0	14171	-20631	-3	997	5516	6.92	28.10
2.90	0	14226	-20763	-1	997	5590	5.55	28.47
3.00	0	14275	-20885	-0	997	5659	4.26	28.83
3.10	0	14317	-20995	-0	997	5723	3.06	29.15
3.20	0	8145	-21091	-0	7203	5784	1.94	29.46
3.30	0	6835	-21138	-0	8773	5817	1.33	29.63
3.40	0	5552	-21174	-0	9843	5843	0.85	29.76
3.50	0	4792	-21201	-0	10603	5863	0.46	29.87
3.60	0	4175	-21222	-0	11200	5881	0.14	29.96

Case 2B

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-SR80

DIRECTION OF FLOW Non Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.2	27.26
20	.0694	85.1	12.54
30	.0692	91.6	3.25
40	.0692	91.6	.92
50	.0692	91.6	.35
60	.0692	91.6	.17
70	.0692	91.6	.08
80	.0692	91.6	.04
90	.0692	91.6	.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 45102-SR80 ACTUATOR Case 2B

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Ibreak= 76190	Ispring ending= 21280	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Pgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0694	.0692	.0692	.0692	.0692	.0692	.0692	.0692
VELOCITY	43.2	85.1	91.6	91.6	91.6	91.6	91.6	91.6	91.6
PRES DROP	27.26	12.54	3.25	0.92	0.35	0.17	0.08	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	25296	76167	-54891	2284	1663	5	90.00	0.03
0.10	20676	71615	-54891	2284	1663	5	90.00	0.03
0.20	16652	67590	-54891	2284	1663	5	90.00	0.03
0.30	13067	64006	-54891	2284	1663	5	90.00	0.03
0.40	9852	60791	-54891	2284	1663	5	90.00	0.03
0.50	6952	57891	-54891	2284	1663	5	90.00	0.03
0.60	4322	55261	-54891	2284	1663	5	90.00	0.03
0.70	1926	52865	-54891	2284	1663	5	90.00	0.03
0.80	0	50672	-54891	2284	1663	5	90.00	0.03
0.90	0	43469	-47795	1488	997	0	86.44	0.03
1.00	0	40181	-41935	642	997	6	82.66	0.03
1.10	0	35688	-36822	-86	997	8	78.38	0.04
1.20	0	31947	-32623	-466	997	12	73.77	0.06
1.30	0	28863	-29241	-747	997	17	68.85	0.09
1.40	0	26099	-26587	-618	997	26	63.70	0.13
1.50	0	24002	-24591	-476	997	38	58.46	0.19
1.60	0	22403	-23148	-308	997	57	53.22	0.29
1.70	0	21301	-22166	-188	997	90	48.09	0.45
1.80	0	20423	-21365	-143	997	145	43.14	0.74
1.90	0	19517	-20580	-110	997	252	38.43	1.28
2.00	0	18821	-20076	-100	997	454	34.01	2.31
2.10	0	18341	-19789	-90	997	652	29.92	3.32
2.20	0	17512	-19661	-69	997	1338	26.16	6.81
2.30	0	16908	-19648	-52	997	1947	22.82	9.91
2.40	0	16382	-19712	-38	997	2506	19.84	12.76
2.50	0	15703	-19823	-25	997	3273	17.19	16.67
2.60	0	15158	-19961	-16	997	3948	14.85	20.11
2.70	0	14683	-20110	-10	997	4549	12.77	23.17
2.80	0	14201	-20262	-6	997	5085	10.91	25.90
2.90	0	14110	-20411	-4	997	5391	9.24	27.46
3.00	0	14151	-20555	-2	997	5473	7.71	27.83
3.10	0	14195	-20692	-1	997	5550	6.28	28.27
3.20	0	14248	-20820	-0	997	5622	4.95	28.64
3.30	0	14295	-20937	-0	997	5689	3.71	28.98
3.40	0	10265	-21040	-0	5064	5751	2.54	29.30
3.50	0	7799	-21106	-0	7718	5794	1.75	29.51
3.60	0	6324	-21150	-0	9119	5825	1.18	29.67
3.70	0	5334	-21182	-0	10068	5849	0.74	29.79
3.80	0	4605	-21207	-0	10778	5868	0.37	29.89
3.90	0	4034	-21227	-0	11340	5885	0.06	29.98

0489

Case 3

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 185 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	70.5	30.06
20	.0692	138.2	29.52
30	.0695	277.2	26.57
40	.0700	399.2	21.09
50	.0705	480.6	13.42
60	.0708	496.8	6.85
70	.0707	513.6	3.44
80	.0707	513.6	1.74
90	.0707	513.6	1.09

Case 3

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 451C2-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Ibreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0692	.0695	.0700	.0705	.0708	.0707	.0707	.0707
VELOCITY	70.5	138.2	279.2	399.2	480.6	496.8	513.6	513.6	513.6
PRES DROP	30.06	29.52	26.57	21.09	13.42	6.85	3.44	1.74	1.09

LOCA CLOSES THE VALVE TO 61 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -88786 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	59741	-25480	-36818	1663	5889	61.00	6.50
0.10	0	30629	-22171	-13388	997	2910	48.12	14.85
0.20	0	21982	-20976	-7283	997	3979	41.01	20.30
0.30	0	19499	-20274	-4119	997	4576	35.97	23.29
0.40	0	16331	-19890	-2239	997	5039	31.64	25.66
0.50	0	15011	-19715	-1312	997	5321	28.19	27.10
0.60	0	14118	-19648	-801	997	5493	25.20	27.98
0.70	0	13610	-19651	-477	997	5646	22.56	28.76
0.80	0	13286	-19702	-271	997	5785	20.16	29.46
0.90	0	13236	-19785	-185	997	5816	17.98	29.62
1.00	0	13243	-19892	-126	997	5837	15.95	29.73
1.10	0	13299	-20015	-84	997	5857	14.05	29.84
1.20	0	13390	-20149	-53	997	5876	12.28	29.93
1.30	0	13478	-20288	-33	997	5894	10.62	30.02
1.40	0	13598	-20428	-20	997	5899	9.06	30.05
1.50	0	13726	-20566	-11	997	5897	7.59	30.04
1.60	0	13853	-20698	-6	997	5896	6.22	30.03
1.70	0	13974	-20823	-3	997	5894	4.92	30.02
1.80	0	14087	-20937	-1	997	5893	3.70	30.02
1.90	0	10178	-21039	-0	5008	5891	2.55	30.01
2.00	0	7746	-21104	-0	7667	5891	1.77	30.01
2.10	0	6305	-21148	-0	9070	5890	1.21	30.00
2.20	0	5336	-21181	-0	10022	5889	0.76	30.00
2.30	0	4624	-21206	-0	10737	5889	0.39	30.00
2.40	0	4065	-21226	-0	11304	5888	0.08	30.00

0325

Case 3

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YORE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 185 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	70.5	30.06
20	.0692	138.2	29.52
30	.0695	277.2	26.57
40	.0700	399.2	21.09
50	.0705	480.6	13.42
60	.0708	496.8	6.85
70	.0707	513.6	3.44
80	.0707	513.6	1.74
90	.0707	513.6	1.09

C(4)-3

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4510[illegible]-SR80 ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60649	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 9
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.702
INERTIA OF DISC ASS'Y= 187		dt= 1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0692	.0695	.0700	.0705	.0708	.0707	.0707	.0707
VELOCITY	70.5	138.2	279.2	399.2	480.6	496.8	513.6	513.6	513.6
PRES DROP	30.06	29.52	26.57	21.09	13.42	6.85	3.44	1.74	1.09

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	96595	76167	-54891	73376	1663	213	90.00	1.09
1.00	51004	30643	-54891	73376	1663	213	90.00	1.09
2.00	43636	23274	-54891	73376	1663	213	90.00	1.09
3.00	39385	19023	-54891	73376	1663	213	90.00	1.09
4.00	36545	16184	-54891	73376	1663	213	90.00	1.09
5.00	34489	14128	-54891	73376	1663	213	90.00	1.09
6.00	32923	12562	-54891	73376	1663	213	90.00	1.09
7.00	31685	11323	-54891	73376	1663	213	90.00	1.09
8.00	30678	10317	-54891	73376	1663	213	90.00	1.09
9.00	29843	9482	-54891	73376	1663	213	90.00	1.09
10.00	29138	8776	-54891	73376	1663	213	90.00	1.09
11.00	28533	8172	-54891	73376	1663	213	90.00	1.09
12.00	28009	7648	-54891	73376	1663	213	90.00	1.09
13.00	27550	7189	-54891	73376	1663	213	90.00	1.09
14.00	27144	6783	-54891	73376	1663	213	90.00	1.09
15.00	26783	6422	-54891	73376	1663	213	90.00	1.09
16.00	26460	6099	-54891	73376	1663	213	90.00	1.09
17.00	26168	5807	-54891	73376	1663	213	90.00	1.09
18.00	25903	5542	-54891	73376	1663	213	90.00	1.09
19.00	25662	5301	-54891	73376	1663	213	90.00	1.09
20.00	25442	5080	-54891	73376	1663	213	90.00	1.09
21.00	25239	4878	-54891	73376	1663	213	90.00	1.09
22.00	25052	4691	-54891	73376	1663	213	90.00	1.09
23.00	24879	4518	-54891	73376	1663	213	90.00	1.09
24.00	24719	4358	-54891	73376	1663	213	90.00	1.09
25.00	24570	4209	-54891	73376	1663	213	90.00	1.09

Case 3 A

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33082-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	66.7	29.96
20	.0695	131.4	29.84
30	.0706	255.5	29.42
40	.0733	401.8	28.31
50	.0797	548.9	25.56
60	.0929	637.7	19.89
70	.1157	646.6	9.87
80	.1231	662.0	5.90
90	.1296	628.8	3.44

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33082--580 ACTUATOR

Case 3A

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10.10	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.30	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 90= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SEAL TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0706	.0733	.0797	.0929	.1157	.1231	.1296
VELOCITY	66.7	131.4	255.5	401.8	548.9	639.7	646.6	662.0	628.8
PRES DROP	29.96	29.84	29.42	28.31	25.56	19.89	9.87	5.90	3.44

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

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -48471 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	29062	-12821	-18789	1210	1768	63.00	16.88
0.10	0	6739	-9652	-352	726	1702	31.28	29.27
0.20	0	7581	-9530	-109	726	1760	24.18	29.66
0.30	0	7156	-9599	-28	726	1761	17.31	29.87
0.40	0	7389	-9755	-8	726	1767	11.99	29.93
0.50	0	7509	-9931	-1	726	1768	7.51	29.96
0.60	0	7659	-10082	-0	726	1769	3.79	29.98
0.70	0	3959	-10185	-0	4517	1769	0.68	29.99

0479

Case 3 A

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33082-SR80

DIRECTION OF FLOW Non Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 2195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB. IN.SEC^2 δt 0.5 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	66.7	29.96
20	.0695	134.4	29.84
30	.0706	255.5	29.42
40	.0733	401.8	28.31
50	.0797	548.9	25.56
60	.0924	637.7	19.89
70	.1157	646.6	9.87
80	.1231	662.0	5.90
90	.1256	628.8	3.44

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33082-SR80 ACTUATOR

Case 3A

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 21195 | Tbreak= 37091 | Tspring ending= 10210
ACT. VOL.= 4.01 | ACT. YOKE RADIUS= 3.38 | ACT. PRESS= 80 | SOL. VALVE Cv= 8
MEDIA=AIR | VALVE Cv= 23412 | HYDRO. TORQUE @ 90= 12758 | SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210 | SEAL TORQUE= 4316 | Cstem= 2 | Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2 | dt= .5

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0706	.0733	.0797	.0929	.1157	.1231	.1296
VELOCITY	66.7	131.4	255.5	401.8	548.9	639.7	646.5	662.0	628.8
PRES DROP	29.96	29.84	29.42	28.31	25.56	19.89	9.87	5.90	3.44

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	49723	37086	-26857	38049	1210	202	90.00	3.44
0.50	22052	9447	-26857	38049	1210	202	90.00	3.44
1.00	20258	7654	-26857	38049	1210	202	90.00	3.44
1.50	19081	6476	-26857	38049	1210	202	90.00	3.44
2.00	18238	5633	-26857	38049	1210	202	90.00	3.44
2.50	17600	4996	-26857	38049	1210	202	90.00	3.44
3.00	17099	4494	-26857	38049	1210	202	90.00	3.44
3.50	16693	4088	-26857	38049	1210	202	90.00	3.44
4.00	16357	3752	-26857	38049	1210	202	90.00	3.44
4.50	16074	3469	-26857	38049	1210	202	90.00	3.44
5.00	15832	3227	-26857	38049	1210	202	90.00	3.44
5.50	15623	3018	-26857	38049	1210	202	90.00	3.44
6.00	15439	2835	-26857	38049	1210	202	90.00	3.44
6.50	15278	2673	-26857	38049	1210	202	90.00	3.44
7.00	15134	2530	-26857	38049	1210	202	90.00	3.44
7.50	15006	2401	-26857	38049	1210	202	90.00	3.44
8.00	14890	2285	-26857	38049	1210	202	90.00	3.44
8.50	14785	2180	-26857	38049	1210	202	90.00	3.44
9.00	14689	2085	-26857	38049	1210	202	90.00	3.44
9.50	14602	1997	-26857	38047	1210	202	90.00	3.44
10.00	14522	1917	-26857	38049	1210	202	90.00	3.44
10.50	14448	1843	-26857	38049	1210	202	90.00	3.44
11.00	14379	1775	-26857	38049	1210	202	90.00	3.44
11.50	14316	1711	-26857	38049	1210	202	90.00	3.44
12.00	14257	1653	-26857	38049	1210	202	90.00	3.44
12.50	14202	1598	-26857	38049	1210	202	90.00	3.44

0481

Case 3B

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-S880

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	69.6	30.05
20	.0694	137.7	29.48
30	.0702	276.6	26.46
40	.0717	392.4	20.65
50	.0733	465.2	12.79
60	.0760	463.1	6.02
70	.0744	488.5	3.07
80	.0744	488.5	1.60
90	.0744	487.9	1.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4S102-SR80 ACTUATOR

Case 3b

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60642	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0694	.0702	.0717	.0733	.0760	.0744	.0744	.0744
VELOCITY	69.6	137.7	276.6	392.4	465.2	463.1	488.5	488.5	487.9
PRES DROP	30.05	29.48	26.46	20.65	12.79	6.02	3.07	1.60	1.03

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

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -84523 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	59696	-25869	-37463	1663	5889	62.00	5.43
0.10	0	31620	-22366	-14271	997	2607	49.32	13.32
0.20	0	23290	-21144	-7871	997	3742	41.98	19.09
0.30	0	19979	-20348	-4418	997	4441	36.62	22.61
0.40	0	16682	-19926	-2402	997	4948	32.16	25.20
0.50	0	15154	-19730	-1385	997	5277	28.61	26.87
0.60	0	14222	-19652	-848	997	5457	25.57	27.79
0.70	0	13671	-19648	-507	997	5616	22.88	28.60
0.80	0	13326	-19693	-291	997	5759	20.46	29.33
0.90	0	13244	-19773	-193	997	5806	18.25	29.57
1.00	0	13244	-19877	-131	997	5829	16.20	29.69
1.10	0	13294	-19999	-87	997	5850	14.29	29.80
1.20	0	13371	-20131	-56	997	5870	12.50	29.90
1.30	0	13467	-20270	-34	997	5889	10.82	30.00
1.40	0	13583	-20410	-20	997	5897	9.25	30.04
1.50	0	13711	-20549	-12	997	5896	7.77	30.03
1.60	0	13839	-20682	-6	997	5895	6.39	30.03
1.70	0	13961	-20808	-3	997	5893	5.08	30.02
1.80	0	14074	-20924	-1	997	5892	3.85	30.01
1.90	0	10864	-21027	-0	4310	5891	2.69	30.01
2.00	0	7938	-21098	-0	7441	5891	1.85	30.00
2.10	0	6470	-21143	-0	8923	5890	1.27	30.00
2.20	0	5438	-21177	-0	9918	5889	0.81	30.00
2.30	0	4704	-21203	-0	10656	5869	0.43	30.00
2.40	0	4129	-21224	-0	11239	5888	0.11	30.00

Case 3B

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89667 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt 1.0 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	,0692	69.6	30.05
20	,0694	137.7	29.48
30	,0706	276.6	26.46
40	,0717	322.4	20.65
50	,0733	465.2	12.79
60	,0760	482.1	6.02
70	,0744	498.5	3.07
80	,0744	188.5	1,60
90	,0744	487.9	1.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 45102-SR80 ACTUATOR — Case 3B

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60643	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= 1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0674	.0702	.0717	.0733	.0760	.0744	.0744	.0744
VELOCITY	69.6	137.7	276.6	392.4	465.2	463.1	488.5	488.5	487.9
PRES DROP	30.05	29.48	26.46	20.65	12.79	6.02	3.07	1.60	1.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	92889	76167	-54891	69681	1663	202	90.00	1.03
1.00	47298	30643	-54891	69681	1663	202	90.00	1.03
2.00	39930	23274	-54891	69681	1663	202	90.00	1.03
3.00	35679	19023	-54891	69681	1663	202	90.00	1.03
4.00	32839	16184	-54891	69681	1663	202	90.00	1.03
5.00	30783	14128	-54891	69681	1663	202	90.00	1.03
6.00	29217	12562	-54891	69681	1663	202	90.00	1.03
7.00	27979	11323	-54891	69681	1663	202	90.00	1.03
8.00	26972	10317	-54891	69681	1663	202	90.00	1.03
9.00	26137	9482	-54891	69681	1663	202	90.00	1.03
10.00	25431	8776	-54891	69681	1663	202	90.00	1.03
11.00	24827	8172	-54891	69681	1663	202	90.00	1.03
12.00	24303	7648	-54891	69681	1663	202	90.00	1.03
13.00	23844	7189	-54891	69681	1663	202	90.00	1.03
14.00	23438	6783	-54891	69681	1663	202	90.00	1.03
15.00	23077	6422	-54891	69681	1663	202	90.00	1.03
16.00	22754	6098	-54891	69681	1663	202	90.00	1.03
17.00	22462	5807	-54891	69681	1663	202	90.00	1.03
18.00	22197	5542	-54891	69681	1663	202	90.00	1.03
19.00	21956	5301	-54891	69681	1663	202	90.00	1.03
20.00	21735	5080	-54891	69681	1663	202	90.00	1.03
21.00	21533	4878	-54891	69681	1663	202	90.00	1.03
22.00	21346	4691	-54891	69681	1663	202	90.00	1.03
23.00	21173	4518	-54891	69681	1663	202	90.00	1.03
24.00	21013	4358	-54891	69681	1663	202	90.00	1.03
25.00	20864	4209	-54891	69681	1663	202	90.00	1.03

0485

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Prefered

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V .8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.5	22.25
20	.0691	86.9	11.80
30	.0691	91.8	3.26
40	.0691	91.8	.92
50	.0691	91.8	.35
60	.0691	91.8	.17
70	.0691	91.8	.08
80	.0691	91.8	.04
90	.0691	91.8	.03

Case 4

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 451C;-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691
VELOCITY	43.5	86.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8
PRES DROP	27.25	11.80	3.26	0.92	0.35	0.17	0.08	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	20720	76167	-54891	-2291	1663	5	90.00	0.03
0.10	16101	71615	-54891	-2291	1663	5	90.00	0.03
0.20	12076	67590	-54891	-2291	1663	5	90.00	0.03
0.30	8491	64006	-54891	-2291	1663	5	90.00	0.03
0.40	5277	60791	-54891	-2291	1663	5	90.00	0.03
0.50	2377	57891	-54891	-2291	1663	5	90.00	0.03
0.60	0	55261	-54891	-2291	1663	5	90.00	0.03
0.70	0	46683	-47200	-2478	997	-0	86.10	0.03
0.80	0	42526	-40973	-2678	997	7	81.94	0.03
0.90	0	37005	-35662	-2582	997	9	77.23	0.05
1.00	0	32540	-31438	-2236	997	13	72.20	0.07
1.10	0	28831	-28152	-1788	997	20	66.92	0.10
1.20	0	25873	-25677	-1268	997	30	61.51	0.15
1.30	0	23737	-23881	-899	997	47	56.10	0.24
1.40	0	22193	-22633	-595	997	66	50.79	0.33
1.50	0	21232	-21829	-460	997	117	45.65	0.59
1.60	0	20191	-20929	-358	997	172	40.74	0.87
1.70	0	19305	-20289	-281	997	359	36.11	1.83
1.80	0	18673	-19902	-212	997	556	31.81	2.83
1.90	0	17995	-19704	-164	997	996	27.87	5.07
2.00	0	17327	-19643	-135	997	1592	24.32	8.10
2.10	0	16808	-19676	-111	997	2122	21.15	10.81
2.20	0	16155	-19770	-77	997	2823	18.32	14.38
2.30	0	15500	-19899	-48	997	3580	15.83	18.24
2.40	0	14951	-20046	-29	997	4248	13.62	21.64
2.50	0	14481	-20198	-17	997	4841	11.67	24.66
2.60	0	14100	-20350	-10	997	5353	9.92	27.27
2.70	0	14144	-20495	-5	997	5438	8.34	27.70
2.80	0	14175	-20636	-3	997	5517	6.87	28.10
2.90	0	14229	-20768	-1	997	5591	5.50	28.48
3.00	0	14277	-20890	-0	997	5660	4.22	28.83
3.10	0	14319	-20999	-0	997	5725	3.02	29.16
3.20	0	8027	-21094	-0	7321	5786	1.90	29.47
3.30	0	6768	-21141	-0	8845	5818	1.30	29.64
3.40	0	5499	-21176	-0	9894	5844	0.82	29.77
3.50	0	4752	-21203	-0	10643	5864	0.44	29.87
3.60	0	4143	-21223	-0	11232	5882	0.12	29.96

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V .8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 at .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	43.5	22.25
20	.0691	86.9	11.80
30	.0691	91.8	3.26
40	.0691	91.8	.92
50	.0691	91.8	.35
60	.0691	91.8	.17
70	.0691	91.8	.08
80	.0691	91.8	.04
90	.0691	91.8	.03

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4510?-SR80 ACTUATOR

Case Y

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= .1250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691	.0691
VELOCITY	43.5	86.9	91.8	91.8	91.8	91.8	91.8	91.8	91.8
PRES DROP	27.25	11.80	3.26	0.92	0.35	0.17	0.08	0.04	0.03

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	25302	76167	-54891	2291	1663	5	90.00	0.03
0.10	20683	71615	-54891	2291	1663	5	90.00	0.03
0.20	16659	67590	-54891	2291	1663	5	90.00	0.03
0.30	13074	64006	-54891	2291	1663	5	90.00	0.03
0.40	9859	60791	-54891	2291	1663	5	90.00	0.03
0.50	6959	57891	-54891	2291	1663	5	90.00	0.03
0.60	4329	55261	-54891	2291	1663	5	90.00	0.03
0.70	1933	52865	-54891	2291	1663	5	90.00	0.03
0.80	0	50672	-54891	2291	1663	5	90.00	0.03
0.90	0	43465	-47795	1493	997	0	86.44	0.03
1.00	0	40180	-41936	644	997	6	82.66	0.03
1.10	0	35689	-36823	-87	997	8	78.38	0.04
1.20	0	31948	-32623	-467	997	12	73.77	0.06
1.30	0	28866	-29241	-750	997	17	68.85	0.09
1.40	0	26101	-26587	-620	997	26	63.70	0.13
1.50	0	24003	-24591	-477	997	38	58.46	0.19
1.60	0	22403	-23147	-309	997	57	53.22	0.29
1.70	0	21302	-22166	-188	997	90	48.09	0.45
1.80	0	20423	-21365	-143	997	145	43.14	0.74
1.90	0	19516	-20579	-110	997	252	38.43	1.28
2.00	0	18820	-20076	-100	997	456	34.01	2.32
2.10	0	18340	-19789	-91	997	653	29.92	3.32
2.20	0	17547	-19661	-71	997	1283	26.16	6.53
2.30	0	17008	-19649	-54	997	1845	22.81	9.39
2.40	0	16517	-19713	-39	997	2371	19.82	12.07
2.50	0	15796	-19826	-25	997	3182	17.14	16.20
2.60	0	15220	-19964	-16	997	3394	14.79	19.83
2.70	0	14714	-20115	-10	997	4525	12.71	23.05
2.80	0	14286	-20267	-6	997	5088	10.85	25.92
2.90	0	14115	-20416	-3	997	5392	9.19	27.47
3.00	0	14154	-20560	-2	997	5475	7.66	27.89
3.10	0	14199	-20697	-1	997	5552	6.23	28.28
3.20	0	14251	-20824	-0	997	5623	4.91	28.64
3.30	0	14297	-20941	-0	997	5690	3.66	28.99
3.40	0	10092	-21044	-0	5241	5753	2.50	29.31
3.50	0	7739	-21108	-0	7786	5795	1.73	29.52
3.60	0	6275	-21151	-0	9164	5825	1.16	29.67
3.70	0	5302	-21183	-0	10100	5849	0.72	29.80
3.80	0	4580	-21208	-0	10803	5869	0.35	29.90
3.90	0	4014	-21228	-0	11360	5885	0.05	29.98

0601

Case 4A

DETERMINATION OF CLOSING TIME

VALVE SIZE 10" VALVE CLASS 150

ACTUATOR Matryx 26062-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 9294 BREAK 10264 SPRING ENDING 4640

ACTUATOR VOLUME 1.8 SCF ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 3178

HYDRODYNAMIC TORQUE @90 330 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 680 IN.LBS. SEAL TORQUE 839 IN.LBS.

STEM DIA. 1.125 IN. GAGE DIA. 9.85 IN.

INERTIA OF DISC ASS'Y .406 LB.IN.SEC^2 dt .025 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	49.4	29.98
20	.0742	99.3	29.93
30	.0747	195.4	29.74
40	.0759	315.8	29.30
50	.0784	455.5	28.06
60	.0835	588.3	25.82
70	.0974	684.0	17.98
80	.1173	678.5	11.72
90	.1285	657.7	7.00

DETERMINATION OF CLOSING TIME

10 - 150 CLASS VALVE WITH A 26062-SEID ACTUATOR

Case YA

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 9294	Tbreak= 16264	Tspring ending= +640	
ACT. VOL.= 1.8	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 3178	HYDRO. TORQUE E 70= 330	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 680	SEAL TORQUE= 839	Dstem= 1.125	Dgage= 9.85
INERTIA OF DISC ASS'Y= .406		dt= 2.50000000E-02	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0742	.0747	.0759	.0784	.0835	.0974	.1173	.1285
VELOCITY	49.4	99.3	195.4	315.8	455.5	588.3	684.0	678.5	659.7
PRES DROP	29.98	29.93	29.74	29.30	28.06	25.82	19.98	11.72	7.00

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	3630	16262	-11613	-1756	680	45	90.00	7.00
0.02	2266	14912	-11613	-1756	680	45	90.00	7.00
0.05	1131	13777	-11613	-1756	680	45	90.00	7.00
0.07	162	12808	-11613	-1756	680	45	90.00	7.00
0.10	0	11970	-11613	-1756	680	45	90.00	7.00
0.12	0	10764	-9401	-1928	408	-95	84.36	9.66
0.15	0	8885	-7571	-1833	408	49	77.26	13.97
0.17	0	6917	-6256	-1212	408	104	69.20	20.44
0.20	0	5371	-5429	-513	408	161	61.09	25.18
0.22	0	4593	-4955	-213	408	195	53.69	27.23
0.25	0	4193	-4691	-87	408	198	46.85	28.44
0.27	0	3913	-4465	-38	408	202	40.53	29.23
0.30	0	3735	-4310	-16	408	204	34.71	29.53
0.32	0	3649	-4236	-6	408	206	29.41	29.75
0.35	0	3626	-4217	-3	408	206	24.62	29.84
0.37	0	3642	-4235	-1	408	206	20.31	29.92
0.40	0	3684	-4278	-0	408	205	16.46	29.94
0.42	0	3741	-4336	-0	408	204	13.02	29.96
0.45	0	3804	-4399	-0	408	203	9.95	29.98
0.47	0	3868	-4464	-0	408	202	7.22	29.98
0.50	0	3928	-4524	-0	408	201	4.78	29.99
0.52	0	3676	-4578	-0	713	200	2.60	29.99
0.55	0	3306	-4619	-0	1127	203	0.79	29.99

Case 4A

DETERMINATION OF CLOSING TIME

VALVE SIZE 10" VALVE CLASS 150

ACTUATOR Matryx 26062-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 9294 BREAK 16264 SPRING ENDING 4640

ACTUATOR VOLUME 1.8 SCF ACTUATOR YOKE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 3178

HYDRODYNAMIC TORQUE @90 330 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 680 IN.LBS. SEAL TORQUE 839 IN.LBS.

STEM DIA. 1.125 IN. GAGE DIA. 9.85 IN.

INERTIA OF DISC ASSY .406 LB.IN.SEC^2 dt .025 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0741	49.4	29.98
20	.0742	99.3	29.93
30	.0747	195.4	29.74
40	.0759	315.8	29.30
50	.0784	455.5	28.06
60	.0835	588.3	25.82
70	.0974	684.0	19.98
80	.1173	678.5	11.72
90	.1285	657.7	7.00

DETERMINATION OF CLOSING TIME

10 - 150 CLASS VALVE WITH A 26062-SR80 ACTUATOR

Case 4A

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 9294	Tbreak= 16264	Tspring ending= 4640	
ACT. VOL.= 1.8	ACT. YOKE RADIUS= 2.63	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 3170	HYDRO. TORQUE @ 90= 330	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 680	SEAL TORQUE= 839	Dstem= 1.125	Dgage= 9.85
INERTIA OF DISC ASS'Y= .406		dt= 2.5000000E-02	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0741	.0742	.0747	.0759	.0784	.0835	.0974	.1173	.1285
VELOCITY	49.4	99.3	195.4	315.8	455.5	588.3	684.0	678.5	659.7
PRES DROP	29.98	29.93	29.74	29.30	28.06	25.82	19.98	11.72	7.00

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	7144	16262	-11613	1756	680	45	90.00	7.00
0.02	5780	14912	-11613	1756	680	45	90.00	7.00
0.05	4645	13777	-11613	1756	680	45	90.00	7.00
0.07	3676	12808	-11613	1756	680	45	90.00	7.00
0.10	2839	11970	-11613	1756	680	45	90.00	7.00
0.12	2107	11239	-11613	1756	680	45	90.00	7.00
0.15	1462	10594	-11613	1756	680	45	90.00	7.00
0.17	889	10021	-11613	1756	680	45	90.00	7.00
0.20	377	9509	-11613	1756	680	45	90.00	7.00
0.22	0	9047	-11613	1756	680	45	90.00	7.00
0.25	0	8332	-9897	1025	408	-58	85.83	8.76
0.27	0	7727	-8401	180	408	50	80.88	11.30
0.30	0	6857	-7128	-252	408	75	74.95	15.88
0.32	0	6013	-6139	-426	408	113	68.26	20.99
0.35	0	5034	-5428	-231	408	148	61.08	25.18
0.37	0	4491	-4975	-96	408	179	54.09	27.14
0.40	0	4154	-4707	-34	408	191	47.42	28.37
0.42	0	3909	-4486	-14	408	198	41.15	29.15
0.45	0	3737	-4323	-7	408	202	35.32	29.50
0.47	0	3651	-4241	-3	408	205	29.98	29.74
0.50	0	3624	-4217	-1	408	206	25.14	29.83
0.52	0	3638	-4232	-0	408	206	20.78	29.91
0.55	0	3678	-4273	-0	408	205	16.88	29.94
0.57	0	3734	-4329	-0	408	204	13.39	29.96
0.60	0	3797	-4392	-0	408	203	10.28	29.97
0.62	0	3861	-4456	-0	408	202	7.51	29.98
0.65	0	3922	-4518	-0	408	201	5.04	29.98
0.67	0	3782	-4572	-0	601	200	2.84	29.99
0.70	0	3328	-4616	-0	1100	202	0.95	29.99

0497

Case -

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102 - SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1163 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	69.4	30.00
20	.0692	138.6	29.57
30	.0695	280.1	26.68
40	.0700	401.4	21.14
50	.0705	483.7	13.61
60	.0707	513.9	6.50
70	.0707	513.9	3.44
80	.0707	513.9	1.74
90	.0707	513.9	1.09

Case 5

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4S10[illegible]-SR80 ACTUATOR

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= [illegible]1250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ [illegible]0= 89607	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0692	.0695	.0700	.0705	.0707	.0707	.0707	.0707
VELOCITY	69.4	138.6	280.1	401.4	483.7	513.9	513.9	513.9	513.9
PRES DROP	30.00	29.54	26.68	21.14	13.61	6.50	3.44	1.74	1.09

LOCA CLOSES THE VALVE TO 60 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -88869 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	59823	-25114	-35996	1663	5808	60.00	6.50
0.10	0	29609	-21997	-123[illegible]	997	3120	46.94	15.91
0.20	0	20798	-20822	-67[illegible]	[illegible]97	4129	40.07	21.08
0.30	0	19063	-20204	-3[illegible]	[illegible]97	4661	35.32	23.73
0.40	0	15999	-19056	-2[illegible]	997	5116	31.11	26.06
0.50	0	14869	-19700	-1236	997	5363	27.76	27.31
0.60	0	14018	-19645	-753	997	5528	24.82	28.15
0.70	0	13553	-19656	-446	997	5674	22.22	28.90
0.80	0	13261	-19711	-255	997	5800	19.86	29.54
0.90	0	13235	-19798	-176	997	5819	17.70	29.64
1.00	0	13250	-19907	-119	997	5837	15.69	29.73
1.10	0	13314	-20032	-78	997	5854	13.81	29.82
1.20	0	13400	-20167	-49	997	5870	12.05	29.90
1.30	0	13502	-20307	-30	997	5885	10.40	29.98
1.40	0	13625	-20447	-18	997	5888	8.85	30.00
1.50	0	13752	-20584	-10	997	5888	7.40	30.00
1.60	0	13877	-20716	-5	997	5888	6.03	30.00
1.70	0	13996	-20839	-2	997	5888	4.75	30.00
1.80	0	14106	-20952	-1	997	5888	3.54	30.00
1.90	0	9544	-21053	-0	5657	5888	2.40	30.00
2.00	0	7514	-21112	-0	7934	5889	1.67	30.00
2.10	0	6115	-21154	-0	9248	5888	1.13	30.00
2.20	0	5210	-21185	-0	10151	5888	0.69	30.00
2.30	0	4524	-21209	-0	10838	5888	0.34	30.00
2.40	0	3985	-21229	-0	11385	5888	0.03	30.00

0322

Case 5

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 45/07-SR80 ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 60= 69607	SHUT-OFF PRES. DROP= 9
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= 1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0691	.0693	.0695	.0700	.0705	.0707	.0707	.0707	.0707
VELOCITY	69.4	138.2	280.1	401.4	483.7	513.9	513.9	513.9	513.9
PRES DROP	30.00	29.64	26.68	21.14	13.61	6.50	3.44	1.74	1.09

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	96681	76167	-54891	73461	1663	213	90.00	1.09
1.00	51090	30643	-54891	73461	1663	213	90.00	1.09
2.00	43721	23274	-54891	73461	1663	213	90.00	1.09
3.00	39470	19023	-54891	73461	1663	213	90.00	1.09
4.00	36631	16184	-54891	73461	1663	213	90.00	1.09
5.00	34575	14128	-54891	73461	1663	213	90.00	1.09
6.00	33009	12562	-54891	73461	1663	213	90.00	1.09
7.00	31770	11323	-54891	73461	1663	213	90.00	1.09
8.00	30764	10317	-54891	73461	1663	213	90.00	1.09
9.00	29929	9482	-54891	73461	1663	213	90.00	1.09
10.00	29223	8776	-54891	73461	1663	213	90.00	1.09
11.00	28619	8172	-54891	73461	1663	213	90.00	1.09
12.00	28095	7648	-54891	73461	1663	213	90.00	1.09
13.00	27636	7189	-54891	73461	1663	213	90.00	1.09
14.00	27230	6783	-54891	73461	1663	213	90.00	1.09
15.00	26869	6422	-54891	73461	1663	213	90.00	1.09
16.00	26545	6098	-54891	73461	1663	213	90.00	1.09
17.00	26253	5807	-54891	73461	1663	213	90.00	1.09
18.00	25989	5542	-54891	73461	1663	213	90.00	1.09
19.00	25748	5301	-54891	73461	1663	213	90.00	1.09
20.00	25527	5080	-54891	73461	1663	213	90.00	1.09
21.00	25325	4878	-54891	73461	1663	213	90.00	1.09
22.00	25138	4691	-54891	73461	1663	213	90.00	1.09
23.00	24965	4518	-54891	73461	1663	213	90.00	1.09
24.00	24805	4358	-54891	73461	1663	213	90.00	1.09
25.00	24656	4209	-54891	73461	1663	213	90.00	1.09

0341

Case 5A

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33082-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12758 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	66.8	29.96
20	.0695	131.4	29.85
30	.0706	255.7	29.44
40	.0732	402.5	28.35
50	.0794	550.5	25.64
60	.0923	643.6	20.09
70	.1157	646.4	9.86
80	.1231	662.0	5.90
90	.1296	628.8	3.44

Case 5

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102 - SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 . SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1163 IN.LBS SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0691	69.4	30.00
20	.0692	138.6	29.54
30	.0695	280.1	26.68
40	.0700	401.4	21.14
50	.0705	483.7	13.61
60	.0707	513.9	6.50
70	.0707	513.9	3.44
80	.0707	513.9	1.74
90	.0707	513.9	1.09

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33022-S580 ACTUATOR

Case 5A

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10210	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.38	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA-AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 70= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SEAL TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0706	.0732	.0794	.0923	.1157	.1231	.1296
VELOCITY	66.8	131.4	255.7	402.5	550.5	643.6	646.4	662.0	628.8
PRES DROP	29.96	29.85	29.44	28.35	25.64	20.09	9.86	5.90	3.44

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

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -48471 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	29062	-12821	-18866	1210	1768	63.00	17.02
0.10	0	6738	-9652	-353	726	1703	31.28	29.29
0.20	0	7580	-9530	-109	726	1761	24.18	29.67
0.30	0	7156	-9599	-28	726	1761	17.31	29.87
0.40	0	7389	-9755	-8	726	1767	11.99	29.93
0.50	0	7509	-9931	-1	726	1768	7.51	29.96
0.60	0	7659	-10082	-0	726	1769	3.80	29.98
0.70	0	3959	-10185	-0	4516	1769	0.68	29.99

Case 211

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR Matryx 33088-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 21155 BREAK 37091 SPRING ENDING 10210

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.38 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 23412

HYDRODYNAMIC TORQUE @90 12756 SHUT OFF PRESSURE DROP 30 PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt 0.5 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0692	65.8	29.96
20	.0695	131.4	29.85
30	.0706	255.7	29.44
40	.0732	402.5	28.35
50	.0794	550.5	25.64
60	.0923	643.6	20.09
70	.1157	646.4	9.86
80	.1231	662.0	5.90
90	.1296	625.8	3.44

DETERMINATION OF CLOSING TIME

24 - 150/150 CLASS VALVE WITH A 33002-SR80 ACTUATOR

Case 5A

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 21195	Tbreak= 37091	Tspring ending= 10210	
ACT. VOL.= 4.01	ACT. YOKE RADIUS= 3.38	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 23412	HYDRO. TORQUE @ 90= 12758	SHUT-OFF PRES. DROP= 30
PACKING TORQUE= 1210	SE L TORQUE= 4316	Dstem= 2	Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2		dt= .5	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0692	.0695	.0706	.0732	.0794	.0923	.1157	.1231	.1296
VELOCITY	66.8	131.4	255.7	402.5	550.5	643.6	646.4	662.0	628.8
PRES DROP	29.96	29.85	29.44	28.35	25.64	20.09	9.86	5.90	3.44

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	49723	37086	-26857	38049	1210	202	90.00	3.44
0.50	22052	9447	-26857	38049	1210	202	90.00	3.44
1.00	20258	7654	-26857	38049	1210	202	90.00	3.44
1.50	19081	6476	-26857	38049	1210	202	90.00	3.44
2.00	18238	5633	-26857	38049	1210	202	90.00	3.44
2.50	17600	4996	-26857	38049	1210	202	90.00	3.44
3.00	17099	4494	-26857	38049	1210	202	90.00	3.44
3.50	16693	4088	-26857	38049	1210	202	90.00	3.44
4.00	16357	3752	-26857	38049	1210	202	90.00	3.44
4.50	16074	3469	-26857	38049	1210	202	90.00	3.44
5.00	15832	3227	-26857	38049	1210	202	90.00	3.44
5.50	15623	3018	-26857	38049	1210	202	90.00	3.44
6.00	15439	2835	-26857	38049	1210	202	90.00	3.44
6.50	15278	2673	-26857	38049	1210	202	90.00	3.44
7.00	15134	2530	-26857	38049	1210	202	90.00	3.44
7.50	15006	2401	-26857	38049	1210	202	90.00	3.44
8.00	14890	2285	-26857	38049	1210	202	90.00	3.44
8.50	14785	2180	-26857	38049	1210	202	90.00	3.44
9.00	14689	2085	-26857	38049	1210	202	90.00	3.44
9.50	14602	1997	-26857	38049	1210	202	90.00	3.44
10.00	14522	1917	-26857	38049	1210	202	90.00	3.44
10.50	14448	1843	-26857	38049	1210	202	90.00	3.44
11.00	14379	1775	-26857	38049	1210	202	90.00	3.44
11.50	14316	1711	-26857	38049	1210	202	90.00	3.44
12.00	14257	1653	-26857	38049	1210	202	90.00	3.44
12.50	14202	1598	-26857	38049	1210	202	90.00	3.44

0492

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 9 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0653	40.7	8.98
20	.0655	79.5	8.87
30	.0658	170.6	8.68
40	.0671	272.4	7.95
50	.0691	386.6	6.81
60	.0722	476.9	5.04
70	.0751	550.0	3.17
80	.0770	577.9	2.01
90	.0780	590.8	1.36

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 . SHUT OFF PRESSURE DROP 9 PSI

PACKING TORQUE 1163 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0653	40.9	8.98
20	.0651	80.3	9.01
30	.0658	170.6	8.68
40	.0671	272.4	7.95
50	.0691	386.6	6.81
60	.0722	476.6	5.04
70	.0751	550.0	3.17
80	.0770	577.9	2.01
90	.0780	590.8	1.36

Case 6

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4510?-SR80 ACTUATOR

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 69648	HYDRO. TORQUE @ 90= 07607	SHUT-OFF PRES. DROP= 9
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= 1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0653	.0655	.0658	.0671	.0691	.0722	.0751	.0770	.0780
VELOCITY	40.7	79.5	170.6	272.4	386.6	476.9	550.0	577.9	590.8
PRES DROP	8.98	8.87	8.68	7.95	6.81	5.04	3.17	2.01	1.36

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	130390	76167	-54891	107117	1663	266	90.00	1.36
1.00	84798	30643	-54891	107117	1663	266	90.00	1.36
2.00	77430	23274	-54891	107117	1663	266	90.00	1.36
3.00	73179	19023	-54891	107117	1663	266	90.00	1.36
4.00	70339	16184	-54891	107117	1663	266	90.00	1.36
5.00	68284	14128	-54891	107117	1663	266	90.00	1.36
6.00	66718	12562	-54891	107117	1663	266	90.00	1.36
7.00	65479	11323	-54891	107117	1663	266	90.00	1.36
8.00	64473	10317	-54891	107117	1663	266	90.00	1.36
9.00	63638	9482	-54891	107117	1663	266	90.00	1.36
10.00	62932	9776	-54891	107117	1663	266	90.00	1.36
11.00	62328	8172	-54891	107117	1663	266	90.00	1.36
12.00	61803	7648	-54891	107117	1663	266	90.00	1.36
13.00	61344	7189	-54891	107117	1663	266	90.00	1.36
14.00	60939	6783	-54891	107117	1663	266	90.00	1.36
15.00	60578	6422	-54891	107117	1663	266	90.00	1.36
16.00	60254	6098	-54891	107117	1663	266	90.00	1.36
17.00	59962	5807	-54891	107117	1663	266	90.00	1.36
18.00	59698	5542	-54891	107117	1663	266	90.00	1.36
19.00	59457	5301	-54891	107117	1663	266	90.00	1.36
20.00	59236	5080	-54891	107117	1663	266	90.00	1.35
21.00	59033	4878	-54891	107117	1663	266	90.00	1.36
22.00	58847	4691	-54891	107117	1663	266	90.00	1.36
23.00	58674	4518	-54891	107117	1663	266	90.00	1.36
24.00	58514	4358	-54891	107117	1663	266	90.00	1.36
25.00	58365	4209	-54891	107117	1663	266	90.00	1.36

Case CA

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-SR80

DIRECTION OF FLOW Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YORE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA Air VALVE C_V 60648

HYDRODYNAMIC TORQUE @90 89607 SHUT OFF PRESSURE DROP 9 PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 -dt 0.1 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	.0653	43.9	8.97
20	.0655	86.7	8.90
30	.0660	170.5	8.69
40	.0680	270.3	7.87
50	.0707	381.6	6.62
60	.0750	463.4	4.81
70	.0790	524.7	2.93
80	.0812	550.3	1.86
90	.0824	561.9	1.26

DETERMINATION OF CLOSING TIME

36 - 150/150 CLASS VALVE WITH A 4510?-SRPO ACTUATOR

Case C#

THE VALVE IS IN THE PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= 21250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ 90= 89607	SHUT-OFF PRES. DROP= 9
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= .1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0653	.0655	.0660	.0680	.0707	.0750	.07??	.0812	.0824
VELOCITY	43.9	86.7	170.5	270.3	381.6	463.4	524.7	550.3	561.9
PRES DROP	8.97	8.90	8.69	7.87	6.62	4.81	2.93	1.86	1.26

LOCA CLOSES THE VALVE TO 61 DEGREES WITH THE ACTUATOR STILL ACTUATED

MAXIMUM AERODYNAMIC TORQUE AS VALVE CLOSES IS -117065 IN.LBS. @ 80 DEGREES

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	0	59741	-25420	-34793	1663	1766	61.00	4.62
0.10	0	26834	-22171	-8022	997	1339	48.12	6.85
0.20	0	21449	-21129	-3824	997	1492	41.89	7.63
0.30	0	20185	-20308	-1965	997	1595	36.96	8.11
0.40	0	18385	-19947	-964	997	1667	32.44	8.48
0.50	0	17712	-19727	-490	997	1712	28.52	8.72
0.60	0	17331	-19646	-277	997	1727	24.98	8.79
0.70	0	17191	-19663	-146	997	1740	21.76	8.86
0.80	0	17187	-19749	-79	997	1749	18.82	8.90
0.90	0	17277	-19881	-48	997	1752	16.12	8.92
1.00	0	17410	-20044	-28	997	1756	13.65	8.94
1.10	0	17568	-20223	-15	997	1759	11.38	8.96
1.20	0	17739	-20407	-7	997	1761	9.29	8.97
1.30	0	17910	-20588	-3	997	1762	7.37	8.97
1.40	0	18073	-20758	-1	997	1763	5.60	8.98
1.50	0	18222	-20912	-0	997	1764	3.97	8.98
1.60	0	13993	-21046	-0	5355	1765	2.47	8.99
1.70	0	11015	-21133	-0	8591	1766	1.41	8.99
1.80	0	9290	-21190	-0	10288	1766	0.62	8.99

0491

Case 6A

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR Matryx 45102-SR80

DIRECTION OF FLOW Non-Preferred

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF

ACTUATOR YORE RADIUS 4,5 IN.

ACTUATOR PRESSURE 80 PSIG

SOLENOID VALVE C_V 8

MEDIA Air

VALVE C_V 10648

HYDRODYNAMIC TORQUE @90 89607

SHUT OFF PRESSURE DROP 9 PSI

PACKING TORQUE 1163 IN.LBS.

SEAL TORQUE 10452 IN.LBS.

STEM DIA. 2.75 IN.

GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2

-dt 1,0 SEC.

DEG.	DENSITY (LBS/FT^3)	VELOCITY (FT/SEC)	PRESSURE DROP (PSI)
10	,0653	43,9	8,97
20	,0655	86,7	8,90
30	,0666	170,5	8,69
40	,0680	270,3	7,87
50	,0707	381,6	6,62
60	,0755	463.4	4.81
70	,0799	524.7	2.93
80	,0815	550.3	1,86
90	,082[illegible]	561.9	1,26

DETERMINATION OF CLOSING TIME

36 - 150 ##0 CLASS VALVE WITH A 4510[illegible]-SR80 ACTUATOR — Case CH

THE VALVE IS IN THE NON-PREFERRED DIRECTION

Trun= 43530	Tbreak= 76190	Tspring ending= .1250	
ACT. VOL.= 10	ACT. YOKE RADIUS= 4.5	ACT. PRESS= 80	SOL. VALVE Cv= 8
MEDIA=AIR	VALVE Cv= 60648	HYDRO. TORQUE @ [illegible])= 8960/	SHUT-OFF PRES. DROP= 9
PACKING TORQUE= 1663	SEAL TORQUE= 10452	Dstem= 2.75	Dgage= 34.782
INERTIA OF DISC ASS'Y= 187		dt= 1	

DEG.	10	20	30	40	50	60	70	80	90
DENSITY	.0653	.0655	.0660	.0680	.0707	.0750	.07[illegible]	.0812	.0824
VELOCITY	43.9	86.7	170.5	270.3	381.6	463.4	524.7	550.3	561.9
PRES DROP	8.97	8.90	8.69	7.87	6.62	4.81	2.93	1.86	1.26

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE trq&inertia	ANGLE degrees	DELTA P psi
0.00	125613	76167	-54891	102360	1663	247	90.00	1.26
1.00	80021	30643	-54891	102360	1663	247	90.00	1.26
2.00	72653	23274	-54891	102360	1663	247	90.00	1.26
3.00	68402	19023	-54891	102360	1663	247	90.00	1.26
4.00	65562	16184	-54891	102360	1663	247	90.00	1.26
5.00	63507	14128	-54891	102360	1663	247	90.00	1.26
6.00	61940	12562	-54891	102360	1663	247	90.00	1.26
7.00	60702	11323	-54091	102360	1663	247	90.00	1.26
8.00	59696	10317	-54891	102360	1663	247	90.00	1.26
9.00	58860	9482	-54891	102360	1663	247	90.00	1.26
10.00	58155	8776	-54891	102360	1663	247	90.00	1.26
11.00	57550	8172	-54891	102360	1663	247	90.00	1.26
12.00	57026	7648	-54891	102360	1663	247	90.00	1.26
13.00	56567	7189	-54891	102360	1663	247	90.00	1.26
14.00	56162	6783	-54891	102360	1663	247	90.00	1.26
15.00	55801	6422	-54891	102360	1663	247	90.00	1.26
16.00	55477	6098	-54891	102360	1663	247	90.00	1.26
17.00	55185	5807	-54891	102360	1663	247	90.00	1.26
18.00	54920	5542	-54891	102360	1663	247	90.00	1.26
19.00	54679	5301	-54891	102360	1663	247	90.00	1.26
20.00	54459	5080	-54891	102360	1663	247	90.00	1.26
21.00	54256	4878	-54091	102360	1663	247	90.00	1.26
22.00	54070	4691	-54891	102360	1663	247	90.00	1.26
23.00	53897	4518	-54891	102360	1663	247	90.00	1.26
24.00	53737	4358	-54091	102360	1663	247	90.00	1.26
25.00	53588	4209	-54891	102360	1663	247	90.00	1.26

APPENDIX D

Comparison of Actual to Calculated Closing Times

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

DETERMINATION OF CLOSING TIME

VALVE SIZE 36" VALVE CLASS 150/150

ACTUATOR 45102-SR80

DIRECTION OF FLOW No Flow

ACTUATOR TORQUES (IN.LBS)

RUN 43530 BREAK 76190 SPRING ENDING 21250

ACTUATOR VOLUME 10 SCF ACTUATOR YOKE RADIUS 4.5 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA ________ VALVE C_V ________

HYDRODYNAMIC TORQUE @90 ________ SHUT OFF PRESSURE DROP ____ PSI

PACKING TORQUE 1663 IN.LBS. SEAL TORQUE 10456 IN.LBS.

STEM DIA. 2.75 IN. GAGE DIA. 34.782 IN.

INERTIA OF DISC ASS'Y 187 LB.IN.SEC^2 dt .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

36 - 150/150 CLASS VALVE WITH A 4510?-SR80 ACTUATOR

THERE IS NO FLOW

Trun= 43530
ACT. VOL.= 10
PACKING TORQUE= 1663
INERTIA OF DISC ASS'Y= 187

Tbreak= 76190
ACT. YOKE RADIUS= 4.5
SEAL TORQUE= 10452

Tspring ending= 21250
ACT. PRESS= 80
Dstem= 2.75
dt= .1

SOL. VALVE Cv= 8
Dgage= 34.782

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	23005	76167	-54891	0	1663	0	90.00	0.00
0.10	18386	71615	-54891	0	1663	0	90.00	0.00
0.20	14362	67590	-54891	0	1663	0	90.00	0.00
0.30	10777	64006	-54891	0	1663	0	90.00	0.00
0.40	7562	60791	-54891	0	1663	0	90.00	0.00
0.50	4662	57891	-54891	0	1663	0	90.00	0.00
0.60	2032	55261	-54891	0	1663	0	90.00	0.00
0.70	0	52865	-54891	0	1663	0	90.00	0.00
0.80	0	44603	-47510	0	997	-6	86.28	0.00
0.90	0	40430	-41523	0	997	-0	82.36	0.00
1.00	0	35220	-34411	0	997	-0	77.98	0.00
1.10	0	31201	-32299	0	997	-0	73.35	0.00
1.20	0	27943	-29027	0	997	-0	68.49	0.00
1.30	0	25425	-26480	0	997	-0	63.45	0.00
1.40	0	23520	-24549	0	997	-0	58.33	0.00
1.50	0	22139	-23140	0	997	-0	53.19	0.00
1.60	0	21195	-22171	0	997	0	48.12	0.00
1.70	0	20424	-21375	0	997	0	43.20	0.00
1.80	0	19657	-20587	0	997	0	38.48	0.00
1.90	0	19166	-20078	0	997	0	34.03	0.00
2.00	0	18886	-19786	0	997	0	29.86	0.00
2.10	0	18766	-19658	0	997	0	26.00	0.00
2.20	0	18765	-19653	0	997	0	22.44	0.00
2.30	0	18849	-19735	0	997	0	19.18	0.00
2.40	0	18990	-19877	0	997	0	16.19	0.00
2.50	0	19167	-20057	0	997	0	13.47	0.00
2.60	0	19362	-20255	0	997	0	11.00	0.00
2.70	0	19560	-20458	0	997	0	8.74	0.00
2.80	0	19751	-20654	0	997	0	6.68	0.00
2.90	0	19927	-20834	0	997	0	4.80	0.00
3.00	0	20080	-20993	0	997	0	3.09	0.00
3.10	0	12878	-21124	0	8326	0	1.52	0.00
3.20	0	11209	-21192	0	10343	1	0.60	0.00

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VALVE ASSEMBLY CYCLE TEST REPORT Page 1 of 2

PSI VALVE SERIAL NO.		TRAVELER NO.	
16204-29A		80-16204-29-0880	
CUSTOMER Baldwin Associates	PURCHASE ORDER NO. C-9702	ITEM	TAG NO. 1VQ003
OPERATOR TYPE 45102 SR-80	MANUFACTURER Matryx	SERIAL NO. 26983-1-2	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 16204 TP-06

TEST CONDITIONS

1. Each valve shall be cycle tested with the specific actuator which will be shipped with that particular valve. Pneumatic actuators are designed for operation between 80 and 120 PSIG air but shall have 80 PSIG air supply for this cycle test.
2. Each valve shall be cycled, open and closed, three (3) times with its actuator. Valves with pneumatic actuators shall be timed during both the opening and closing segments of the cycle. Valve opening time shall not be greater than thirty (30) seconds. Valve closing time shall not be greater than six (6) seconds. Limit switches shall be set at this time. During the cycle test, there shall be no binding, rubbing, vibration, scouring or malfunctions.
3. Each pneumatic actuator shall be shell tested to 120 PSIG by applying air to the appropriate port. A soap solution shall be applied to all joints to detect signs

TEST RESULTS

1. Failure Mode: F.C.
2. Fully Open to Fully Closed: Fully Closed to Fully Opened:

First time: 3.8 seconds		First time: 20.3 seconds
Second time: 3.3 seconds		Second time: 20. seconds
Third time: 3.3 seconds		Third time: 20.1 seconds

3. The actuator showed no signs of leakage during the actuator shell test.
4. During the cycle test, there was no binding, rubbing, vibration, scouring or malfunctions.
5. The cycle test and actuator shell test were performed and completed satisfactorily in accordance with all requirements per PSI Specification No. 16204 TP-06.

TESTED BY	DATE	INSPECTED BY	DATE
J. Felicetti	1/28/81	M. Campanale	1/28/81
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

DETERMINATION OF CLOSING TIME

VALVE SIZE 24" VALVE CLASS 150/150

ACTUATOR 33082-SR80

DIRECTION OF FLOW No Flow

ACTUATOR TORQUES (IN.LBS)

RUN 21195 BREAK 37091 SPRING ENDING 10201

ACTUATOR VOLUME 4.01 SCF ACTUATOR YOKE RADIUS 3.88 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA ______ VALVE C_V ______

HYDRODYNAMIC TORQUE @90 ______ SHUT OFF PRESSURE DROP ______ PSI

PACKING TORQUE 1210 IN.LBS. SEAL TORQUE 4316 IN.LBS.

STEM DIA. 2.0 IN. GAGE DIA. 22.352 IN.

INERTIA OF DISC ASS'Y 33.2 LB.IN.SEC^2 dt .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

24 - 150/150 CLASS VALVE WITH A 3308[illegible]-SR80 ACTUATOR

THERE IS NO FLOW

Trun= 21195 Tbreak= 37091 Tspring ending= 10201
ACT. VOL.= 4.01 ACT. YOKE RADIUS= 3.88 ACT. PRESS= 80 SOL. VALVE Cv= 8
PACKING TORQUE= 1210 SEAL TORQUE= 4316 Dstem= 2 Dgage= 22.352
INERTIA OF DISC ASS'Y= 33.2 dt= .1

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE brg&inertia	ANGLE degrees	DELTA P psi
0.00	11462	37086	-26866	0	1210	0	90.00	0.00
0.10	5902	31558	-26866	0	1210	0	90.00	0.00
0.20	1899	27556	-26866	0	1210	0	90.00	0.00
0.30	0	24504	-26866	0	1210	0	90.00	0.00
0.40	0	17599	-19086	0	726	-16	80.38	0.00
0.50	0	13453	-14299	0	726	-3	68.93	0.00
0.60	0	10839	-11644	0	726	-2	56.12	0.00
0.70	0	9725	-10437	0	726	0	43.55	0.00
0.80	0	9029	-9683	0	726	2	32.20	0.00
0.90	0	8919	-9529	0	726	3	22.68	0.00
1.00	0	9059	-9654	0	726	3	14.98	0.00
1.10	0	9271	-9869	0	726	2	8.88	0.00
1.20	0	9455	-10066	0	726	2	4.04	0.00
1.30	0	5386	-10188	0	4900	1	0.19	0.00

0315

NUCLEAR POSI-SEAL INTERNATIONAL, INC. NUCLEAR

VALVE ASSEMBLY CYCLE TEST REPORT

PSI VALVE SERIAL NO. 16204-28 C		TRAVELER NO. 80-16204-28-0800	
CUSTOMER Baldwin Associates	PURCHASE ORDER NO. C-9702	ITEM	TAG NO. 1YQOC2
OPERATOR TYPE 33082 SR-80	MANUFACTURER Matryx	SERIAL NO. 26986 / 1	

ACCESSORIES: As listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 16204 TP-06

TEST CONDITIONS

1. Each valve shall be cycle tested with the specific actuator which will be shipped with that particular valve. Pneumatic actuators are designed for operation between 80 and 120 PSIG air but shall have 80 PSIG air supply for this cycle test.
2. Each valve shall be cycled, open and closed, three (3) times with its actuator. Valves with pneumatic actuators shall be timed during both the opening and closing segments of the cycle. Valve opening time shall not be greater than thirty (30) seconds. Valve closing time shall not be greater than six (6) seconds. Limit switches shall be set at this time. During the cycle test, there shall be no binding, rubbing, vibration, scouring or malfunctions.
3. Each pneumatic actuator shall be shell tested to 120 PSIG by applying air to the appropriate port. A soap solution shall be applied to all joints to detect signs

TEST RESULTS

1. Failure Mode: F/C
2. Fully Open to Fully Closed:
   First time: 1.2 seconds
   Second time: 1.3 seconds
   Third time: 1.2 seconds

   Fully Closed to Fully Opened:
   First time: 12.2 seconds
   Second time: 12.2 seconds
   Third time: 12.1 seconds
3. The actuator showed no signs of leakage during the actuator shell test.
4. During the cycle test, there was no binding, rubbing, vibration, scouring or malfunctions.
5. The cycle test and actuator shell test were performed and completed satisfactorily in accordance with all requirements per PSI Specification No. 16204 TP-06.

TESTED BY	DATE	INSPECTED BY	DATE
R. Lofton	3-27-81	L. Barton	3-27-81
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE
		D-6	

DETERMINATION OF CLOSING TIME

VALVE SIZE 10" VALVE CLASS 150

ACTUATOR 2C062-SR80

DIRECTION OF FLOW No Flow

ACTUATOR TORQUES (IN.LBS)

RUN 9294 BREAK 16264 SPRING ENDING 4640

ACTUATOR VOLUME 1.8 SCF ACTUATOR YORE RADIUS 2.63 IN.

ACTUATOR PRESSURE 80 PSIG SOLENOID VALVE C_V 8

MEDIA ______ VALVE C_V ______

HYDRODYNAMIC TORQUE @90 ______ SHUT OFF PRESSURE DROP ______ PSI

PACKING TORQUE 680 IN.LBS. SEAL TORQUE 839 IN.LBS.

STEM DIA. 1.125 IN. CAGE DIA. 9.85 IN.

INERTIA OF DISC ASS'Y .406 LB.IN.SEC^2 dt .10 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

10 - 150 CLASS VALVE WITH A 26062-SRBC ACTUATOR

THERE IS NO FLOW

Trun= 9294
Tbreak= 16264
Tspring ending= 4840
ACT. VOL.= 1.8
ACT. YOKE RADIUS= 2.63
ACT. PRESS= 80
SOL. VALVE Cv= 8
PACKING TORQUE= 680
SEAL TORQUE= 839
Dstem= 1.125
Dgage= 9.85
INERTIA OF DISC ASS'Y= .406
dt= 2.50000000E-02

TIME sec	TORQUE tend to open	TORQUE air	TORQUE spring	TORQUE flow	TORQUE packing & seal	TORQUE trq&inertia	ANGLE degrees	DELTA P psi
0.00	5342	16262	-11613	0	680	0	90.00	0.00
0.02	3978	14912	-11613	0	680	0	90.00	0.00
0.05	2843	13777	-11613	0	680	0	90.00	0.00
0.07	1874	12808	-11613	0	680	0	90.00	0.00
0.10	1037	11970	-11613	0	680	0	90.00	0.00
0.12	305	11239	-11613	0	680	0	90.00	0.00
0.15	0	10594	-11613	0	680	0	90.00	0.00
0.17	0	9138	-9631	0	408	-137	85.06	0.00
0.20	0	7607	-8026	0	408	-21	79.34	0.00
0.22	0	6399	-6814	0	408	-15	73.09	0.00
0.25	0	5519	-5932	0	408	-10	66.45	0.00
0.27	0	4904	-5314	0	408	-6	59.59	0.00
0.30	0	4499	-4900	0	408	-0	52.70	0.00
0.32	0	4261	-4667	0	408	4	45.97	0.00
0.35	0	4029	-4433	0	408	9	39.56	0.00
0.37	0	3887	-4290	0	408	12	33.60	0.00
0.40	0	3825	-4227	0	408	14	28.16	0.00
0.42	0	3818	-4219	0	408	14	23.26	0.00
0.45	0	3847	-4248	0	408	14	18.89	0.00
0.47	0	3899	-4301	0	408	13	15.00	0.00
0.50	0	3963	-4365	0	408	12	11.55	0.00
0.52	0	4031	-4433	0	408	11	8.50	0.00
0.55	0	4097	-4499	0	408	9	5.80	0.00
0.57	0	4156	-4558	0	408	8	3.40	0.00
0.60	0	3569	-4609	0	1044	7	1.27	0.00

0317

VALVE ASSEMBLY CYCLE TEST REPORT

PSI VALVE SERIAL NO.		TRAVELER NO.	
16204-31A		80-16204-31-0500	
CUSTOMER: Baldwin Associates	PURCHASE ORDER NO.: C-9702	ITEM	TAG NO.: 1VQ005
OPERATOR TYPE: #26062 SR-80	MANUFACTURER: Matryx	SERIAL NO.: 26984	

ACCESSORIES: As Listed per Spec. Sheet

CYCLE TEST REQUIREMENTS PER SPECIFICATION: 16204 TP-06

TEST CONDITIONS

1. Each valve shall be cycle tested with the specific actuator which will be shipped with that particular valve. Pneumatic actuators are designed for operation between 80 and 120 PSIG air but shall have 80 PSIG air supply for this cycle test.
2. Each valve shall be cycled, open and closed, three (3) times with its actuator. Valves with pneumatic actuators shall be timed during both the opening and closing segments of the cycle. Valve opening time shall not be greater than thirty (30) seconds. Valve closing time shall not be greater than six (6) seconds. Limit switches shall be set at this time. During the cycle test, there shall be no binding, rubbing, vibration, scouring or malfunctions.
3. Each pneumatic actuator shall be shell tested to 120 PSIG by applying air to the appropriate port. A soap solution shall be applied to all joints to detect signs

TEST RESULTS

1. Failure Mode: F.C.
2. Fully Open to Fully Closed: / Fully Closed to Fully Opened:

First time:	.4	seconds	First time:	3.8	seconds
Second time:	.4	seconds	Second time:	3.6	seconds
Third time:	.4	seconds	Third time:	3.5	seconds

3. The actuator showed no signs of leakage during the actuator shell test.
4. During the cycle test, there was no binding, rubbing, vibration, scouring or malfunctions.
5. The cycle test and actuator shell test were performed and completed satisfactorily in accordance with all requirements per PSI Specification No. 16204 TP-06.

TESTED BY	DATE	INSPECTED BY	DATE
C. Dorendon	1/19/81	M. Campanale	1/19/81
WITNESSED BY	DATE	AUTHORIZED INSPECTOR	DATE

APPENDIX E

Seismic and LOCA Stress Analyses

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 36"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102 - SR80

CUSTOMER: Illinois Power

P.O. NO.: C-9702

SPEC. NO.: K-2868

REFERENCE NO.: 16204

ITEM NO.: 30

REFERENCE DWGS.

A.	ASS'Y DWG. NO. 16204-29	REV.	C
B.	BODY DWG. NO. 1134-360-1	REV.	
C.	DISC DWG. NO. 1134-360-8	REV.	
D.	STEM DWG. NO. 1304-528	REV.	
E.	PIN DWG. NO. 1306-111	REV.	

ALLOWABLE STRESSES

A.	BODY	SA516 Gr 70	28875	PSI
B.	DISC	SA216 Gr WCB	28875	PSI
C.	STEM	SA564 Gr 630 Cond H1075	59730	PSI
D.	PIN	SA564 Gr 630 Cond H1075	59730	PSI
E.	BRACKET	CS	22605	PSI
F.	BOLTING	A193 Gr B7	41250	PSI

DESIGN CONDITIONS

PRES. - P1 23.7

TEMPERATURE 330°

VALVE TORQUES

PACKING TORQUE 1663

MAX. AERO. TORQUE - 122,133

CORR. BEARING TORQUE 395

G - LOADINGS

TRANSVERSE 5.5

VERTICAL 3

LONGITUDINAL 4.5

MEDIA Air

FLOW DIRECTION Preferred

SIZE 36" CLASS 150/150

DIMENSIONAL DATA

ACTUATOR 45102-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.38	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	14.048	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	4.69	X3	X3
HEIGHT BRACKET	1	X4	X4
HEIGHT VALVE NECK	6.75	X5	X5
ACTUATOR WEIGHT	852	W1	W4
BRACKET WEIGHT	90	W2	W5
DISC WEIGHT	820	W4	W3
THICKNESS OF BRACKET LOWER PLATE	1.125	T1	T1
WIDTH OF BRACKET	11	T2	T2
WIDTH OF VALVE NECK	10	T3	T3
THICKNESS OF VALVE NECK	5.75	T4	T4
THICKNESS OF BRACKET SIDE PLATES	1.0	T9	T9
THICKNESS OF BRACKET TOP PLATE	.875	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	3.752	Di	B5
STEM DIA.	2.747	D1	D1
GAGE DIA. OF DISC	34.782	D	D
WIDTH SMALL DIA. BACK OF DISC	3.75	E1	E1
WIDTH LARGE DIA. OF DISC	1.25	E2	E2
THRUST WASHER THICKNESS	.602	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	2.625	Y2	Y2
NO. OF ACTUATOR BOLTS	8	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.462	A1	A1
DBC OF ACTUATOR BOLTS	8.25	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	8	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	4.5	X8	X8
LENGTH OF BRACKET	14	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	7.69	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1.5	R6	R6
TORQUE ON DISC PIN	65	&	T7
DISC PIN DIA.	.998	dp	D5
VALVE BODY O.D.	46.250	d1	D8
VALVE BODY WATERWAY DIA.	35.125	R7	R7
ADJACENT PIPING O.D.	36	R8	R8
ADJACENT PIPING I.D.	35	R9	R9
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS		N3	N3
DBC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
DIA. OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC & LOCA ANALYSIS

36 CLASS 150/150 VALVE ASSEMBLY
WITH 45102-SR80 ACTUATOR

CUSTOMER: ILLINOIS POWER
P.O.NO.C-9702
SPEC.NO.:K-2868
REF,NO,:16204
ITEM NO.:30

REFERENCE DWGS.
A.ASS'Y DWG.NO.:16204-29 REV.C
B.BODY DWG.NO.:1134-360-1 REV.
C.DISC DWG.NO.:1134-360-8 REV.
D.STEM DWG.NO.:1304-528 REV.
E.PIN DWG.NO. :1306-111 REV.

ALLOWABLE STRESSES (PSI)
A.BODY: 28875
B.DISC: 28875
C.STEM: 59730
D.PIN: 59730
E.BRACKET: 22605
F.BOLTING: 41250

DESIGN CONDITIONS
PRESSURE(PSIG)= 23.7
TEMPERATURE('F)= 330

VALVE TORQUE(IN-LBS)
PACKING TORQUE= 1663
BEARING TORQUE= 395
AERODYNAMIC TORQUE=-122133

G LOADINGS
TRANSVERSE= 5.5
VERTICAL= 3
LONGITUDINAL= 4.5

MEDIA - AIR
FLOW DIRECTION - PREFERRED

DIMENSIONAL DATA

X1= 3.38	X2= 14.048	X3= 4.69	X4= 6	X5= 6.75	W1= 852	W2= 90
W4= 820	T1= 1.125	T2= 11	T3= 10	T4= 5.75	T9= 1	TO= .875
d3= 0	Di= 3.752	D1= 2.747	D= 34.782	E1= 3.75	E2= 1.25	
L2= .602	Y2= 2.625	N1= 8	A1= .462	X6= 8.25	N2= 4	
A2= .334	X7= 8	X8= 4.5	T5= 14	R5= 2.69	R6= 1.5	
X= 65	dp= .998	d1= 40.25	R7= 35.125	R8= 36	R9= 35	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 72 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 594 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 135 VS.33HZ.
LATERAL DISC/STEM= 130 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 12236 PSI
TENSILE= 5040 PSI
COMBINED= 15013 PSI VS.ALLOW.= 41250

BRACKET BOLT STRESSES
SHEAR= 34249 PSI
TENSILE= 25047 PSI
COMBINED= 48990 PSI VS.ALLOW= 41250

BRACKET STRESSES
SHEAR= 1787 PSI
TENSILE= 5123 PSI
COMBINED= 5685 PSI VS.ALLOW= 22605

VALVE NECK STRESSES
SHEAR= 4321 PSI
TENSILE= 3068 PSI
COMBINED= 6120 PSI VS.ALLOW= 28875

STEM STRESSES
SHEAR= 29501 PSI
TENSILE= 4826 PSI
COMBINED= 32013 PSI VS.ALLOW= 59730

DISC PIN STRESS
SHEAR=-30391 PSI VS.ALLOW= 35838

SECTION MODULUS
VALVE= 2688.95 IN↑3
PIPING= 488.12 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 8.02700000E-03 INCHES
VERTICAL= 7.90000000E-05 INCHES
TRANSVERSE= 2.70000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED...[signature]...DATED...9/22/82....

Case 6

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 20"

VALVE CLASS: 150/150

ACTUATOR: Matryx 45102-SR80

CUSTOMER: Illinois Power

P.O. NO.: C-9702

SPEC. NO.: K-2818

REFERENCE NO.: 16204

ITEM NO.: 30

REFERENCE DWGS.

A. ASS'Y DWG. NO. 16204-29 REV. C

B. BODY DWG. NO. 1134-360-1 REV.

C. DISC DWG. NO. 1134-360-8 REV.

D. STEM DWG. NO. 1304-525 REV.

D. PIN DWG. NO. 1366-111 REV.

ALLOWABLE STRESSES

A. BODY SA516 Gr 70 28875 PSI

B. DISC SA216 Gr WCB 28875 PSI

C. STEM SA564 Gr 630 Cond H1075 59730 PSI

D. PIN SA564 Gr 630 Cond H1075 59730 PSI

E. BRACKET CS 22605 PSI

F. BOLTING A193 Gr B7 (Actuator) 41250 PSI

A354 Gr BD (Bracket) 49500

DESIGN CONDITIONS

PRES. - P1 23.7

TEMPERATURE 330

VALVE TORQUES

PACKING TORQUE 1663

MAX. AERO. TORQUE 127,133

CORR. BEARING TORQUE 395

G - LOADINGS

TRANSVERSE 5.5

VERTICAL 3

LONGITUDINAL 4.5

MEDIA Air

FLOW DIRECTION Preferred

SIZE 36" CLASS 150/150

ACTUATOR 45102-SR80

DIMENSIONAL DATA

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	3.38	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	14.048	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	4.69	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	6.75	X5	X5
ACTUATOR WEIGHT	852	W1	W4
BRACKET WEIGHT	90	W2	W5
DISC WEIGHT	820	W4	W3
THICKNESS OF BRACKET LOWER PLATE	1.125	T1	T1
WIDTH OF BRACKET	11	T2	T2
WIDTH OF VALVE NECK	10	T3	T3
THICKNESS OF VALVE NECK	5.75	T4	T4
THICKNESS OF BRACKET SIDE PLATES	1.0	T9	T9
THICKNESS OF BRACKET TOP PLATE	.875	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	3.752	Di	B5
STEM DIA.	2.747	D1	D1
GAGE DIA. OF DISC	34.782	D	D
WIDTH SMALL DIA. BACK OF DISC	3.75	E1	E1
WIDTH LARGE DIA. OF DISC	1.25	E2	E2
THRUST WASHER THICKNESS	.602	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	2.125	Y2	Y2
NO. OF ACTUATOR BOLTS	8	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.462	A1	A1
DBC OF ACTUATOR BOLTS	8.25	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	8	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	4.5	X8	X8
LENGTH OF BRACKET	14	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	7.69	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1.5	R6	R6
TORQUE ON DISC PIN	65	ℓ	T7
DISC PIN DIA.	.998	dp	D5
VALVE BODY O.D.	41.250	d1	D8
VALVE BODY WATERWAY DIA.	35.125	R7	R7
ADJACENT PIPING O.D.	36	R8	R8
ADJACENT PIPING I.D.	35	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
... OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC & LOCA ANALYSIS

36 CLASS 150/150 VALVE ASSEMBLY
WITH 45102-SR80 ACTUATOR

CUSTOMER: ILLINOIS POWER
P.O.NO.C-9702
SPEC.NO.:K-2868
REF,NO,:16204
ITEM NO.:30

REFERENCE DWGS.
A.ASS'Y DWG.NO.:16204-29 REV.C
B.BODY DWG.NO.:1134-360-1 REV.
C.DISC DWG.NO.:1134-360-8 REV.
D.STEM DWG.NO.:1304-528 REV.
E.PIN DWG.NO. :1306-111 REV.

ALLOWABLE STRESSES (PSI)
A.BODY: 28875
B.DISC: 28875
C.STEM: 59730
D.PIN: 59730
E.BRACKET: 22605
F.BOLTING: 49500

DESIGN CONDITIONS
PRESSURE(PSIG)= 23.7
TEMPERATURE('F)= 330

VALVE TORQUE(IN-LBS)
PACKING TORQUE= 1663
BEARING TORQUE= 395
AERODYNAMIC TORQUE=-122133

G LOADINGS
TRANSVERSE= 5.5
VERTICAL= 3
LONGITUDINAL= 4.5

MEDIA - AIR
FLOW DIRECTION - PREFERRED

DIMENSIONAL DATA

X1= 3.38	X2= 14.048	X3= 4.69	X4= 6	X5= 6.75	W1= 852	W2= 90
W4= 820	T1= 1.125	T2= 11	T3= 10	T4= 5.75	T9= 1	T0= .875
d3= 0	Di= 3.752	D1= 2.747	D= 34.782	E1= 3.75	E2= 1.25	
L2= .602	Y2= 2.625	N1= 8	A1= .462	X6= 8.25	N2= 4	
A2= .334	X7= 8	X8= 4.5	T5= 14	R5= 2.69	R6= 1.5	
%= 65	dp= .998	d1= 40.25	R7= 35.125	R8= 36	R9= 35	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 72 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 594 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 135 VS.33HZ.
LATERAL DISC/STEM= 130 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 12236 PSI
TENSILE= 5040 PSI
COMBINED= 15013 PSI VS.ALLOW.= 49500

BRACKET BOLT STRESSES
SHEAR= 34248 PSI
TENSILE= 25047 PSI
COMBINED= 48990 PSI VS.ALLOW= 49500

BRACKET STRESSES
SHEAR= 1787 PSI
TENSILE= 5123 PSI
COMBINED= 5685 PSI VS.ALLOW= 22605

VALVE NECK STRESSES
SHEAR= 4321 PSI
TENSILE= 3068 PSI
COMBINED= 6120 PSI VS.ALLOW= 28875

STEM STRESSES
SHEAR= 29501 PSI
TENSILE= 4826 PSI
COMBINED= 32013 PSI VS.ALLOW= 59730

DISC PIN STRESS
SHEAR=-30391 PSI VS.ALLOW= 35838

SECTION MODULUS
VALVE= 2688.95 IN↑3
PIPING= 408.12 IN↑3

ACTUATOR DEFLECTIONS
LONGITUDINAL= 8.02700000E-03 INCHES
VERTICAL= 7.90000000E-05 INCHES
TRANSVERSE= 2.70000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED....John L. Parker....DATED....9/22/82.....

0371

E-C

Case 3A

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 24"

VALVE CLASS: 150/150

ACTUATOR: Matryx 33082-SR80

CUSTOMER: Illinois Power Co.

P.O. NO.: C-9702

SPEC. NO.: K-2868

REFERENCE NO.: 16204

ITEM NO.: 28

REFERENCE DWGS.

A. ASS'Y DWG. NO.	16204-28	REV.	C
B. BODY DWG. NO.	1114-240-6	REV.	
C. DISC DWG. NO.	1134-240-3	REV.	
D. STEM DWG. NO.	1304-520	REV.	
E. PIN DWG. NO.	1306-80	REV.	

ALLOWABLE STRESSES

A. BODY	SA516 Gr 70	28875	PSI
B. DISC	SA216 Gr WCB	28875	PSI
C. STEM	SA564 Gr 630 Cond H1075	59730	PSI
D. PIN	SA564 Gr 630 Cond H1075	59730	PSI
E. BRACKET	CS	22605	PSI
F. BOLTING	A193 Gr B7	41250	PSI

DESIGN CONDITIONS

PRES. - P1 44.7

TEMPERATURE 330.

VALVE TORQUES

PACKING TORQUE 1210

MAX. AERO. TORQUE - 48,376

CORR. BEARING TORQUE - 348

G - LOADINGS

TRANSVERSE 5.5

VERTICAL 3

LONGITUDINAL 4.5

MEDIA Air

FLOW DIRECTION Preferred

SIZE 24" CLASS 150/150

DIMENSIONAL DATA

ACTUATOR 33082-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	2.88	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	10.39	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.5	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	5.5	X5	X5
ACTUATOR WEIGHT	417	W1	W4
BRACKET WEIGHT	50	W2	W5
DISC WEIGHT	280	W4	W3
THICKNESS OF BRACKET LOWER PLATE	1.125	T1	T1
WIDTH OF BRACKET	7	T2	T2
WIDTH OF VALVE NECK	8	T3	T3
THICKNESS OF VALVE NECK	4	T4	T4
THICKNESS OF BRACKET SIDE PLATES	1	T9	T9
THICKNESS OF BRACKET TOP PLATE	.875	TO	TO
VALVE NECK O.D.	0	d3	Do
PACKING BORE I.D.	2.75	Di	B5
STEM DIA.	2.0	D1	D1
GAGE DIA. OF DISC	22.352	D	D
WIDTH SMALL DIA. BACK OF DISC	2.438	E1	E1
[illegible] LARGE DIA. OF DISC	1.313	E2	E2
THRUST WASHER THICKNESS	.396	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	2.062	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.334	A1	A1
DBC OF ACTUATOR BOLTS	5.75	X6	X6
NO. OF BRACKET/VALVE BOLTS	4	N2	N2
TENSILE STRESS AREA OF BRACKET/VALVE BOLTS	.334	A2	A2
TRANSVERSE DIST. BETWEEN BRACKET BOLTS	5	X7	X7
LONGITUDINAL DIST. BETWEEN BRACKET BOLTS	2	X8	X8
LENGTH OF BRACKET	11	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	3.234	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1.375	R6	R6
% TORQUE ON DISC PIN	65	ℓ	T7
DISC PIN DIA.	.746	dp	D5
VALVE BODY O.D.	27.25	d1	D8
VALVE BODY WATERWAY DIA.	22.75	R7	R7
ADJACENT PIPING O.D.	24	R8	R8
ADJACENT PIPING I.D.	22.626	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
[illegible] OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	70,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC & LOCA ANALYSIS

24 CLASS 150/150 VALVE ASSEMBLY
WITH 33062-SR80 ACTUATOR

CUSTOMER: ILLINOIS POWER
P.O.NO.C-9702
SPEC.NO.: K-2868
REF,NO,:16204
ITEM NO.:28

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:16204-28 REV.C	A.BODY: 20875
B.BODY DWG.NO.:1114-240-6 REV.	B.DISC: 20875
C.DISC DWG.NO.:1134-240-3 REV.	C.STEM: 59730
D.STEM DWG.NO.:1304-520 REV.	D.PIN: 59730
E.PIN DWG.NO. :1306-80 REV.	E.BRACKET: 22605
	F.BOLTING: 41250

DESIGN CONDITIONS
PRESSURE(PSIG)= 44.7
TEMPERATURE('F)= 330

VALVE TORQUE(IN-LBS)	G LOADINGS	
PACKING TORQUE= 1210	TRANSVERSE= 5.5	MEDIA - AIR
BEARING TORQUE= 348	VERTICAL= 3	FLOW DIRECTION - PREFERRED
AERODYNAMIC TORQUE=-48376	LONGITUDINAL= 4.5	

DIMENSIONAL DATA

X1= 2.88	X2= 10.39	X3= 3.5	X4= 6	X5= 5.5	W1= 417	W2= 50
W4= 280	T1= 1.125	T2= 7	T3= 8	T4= 4	T9= 1	T0= .875
d3= 0	Di= 2.75	D1= 2	D= 22.352	E1= 2.438	E2= 1.313	
L2= .396	Y2= 2.062	N1= 4	Ai= .334	X6= 5.75	N2= 4	
A2= .334	X7= 5	X8= 2	TS= 11	R5= 3.239	R6= 1.375	
Z= 65	dp= .746	d1= 27.25	R7= 22.75	R8= 24	R9= 22.626	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)	ACTUATOR BOLT STRESSES
LONGITUDINAL(Z) ACT./VALVE= 93 VS. 33HZ.	SHEAR= 18386 PSI
VERTICAL(Y) ACT./VALVE= 772 VS. 33HZ.	TENSILE= 6612 PSI
TRANSVERSE(X) ACT./VALVE= 173 VS.33HZ.	COMBINED= 21987 PSI VS.ALLOW.=,41250
LATERAL DISC/STEM= 221 VS.33HZ.	

BRACKET BOLT STRESSES	BRACKET STRESSES
SHEAR= 22045 PSI	SHEAR= 1372 PSI
TENSILE= 21205 PSI	TENSILE= 5877 PSI
COMBINED= 35065 PSI VS.ALLOW= 41250	COMBINED= 6181 PSI VS.ALLOW= 22605

VALVE NECK STRESSES	STEM STRESSES
SHEAR= 4685 PSI	SHEAR= 29805 PSI
TENSILE= 3608 PSI	TENSILE= 6135 PSI
COMBINED= 6825 PSI VS.ALLOW= 20875	COMBINED= 33030 PSI VS.ALLOW= 59730

DISC PIN STRESS	SECTION MODULUS
SHEAR=-29836 PSI VS.ALLOW= 35838	VALVE= 1021.47 IN↑3
	PIPING= 285.1 IN↑3

ACTUATOR DEFLECTIONS	BODY BOLTING
LONGITUDINAL= 4.81300000E-03 INCHES	NOT APPLICABLE
VERTICAL= 4.60000000E-05 INCHES	
TRANSVERSE= 1.60000000E-03 INCHES	

SIGNED.....John R. Bergman.....DATED.....2/28/82....

0531

E-9

Case 2A

NUCLEAR LOCA & SEISMIC ANALYSIS

VALVE SIZE: 10"

VALVE CLASS: 150

ACTUATOR: 2660Z - SR80

CUSTOMER: Illinois Power Co.

P.O. NO.: C-9702

SPEC. NO.: K-2868

REFERENCE NO.: 16204

ITEM NO.: 31

REFERENCE DWGS.

A. ASS'Y DWG. NO. 16204 - 31 REV. C

B. BODY DWG. NO. 1144-100-11 REV.

C. DISC DWG. NO. 1144-100-8 REV.

D. STEM DWG. NO. 1304-510 REV.

E. PIN DWG. NO. 1306-99 REV.

ALLOWABLE STRESSES

A. BODY	SA 516 G-70	28875	PSI
B. DISC	SA216 G- WCB	28875	PSI
C. STEM	SA 564 G-630 Cond H1075	59730	PSI
D. PIN	SA 564 G-630 Cond H1075	59730	PSI
E. BRACKET	CS	22605	PSI
F. BOLTING	A193 G-B7	41250	PSI

DESIGN CONDITIONS

PRES. - P1 44.7

TEMPERATURE 330°

VALVE TORQUES

PACKING TORQUE 680

MAX. AERO. TORQUE - 2769

CORR. BEARING TORQUE 9

G - LOADINGS

TRANSVERSE 5.5

VERTICAL 3

LONGITUDINAL 4.5

MEDIA Air

FLOW DIRECTION Preferred

SIZE 10" CLASS 150

DIMENSIONAL DATA

ACTUATOR 2602-SR80

DESCRIPTION OF VARIABLE		INPUT NAME	COMPUTER NAME
TRANSVERSE DIST. ACTUATOR C.G. TO ℄ VALVE	2.53	X1	X1
LONGITUDINAL DIST. ACTUATOR C.G. TO ℄ VALVE	8.943	X2	X2
VERTICAL DIST. ACTUATOR C.G. TO BRACKET	3.25	X3	X3
HEIGHT BRACKET	6	X4	X4
HEIGHT VALVE NECK	4.25	X5	X5
ACTUATOR WEIGHT	255	W1	W4
BRACKET WEIGHT	25	W2	W5
DISC WEIGHT	29	W4	W3
THICKNESS OF BRACKET LOWER PLATE	.875	T1	T1
WIDTH OF BRACKET	5	T2	T2
WIDTH OF VALVE NECK	6.0	T3	T3
THICKNESS OF VALVE NECK	2.875	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.	1.63	Di	B5
STEM DIA.	1.22	D1	D1
GAGE DIA. OF DISC	9.85	D	D
WIDTH SMALL DIA. BACK OF DISC	1.625	E1	E1
W[illegible] LARGE DIA. OF DISC	.813	E2	E2
THRUST WASHER THICKNESS	.337	L2	L2
DIST. ℄ STEM TO FRONT OF DISC	1.5	Y2	Y2
NO. OF ACTUATOR BOLTS	4	N1	N1
TENSILE STRESS AREA OF ACTUATOR BOLTS	.1416	A1	A1
BC 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	9.25	T5	T5
DISTANCE BETWEEN VALVE BODY BOLT HOLES	2.688	R5	R5
DIA. OF VALVE BODY BOLT HOLES	1	R6	R6
TORQUE ON DISC PIN	65	g	T7
DISC PIN DIA.	.309	dp	D5
VALVE BODY O.D.	13.25	d1	D8
VALVE BODY WATERWAY DIA.	10.187	R7	R7
ADJACENT PIPING O.D.	10.75	R8	R8
ADJACENT PIPING I.D.	10.02	R9	R9
MAXIMUM PIPING BENDING MOMENT	N/A	M4	M4
NO. OF BODY BOLTS		N3	N3
BC OF BODY BOLTS		X0	X0
ROOT AREA OF BODY BOLTS		A4	A4
LENGTH ACROSS GUSSETS	0	L	L
THICKNESS OF GUSSETS	0	T	T
[illegible] OF FLANGE BOSSES	0	B	B
MODULUS OF ELASTICITY	30,000,000	E	E

POSI-SEAL INTERNATIONAL, INC.
NUCLEAR SEISMIC & LOCA ANALYSIS

10 CLASS 150 VALVE ASSEMBLY
WITH 26062-SR80 ACTUATOR

CUSTOMER: ILLINOIS POWER
P.O.NO.C-9702
SPEC.NO.:K-2868
REF,NO,:16204
ITEM NO.:31

REFERENCE DWGS.	ALLOWABLE STRESSES (PSI)
A.ASS'Y DWG.NO.:16204-31 REV.C	A.BODY: 22875
B.BODY DWG.NO.:1144-100-11 REV.	B.DISC: 28875
C.DISC DWG.NO.:1144-100-8 REV.	C.STEM: 59730
D.STEM DWG.NO.:1304-510 REV.	D.PIN: 59730
E.PIN DWG.NO. :1306-99 REV.	E.BRACKET: 22605
	F.BOLTING: 41250

DESIGN CONDITIONS
PRESSURE(PSIG)= 44.7
TEMPERATURE('F)= 330

VALVE TORQUE(IN-LBS)	G LOADINGS	
PACKING TORQUE= 680	TRANSVERSE= 5.5	MEDIA - AIR
BEARING TORQUE= 9	VERTICAL= 3	FLOW DIRECTION - PREFERRED
AERODYNAMIC TORQUE=-2769	LONGITUDINAL= 4.5	

DIMENSIONAL DATA

X1= 2.83	X2= 8.983	X3= 3.25	X4= 6	X5= 4.25	W1= 255	W2= 25
W4= 29	T1= .875	T2= 5	T3= 6	T4= 2.875	T9= .75	T0= .625
d3= 0	Di= 1.63	D1= 1.22	D= 9.85	E1= 1.625	E2= .813	
L2= .337	Y2= 1.5	N1= 4	A1= .1416	X6= 4.5	N2= 4	
A2= .1416	X7= 5	X8= 2	T5= 2.75	R5= 2.688	R6= 1	
Z= 65	dp= .309	d1= 13.25	R7= 10.187	R8= 10.75	R9= 10.02	
L= 0	T= 0	B= 0	E= 30000000			

NATURAL FREQUENCIES (HZ.)
LONGITUDINAL(Z) ACT./VALVE= 71 VS. 33HZ.
VERTICAL(Y) ACT./VALVE= 513 VS. 33HZ.
TRANSVERSE(X) ACT./VALVE= 114 VS.33HZ.
LATERAL DISC/STEM= 1015 VS.33HZ.

ACTUATOR BOLT STRESSES
SHEAR= 11729 PSI
TENSILE= 10789 PSI
COMBINED= 18305 PSI VS.ALLOW.= 41250

BRACKET BOLT STRESSES
SHEAR= 12918 PSI
TENSILE= 28219 PSI
COMBINED= 33240 PSI VS.ALLOW= 41250

BRACKET STRESSES
SHEAR= 916 PSI
TENSILE= 4535 PSI
COMBINED= 4713 PSI VS.ALLOW= 22605

VALVE NECK STRESSES
SHEAR= 2535 PSI
TENSILE= 4533 PSI
COMBINED= 5667 PSI VS.ALLOW= 28875

STEM STRESSES
SHEAR= 5833 PSI
TENSILE= 3728 PSI
COMBINED= 7988 PSI VS.ALLOW= 59730

DISC PIN STRESS
SHEAR=-13453 PSI VS.ALLOW= 39838

SECTION MODULUS
VALVE= 148.58 IN↑3
PIPING= 29.9 IN↑3

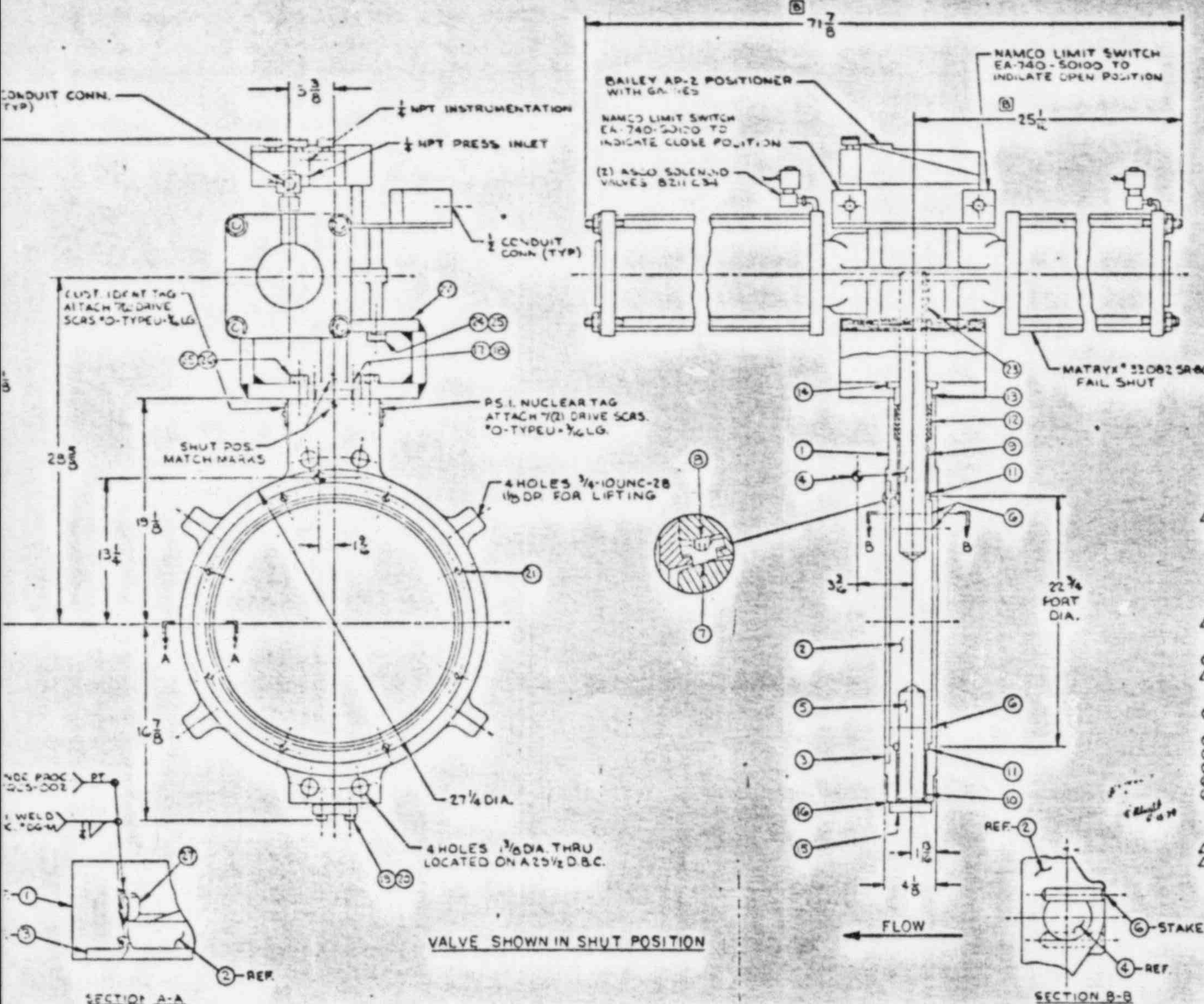
ACTUATOR DEFLECTIONS
LONGITUDINAL= 8.22900000E-03 INCHES
VERTICAL= 1.06000000E-04 INCHES
TRANSVERSE= 3.90000000E-03 INCHES

BODY BOLTING
NOT APPLICABLE

SIGNED....[signature]......DATED..2/17/82.......

0533

E-12



GENERAL NOTES

1. THIS VALVE ASSEMBLY IS DESIGNED AND MFD. IN ACCORDANCE WITH THE ASME BOILER AND PRESS. VESSEL CODE SECT. III SUBSECTION NC 1974 ED. INCLUDING THE WINTER 1976 ADDENDA (CLASS 2 VALVE)
2. CUSTOMER: ILLINOIS POWER CO. CLINTON POWER STATION UNIT Nº 1
3. BALDWIN ASSOC P.O. Nº 1C-5702
4. DESIGN PRESS: 30 PSIG
5. DESIGN TEMP: 330°F
6. MEDIA: AIR
7. TAG Nº: 1VQ001A, 1VQ001B, 1VQ002
8. ACCESSORIES TO BE SHOWN ON DWG UPON RECEIPT OF CERT ACTUATOR DWG FROM MATRYX. ACCESSORIES INCLUDE: (2) NAMCO LIMIT SWITCHES, DPDT, EA740-50100, (1) OPEN (1) SHUT; (2) ASCO SOLENOID VALVE 8211 C34; (1) BAILEY POSITIONER "AP-2

△ - CODE PARTS
⊗ - RECOMMENDED SPARE PARTS
⊕ - CENTER OF GRAVITY
TOTAL ASS'Y WT - 1028 LBS.

	PC NO.	QTY	DWG NO	DESCRIPTION	MATERIAL	MAT'L SPECIFICATION
△	27	1	4191	STOP	CS	ASME SA216 GR
	26	4	[illegible]	HEX HD BOLT	CS	ASTM A193 GR B7
	25	8	3/4 SIZE	LOCKWASHER	CS	
	24	4	[illegible]	HEX HD BOLT	CS	ASTM A193 GR B7
	23	1	5/8 SQ - 2 1/2 LG	KEY	KEYSTOCK	
	22	1	6445	MOUNTING BRKT.	CS	
	21	8	[illegible]	FL HD MACH SCR	316SS	
	20	4	5/8 SIZE	LOCKWASHER	316SS	
△	19	4	[illegible]	HEX HD BOLT	410SS	ASME [illegible]
	18	2	5/8-11UNC-2B	HEX NUT	316SS	ASTM A194 GR [illegible]
	17	2	4243-2	STUD	316SS STRN HDN	ASTM A193 GR B[illegible]
⊗	16	1	[illegible]	GASKET	ASBESTOS	
△	15	1	1144-[illegible]	GASKET RETAINER	CS	ASME SA516 GR
	14	1	4006	GLAND FOLLOWER	316SS	ASTM A[illegible]
	13	1	4005	PACKING GLAND	316SS	ASTM A[illegible]
⊗	12	A*		PACKING TANKS [illegible]	ASBESTOS	NUCLEAR GRADE
	11	2	1301-246	THRUST WASHER	316SS	MICROSEAL
⊗	10	2	1300-453	LOWER BEARING	316SS	MICROSEAL
⊗	9	2	1300-453	UPPER BEARING	316SS	MICROSEAL
⊗	8	1	2-231	O-RING	EPR	
⊗	7	1	1114-240-B	SEAL RING	TEFZEL	
⊗	6	3	1306-80	DISC PIN	17-4PH COND H1075	ASME SA564 GR
	5	1	1302-226	LOWER STEM	17-4PH COND H1075	ASME SA564 GR
	4	1	1304-520	STEM	17-4PH COND H1075	ASME SA564 GR
	3	1	2114-240-9	RET RING	CS	ASTM A[illegible]
△	2	1	1114-240-8	DISC	CS	ASME SA216 GR
△	1	1	1114-240-6	BODY	CS	ASME SA216 GR

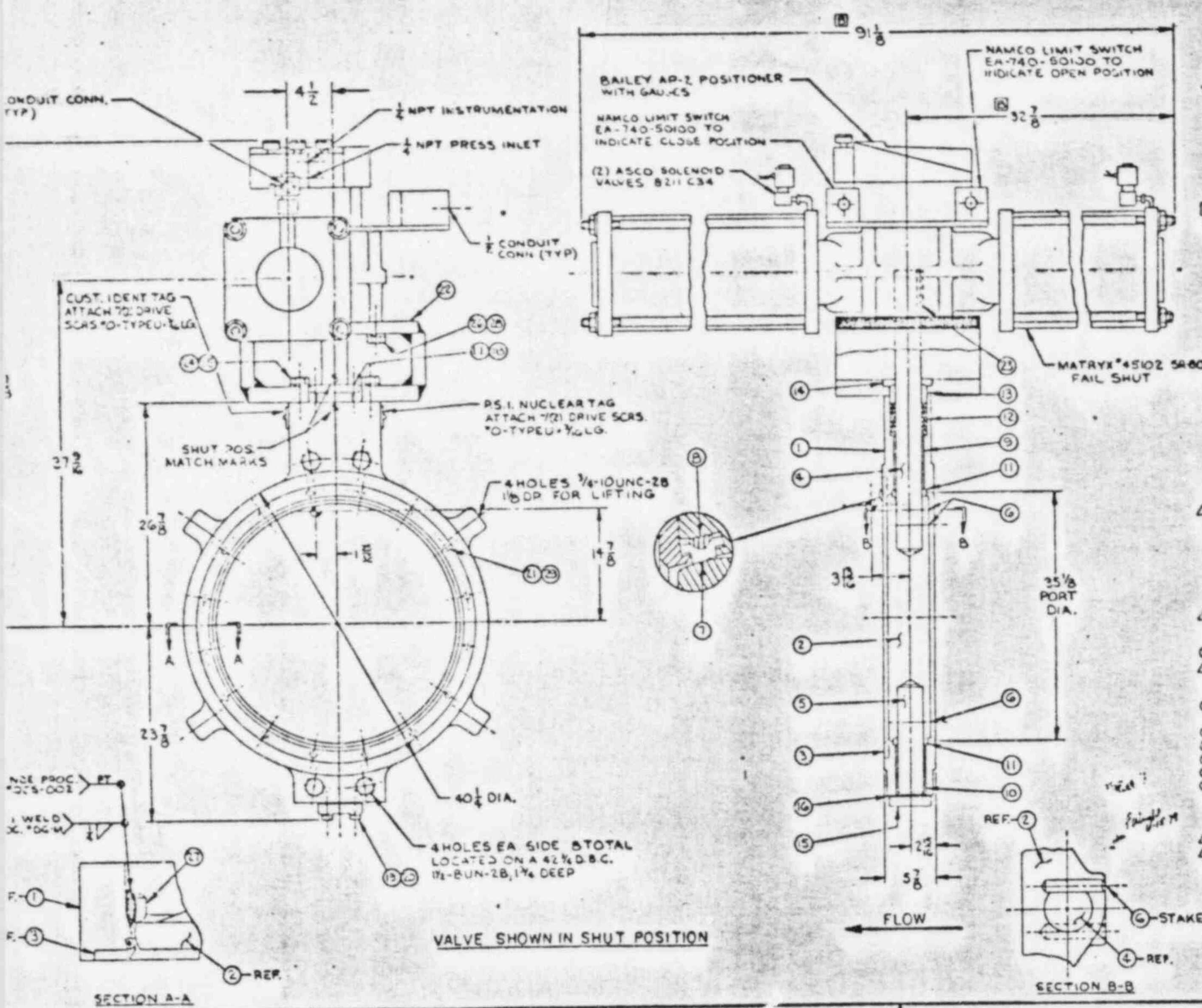
LIST OF MATERIAL FOR ONE ASSY.

DIMENSIONS CERTIFIED CORRECT BY [signature] DATE [illegible]
CUSTOMER P.O. - SEE ABOVE
POSI SEAL REF. - 16204
TAG NO. - SEE ABOVE
DIMENSIONS ARE IN INCHES

POSI SEAL INTERNATIONAL INC
NORTH STONINGTON, CT. 06359

24" CLASS 150/150 VALVE ASSEMBLY MATRYX 33082 SR-80

D 16204-28



GENERAL NOTES

1. THIS VALVE ASSEMBLY IS DESIGNED AND MFD. IN ACCORDANCE WITH THE ASME BOILER AND PRESS. VESSEL CODE SECT. III SUBSECTION NC 1974 ED. INCLUDING THE WINTER 1976 ADDENDA (CLASS 2 VALVE)
2. CUSTOMER: ILLINOIS POWER CO.
   CLINTON POWER STATION UNIT Nº 1
3. BALDWIN ASSOC P.O. Nº: C-5702
4. DESIGN PRESS: 30 PSIG
5. DESIGN TEMP.: 330°F
6. MEDIA: AIR
7. TAG Nº: ITEM Nº 29
   1VQ003

   ITEM Nº 30
   1VQ004 A
   1VQ004 B
   1VR001 A
   1VR001 B
8. ACCESSORIES TO BE SHOWN UPON RECEIPT OF CERT. ACT. DWG FROM MATRYX. ACCESSORIES INCLUDE: (2) NAMCO LIMIT SWITCHES, DPDT EA-740-50100 (1) OPEN (1) SHUT
   (1) BAILEY POSITIONER AP-2
   (2) ASCO SOLENOID VALVE 8211 C34

△ - CODE PARTS.

⊗ - RECOMMENDED SPARE PARTS

⊕ - CENTER OF GRAVITY

TOTAL ASS'Y WT. = 2,425 LBS.

	PC NO	QTY	DWG NO	DESCRIPTION	MATERIAL	MAT'L SPECIFICATION
	29	16	3/4 SIZE	LOCKWASHER HI-COLLAR	316SS	
	28	8	5/8 SIZE	LOCKWASHER	CS	
△	27	1	7171	STOP	CS	ASME SA216 GR
	26	8	[illegible]	HEX HD BOLT	CS	ASTM A193 GR B
	25	4	3/4 SIZE	LOCKWASHER	CS	
	24	4	[illegible]	HEX HD BOLT	CS	ASTM A193 GR B
	23	1	[illegible]	KEY	KEYSTOCK	
	22	1	[illegible]	MOUNTING BRKT.	CS	
	21	16	[illegible]	SOC HD CAP SCR	316SS	
	20	4	[illegible] SIZE	LOCKWASHER	316SS	
△	19	4	[illegible]	HEX HD BOLT	410SS	ASME SA193 GR
	18	2	[illegible]-28	HEX NUT	316SS	ASTM A194 GR
	17	2	4243	STUD	[illegible] STAIN HDN	ASTM A193 GR
⊗	16	1	[illegible] THK	GASKET	ASBESTOS	
△	15	1	[illegible]	GASKET RETAINER	CS	ASME SA516 GR
	14	1	3167	GLAND FOLLOWER	316SS	ASTM A351 GR
	13	1	4123	PACKING GLAND	316SS	ASTM A351 GR C
⊗	12	SET		PACKING RINGS [illegible]	ASBESTOS	NUCLEAR GRADE
	11	2	1301-237	THRUST WASHER	316SS	MICROSEAL
⊗	10	2	1300-455	LOWER BEARING	316SS	MICROSEAL
⊗	9	2	1300-455	UPPER BEARING	316SS	MICROSEAL
⊗	8	1	[illegible]	O-RING	EPR	
⊗	7	1	1134-360-4	SEAL RING	TEFZEL	
⊗	6	3	1306-111	DISC PIN	17-4PH COND H1075	ASME SA564 GR
	5	1	1302-223	LOWER STEM	17-4PH COND H1075	ASME SA564 GR
	4	1	1204-5.A	STEM	17-4PH COND H1075	ASME SA564 GR
	3	1	1134-360-3	RET. RING	CS	ASTM A516 GR
△	2	1	1134-360-2	DISC	CS	ASME SA216 GR
△	1	1	1134-360-1	BODY	CS	ASME SA516 GR

LIST OF MATERIAL FOR ONE ASSY.

DIMENSIONS CERTIFIED CORRECT

BY: [signature] DATE: [illegible]

CUSTOMER P.O. #: SEE ABOVE

POSI SEAL REF. #: 16204

TAG NO.: SEE ABOVE

DIMENSIONS ARE IN INCHES

DRAWN: PD

POSI SEAL INTERNATIONAL IN[C.]

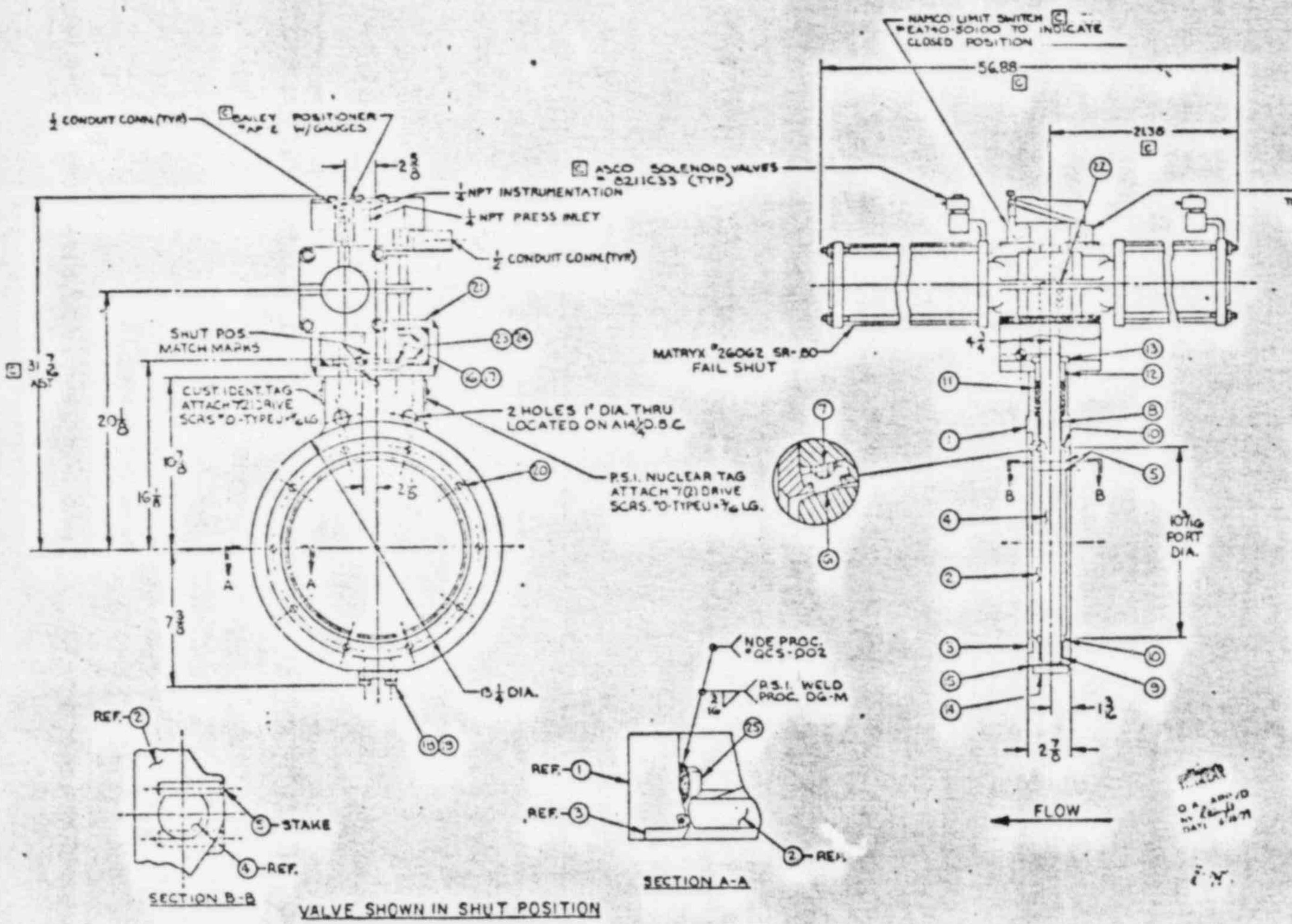
NORTH STONINGTON, CT. 06359

36" CLASS 150/150 VALVE ASSEMBLY

MATRYX #45102 SR-80

SIZE: D

16204-23



GENERAL NOTES

1. THIS VALVE ASSEMBLY IS DESIGNED AND MFD. IN ACCORDANCE WITH THE ASME BOILER AND PRESS VESSEL CODE SECT. III SUBSECTION NC 1974 ED. INCLUDING THE WINTER 1976 ADDENDA. (CLASS 2 VALVE)
2. CUSTOMER: ILLINOIS POWER CO. CLINTON POWER STATION UNIT Nº1
3. BALDWIN ASSOC. P.O. Nº C-9702
4. DESIGN PRESS.: 30 PSIG
5. DESIGN TEMP.: 330°F
6. MEDIA: AIR
7. TAG Nº: 1VQ005
8. ACCESSORIES TO BE SHOWN UPON RECEIPT OF CERT. ACT. DWG. FROM MAT... ACCESSORIES INCLUDE: (2) NAMCO LIMIT SWITCHES DPDT EA740-50100 (1) OPEN (1) SHUT (1) BAILEY POSITIONER "AP-2 (2) ASCO SOLENOID VALVES "8211-C33

Δ - CODE PARTS

⊗ - RECOMMENDED SPARE PARTS

CENTER OF GRAVITY

TOTAL ASS'Y WT. = 350 LBS.

	PC NO.	QTY	DWG NO	DESCRIPTION	MATERIAL	MAT'L SPECIFICATION
Δ	25	1	3406	STOP	CS	ASME SA36
	24	8	½ SIZE	LOCKWASHER	CS	
	23	8	½-13UNC-2A	HEX HD BOLT	CS	ASTM A193 GR B
	22	1	¼ SQ × 2¼ LG	KEY	KEYSTOCK	
	21	1	16439	MOUNTING BRKT	CS	
	20	10	¼-20UNC	FL HD MACH SCR	316SS STRN HDN	ASTM A193 GR B
	19	4	5/8 SIZE	LOCKWASHER	316SS	
Δ	18	4	[illegible]	HEX HD BOLT	410SS	ASME SA193 GR
	17	2	[illegible]	HEX NUT	316SS	ASTM A194
	16	2	4243-4	STUD	316SS STRN HDN	ASTM A193 GR B
⊗	15	1	[illegible]	GASKET	ASBESTOS	
Δ	14	1	1144-100-4	GASKET RETAINER	CS	ASME SA516 GR
	13	1	3235	GLAND FOLLOWER	316SS	ASTM A351 GR CF
	12	1	2633	PACKING GLAND	316SS	ASTM A351 GR C
⊗	11	KIT		PACKING RINGS	ASBESTOS	NUCLEAR GRADE
	10	2	1301-39	THRUST WASHER	316SS	MICROSEAL
⊗	9	1	1300-109	LOWER BEARING	316SS	MICROSEAL
⊗	8	3	1300-109	UPPER BEARING	316SS	MICROSEAL
⊗	7	1	2-376	O-RING	EPR	
⊗	6	1	1144-100-1	SEAL RING	TEFZEL	
⊗	5	2	1306-99	DISC PIN	17-4PH COND H1075	ASME SA564 GR
	4	1	1304-510	STEM	17-4PH COND H1075	ASME SA564 GR
	3	1	12111	RET. RING	CS	ASTM A516 GR
Δ	2	1	1144-100-8	DISC	CS	ASME SA216 GR
Δ	1	1	1144-100-11	BODY	CS	ASME SA516 GR

LIST OF MATERIAL FOR ONE ASSY.

DIMENSIONS CERTIFIED CORRECT
BY: [signature] DATE [illegible]

CUSTOMER P.O. # SEE ABOVE
POSI SEAL REF. # 6204
TAG NO. SEE ABOVE
DIMENSIONS ARE IN INCHES

DRAWN PD
CHECKED
APPROVED

POSI SEAL INTERNATIONAL IN
NORTH STONINGTON, CT. 06359

10"- CLASS 150 VALVE ASSEMBLY
MATRYX "26062 SR-80

D 6-13-79 SCALE NONE 16204-31

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. (See Figures 7&8)

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

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

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

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

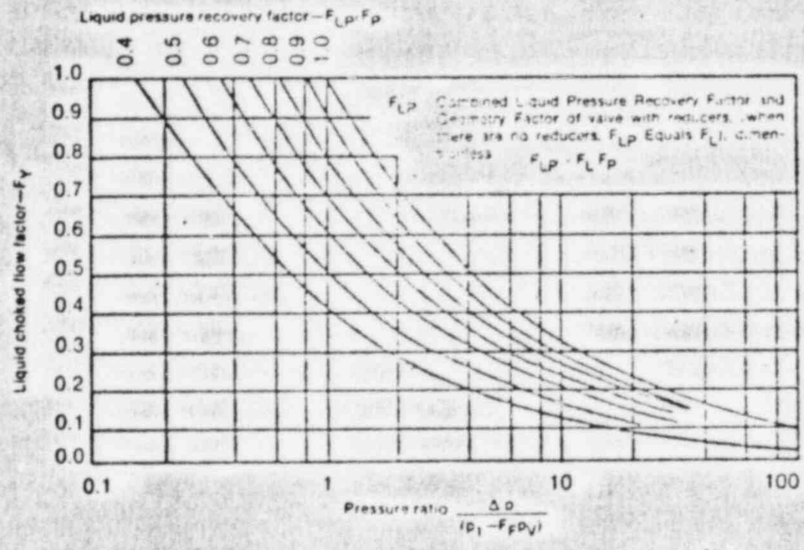
F_R = Reynolds Number Factor, when viscosity (μ) is less then 90 centipoise F_R = 1.0, See Figure 3

F_Y = Liquid Choke Flow Factor, See Fig. 1

$1\ GPM = 8.021\ \frac{ft^3}{hr}$

$1\ GPM = 500.7\ \frac{lbs}{hr}$

FIGURE 1



See Fig. 4 for F_L
See Below for F_P
See Fig 5 for F_F

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.

Trial and Error with Cv calcs.

$$F_p = \sqrt{\frac{C^2_{vp}}{C^2_v + C^2_{vp}}}$$

$$C_{vp} = \frac{29.8D^2}{\sqrt{\left(1-\frac{D^2}{D^2_2}\right)^2 + .5\left(1-\frac{D^2}{D^2_1}\right)}}$$

WHERE:

C_{vp} = flow coefficient of pipe enlargement and contraction combined.

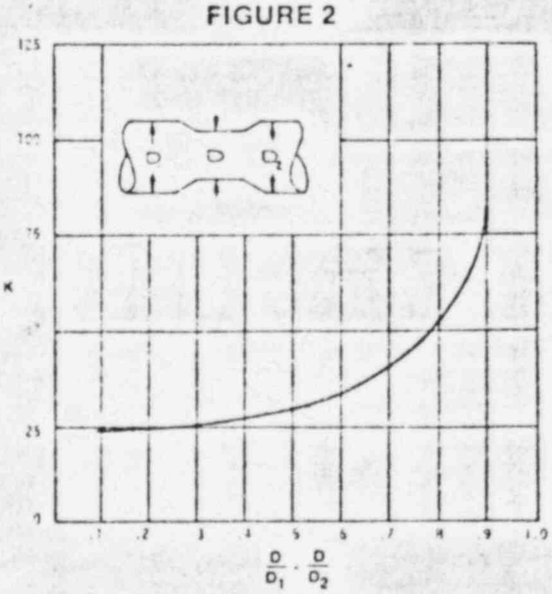
C_v = valve flow coefficient @ flow conditions

D = ID of pipe equal to valve size, inches

D_1 = ID of upstream pipe, inches

D_2 = ID of downstream pipe, inches

FIGURE 2



FOR INSTALLATIONS WHERE D_1 EQUALS D_2:

WHERE:

$C_{vp} = KD^2$ D = ID of pipe equal to valve size, inches

K = Refer to Fig. 2

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. See Table

.8 - Beginning of Cavitation   1 - Full Cavitation

Any increase in the differential pressure across the valve will increase the amount of cavitation and begin to choke the flow. At the differential pressure approximated by the following formula, the flow will be choked.

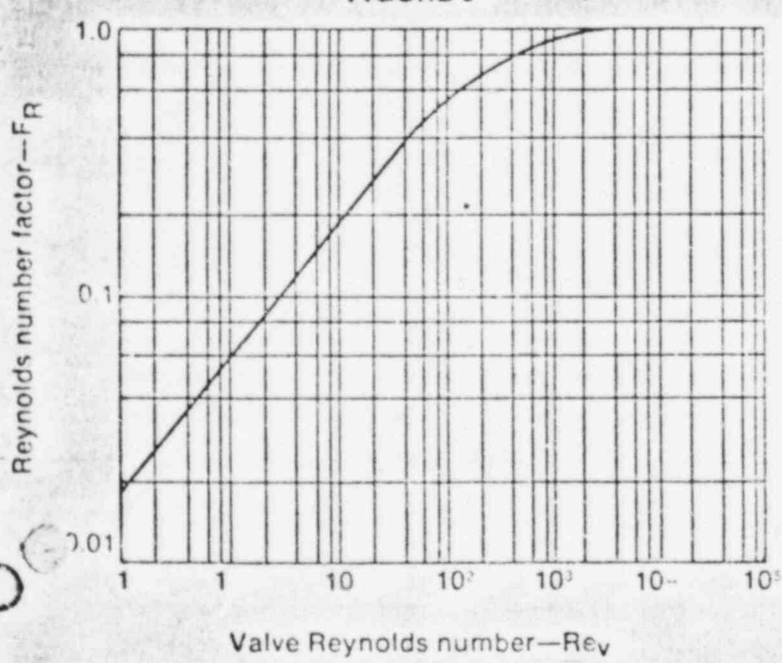
$\Delta P\ \text{choked} = F_L^2 (P_1 - F_F P_v)$

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

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

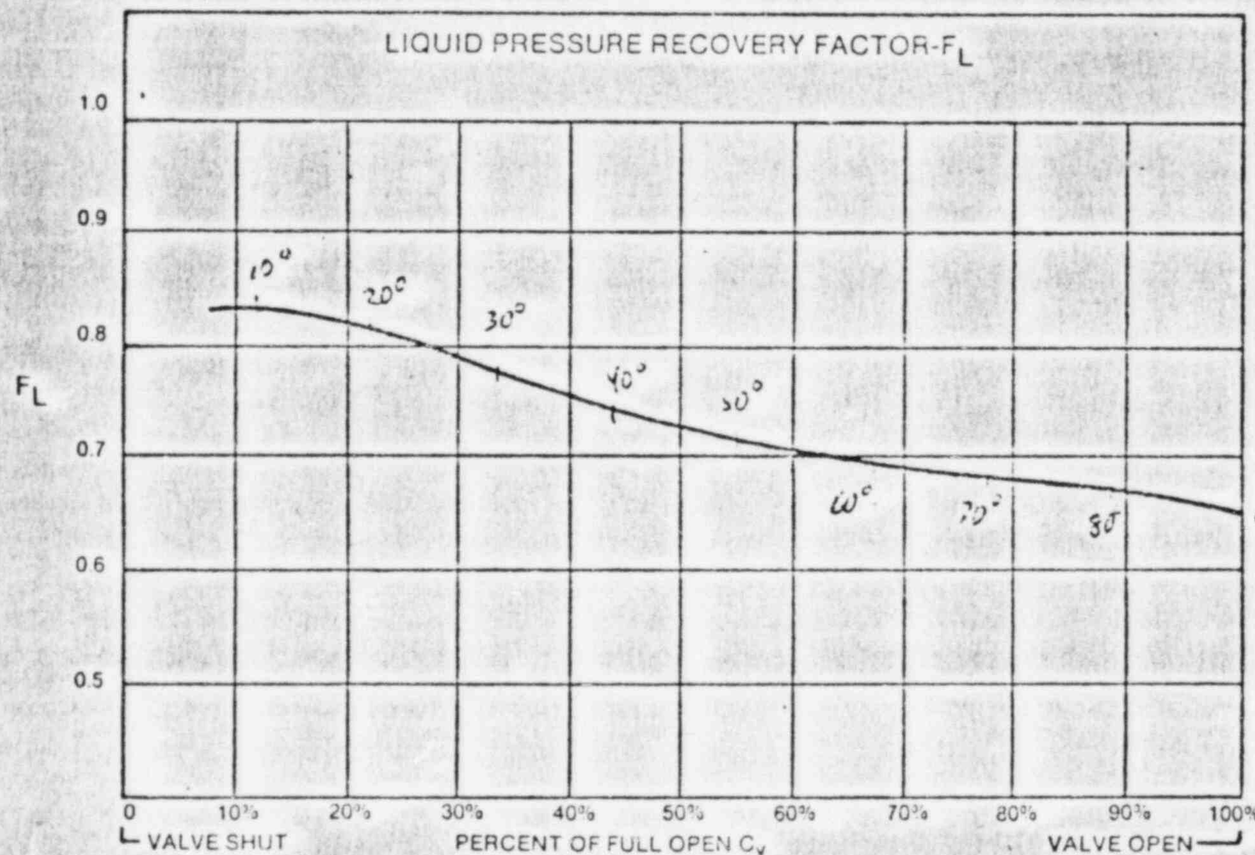
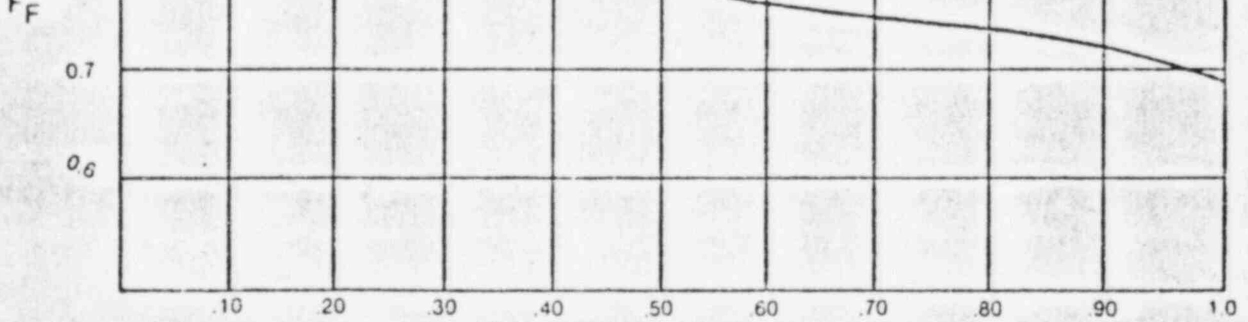


FIGURE 5



$\frac{P_V}{P_C} = \frac{\text{Vapor pressure}}{\text{Critical pressure}}$

	P_c
Water	3200
CO	1071
O_2	736
H_2	155

V. SIZING FOR GAS FLOW

SUBCRITICAL FLOW

$$Q = 1360\, F_P C_v P_1 Y \sqrt{\frac{X}{G T_1 Z}}$$

OR

$$C_v = \frac{Q}{1360 F_P P_1 Y \sqrt{\frac{X}{G T_1 Z}}}$$

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

$$\rho = \frac{P(144)}{53.34\, T_1} = .0764 \text{ @ standard conditions}$$

$$Y = \frac{G\, T_1}{127300\, P_1\, P} \qquad P - ft^2$$

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 $= \dfrac{\text{Density of Gas at Standard Conditions}}{\text{Density of Air at Standard Conditions}}$ (See Table 1)
- X = Pressure drop ratio = $\Delta P/P_1$
- ΔP = Differential pressure across valve in PSI
- Y = Expansion factor

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

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.

STEAM FLOW

$$W = 63.3 F_P C_v Y \sqrt{\frac{X P_1}{V_1}}$$

OR

$$C_v = \frac{W}{63.3 F_P Y \sqrt{\frac{X P_1}{V_1}}}$$

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

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

$$Q_{MAX} = 907.12\, F_P C_v P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}$$

OR

$$C_{V\,MIN} = \frac{Q}{907.12\, F_P P_1 \sqrt{\frac{F_K X_T}{G T_1 Z}}}$$

$$\Delta_{Pc} = F_K X_T P_1$$

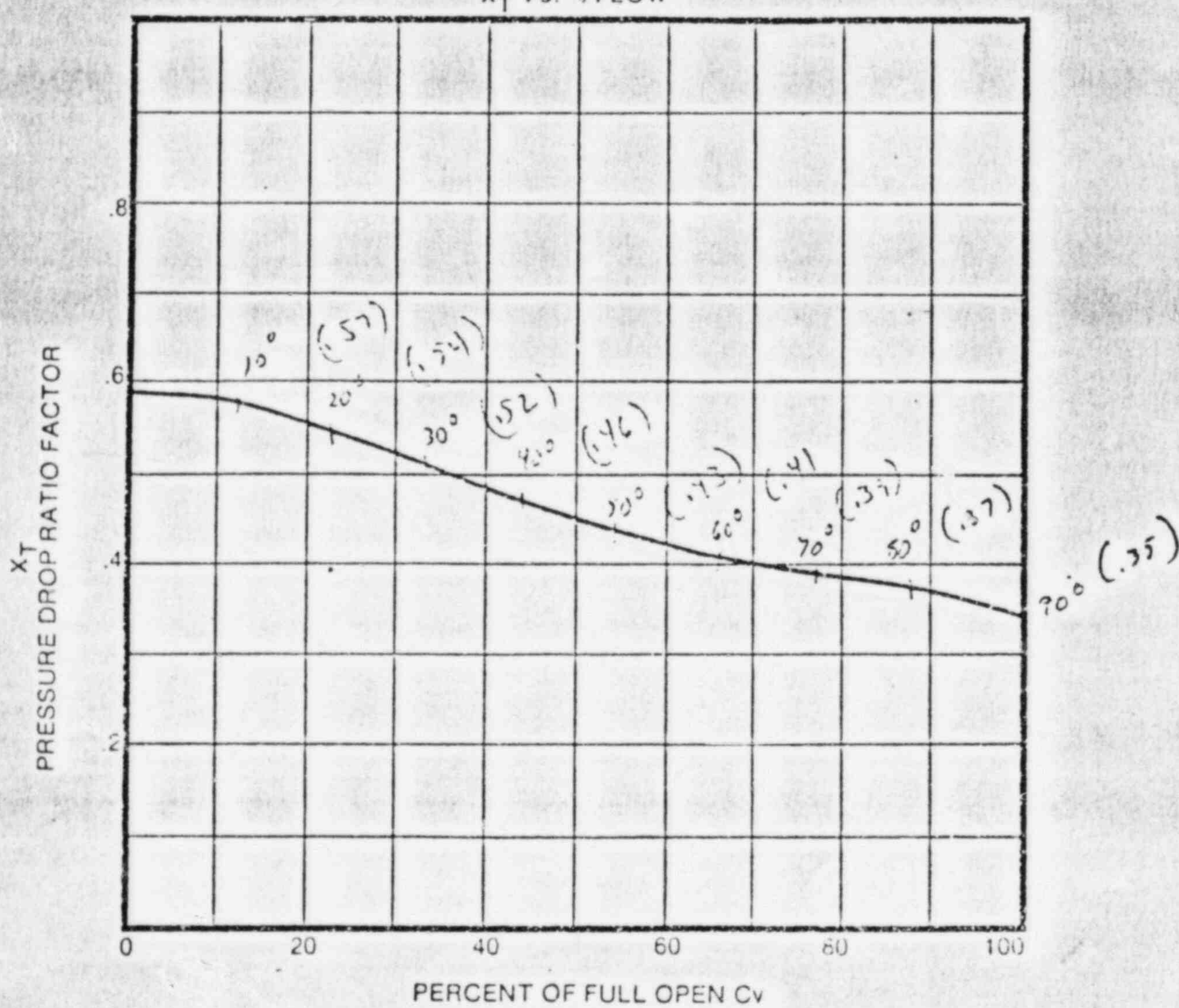
Q_{MAX} = Max Flow that can pass through valve at the stated conditions.

$C_{v\,MIN}$ = Minimum Required C_V in order to pass flow at the stated conditions.

Δ_{Pc} = Max usuable differential pressure drop above which no increase in flow will occur.

F_L = Rated Liquid Pressure Recovery Factor (See Figure 4).

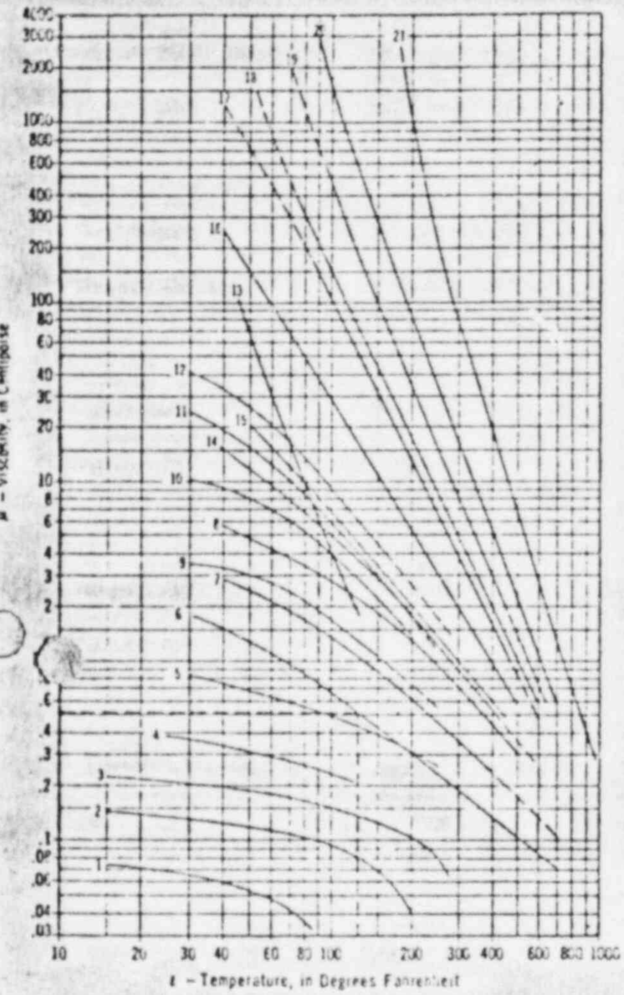
FIGURE 6
X_T VS. % FLOW



VI. TECHNICAL DATA

FIGURE 7

Viscosity of Water and Liquid Petroleum Products

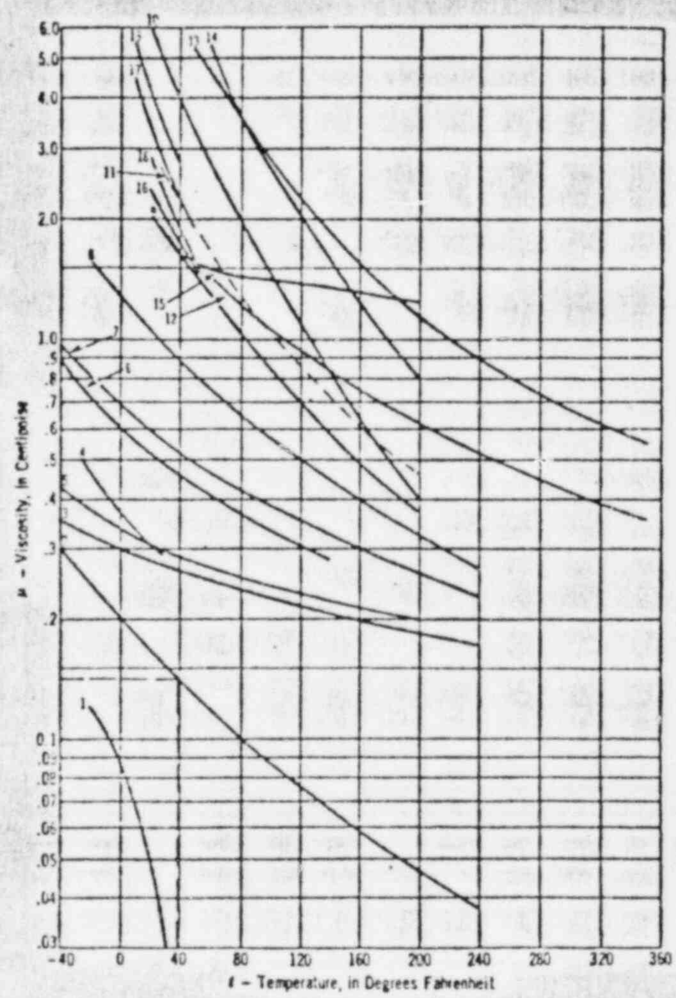


1. Ethane (C_2H_2)
2. Propane (C_3H_3)
3. Butane (C_4H_{10})
4. Natural Gasoline
5. Gasoline
6. Water
7. Kerosene
8. Distillate
9. 48 Deg. API Crude
10. 40 Deg. API Crude
11. 35.6 Deg. API Crude
12. 32.6 Deg. API Crude
13. Salt Creek Crude
14. Fuel 3 (Max.)
15. Fuel 5 (Min.)
16. SAE 10 Lube (100 V.I.)
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-G 60°F/60°F	SPECIFIC GRAVITY GAS-G 60°F AIR=1
Acetic Acid	$HC_2H_3O_2$	60.05	245		612	841	1.05	
Acetic Anhydride	$(CH_3CO)_2O$	102.09	283			676		1.08
Acetone	C_3H_6O	58.08	133		455	691	0.79	2.01
Acetylene	C_2H_2		-119		97	911	0.62	0.91
Air	N_2O_2	28.97	-317		-221	547	0.86	1.0
Alcohol, Ethyl	C_2H_6O	46.07	173	2.3 [1]	470	925	0.794	1.59
Alcohol, Methyl	CH_4O	32.04	148	4.63 [1]	463	1174	0.796	1.11
Ammonia	NH_3	17.03	-28	114	270	1636	0.62	0.59
Aniline	C_6H_7N	93.12	365		798	770	1.02	
Argon	A	39.94	-302		-188	705	1.65	1.38
Benzene	C_6H_6	78.11	176	3.22 [1]	552	710	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		0.63
n-Butane	C_4H_{10}	58.12	31	51.6 [1]	305	550	0.58	2.0
Butyl Alcohol	$C_2H_5CH_2CH_2OH$	74.12	242			711		0.81
Carbon Dioxide	CO_2	44.01	-109	835	88	1072	0.80	1.52
Carbon Monoxide	CO	28.01	-314		-220	507	0.80	0.97
Carbon Tetrachloride	CCL_4	153.84	170		542	661	1.59	5.31
Chlorine	CL_2	70.91	-30	85	291	1118	1.42	2.45
Dowtherm A						454	0.837	
Dowtherm E						583	1.127	
Ethane	C_2H_6	30.07	-127		90	709	0.38	1.04
Ethyl Chloride	C_2H_5CL	64.52	55			2750	0.90	2.22
Ethylene	C_2H_4	28.05	-154		48	742		0.97
Ethyl Ether	$C_4H_{10}O$				383	522		0.46
Fluorine	F_2	38.00	-305	300	-200	809	1.11	1.31
Helium	He	4.003	-454		-450	33	0.18	0.14
Hydrochloric Acid	HCL	36.47	-115				1.64	
Hydrogen	H_2	2.016	-422		-400	188	0.07	0.07
Hydrogen Chloride	HCL	36.47	-115	613	125	1198	0.86	1.26
Hydrogen Sulfide	H_2S	34.07	-76	252	213	1308	0.79	1.17
Isobutane	C_4H_{10}	58.12	11	72.2	274	529	0.56	2.01
Isopropyl Alcohol	C_3H_8O	60.09	180		455	779	0.78	2.08
Methane	CH_4	16.04	-258		-116	673	0.30	0.55
Methyl Chloride	CH_3CL	50.49	-11	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}	114.23	258	0.54 [1]	564	362	0.71	3.94
Oxygen	O_2	32.00	-297		-181	730	1.14	1.105
n-Pentane	C_5H_{12}	72.15	96	15 [1]	386	485	0.63	2.49
Phenol	$C_6H_5 \cdot OH$	94.11	358		786	889	1.07	
Phosphoric Acid	H_3PO_4	98.00	415				1.83	
Propane	C_3H_8	44.10	-44	190 [1]	206	617	0.51	1.52
Propylene	$CH_3CH:CH_2$	42.08	-54		198	661		0.61
Proplyl Alcohol	$CH_3CH_2CH_2OH$	60.09	208			735		0.80
Proplyl Chloride	$CH_3CH_2CH_2CL$	78.54	115			664		0.89
Refrigerant 11	CCL_3F	137.38	75	13.4	388	635		5.04
Refrigerant 12	CCL_2F_2	120.93	-22	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	[illegible]	706	3206.2	1.00	0.62

1. Vapor Pressure in PSIA @ 100°F
2. Specific Gravity @ 494.3°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
$K = C_p/C_v$

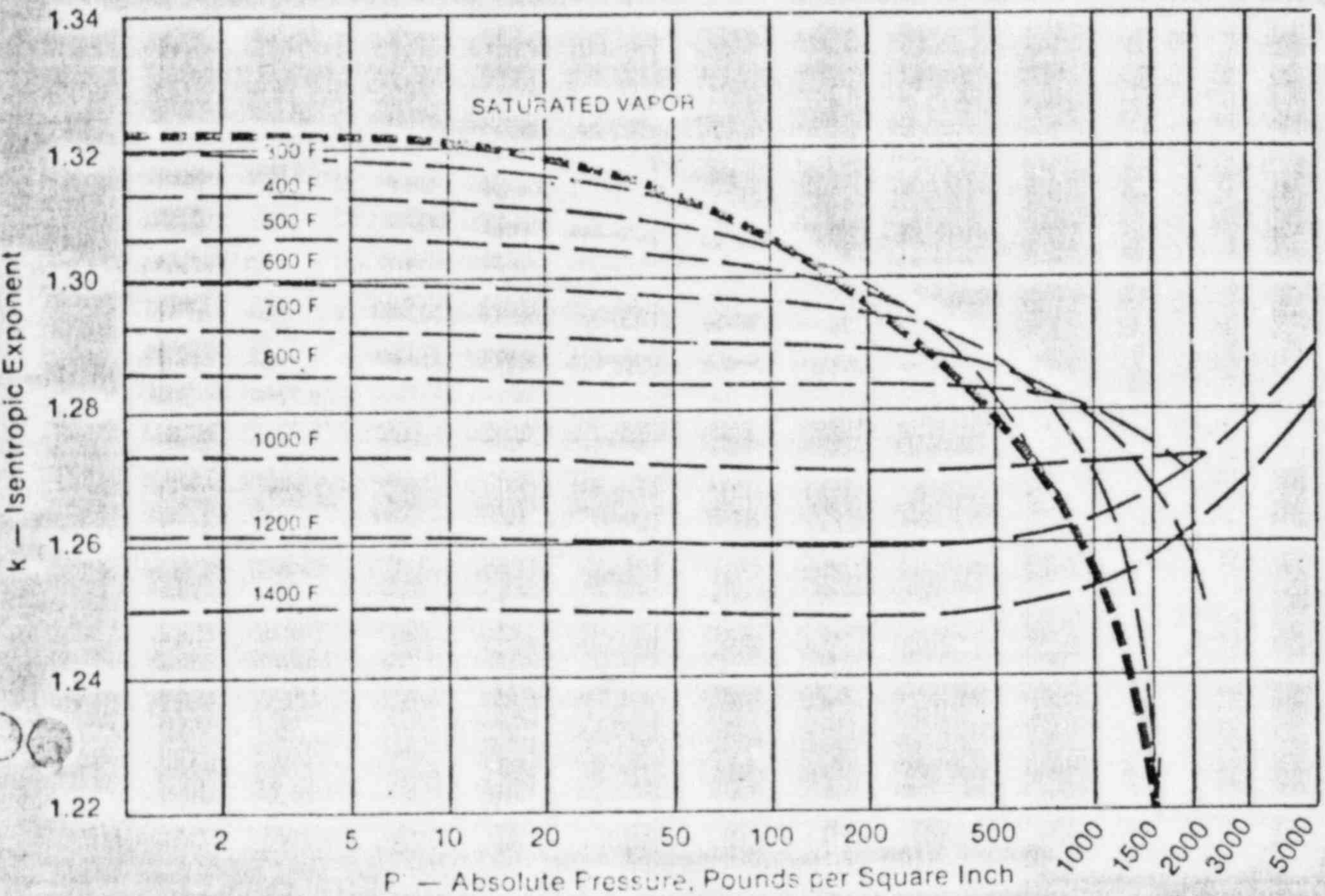


TABLE 2
VALUES OF K FOR VARIOUS GASES

Name of Gas	Chemical Formula or Symbol	K equal to C_p/C_v
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		

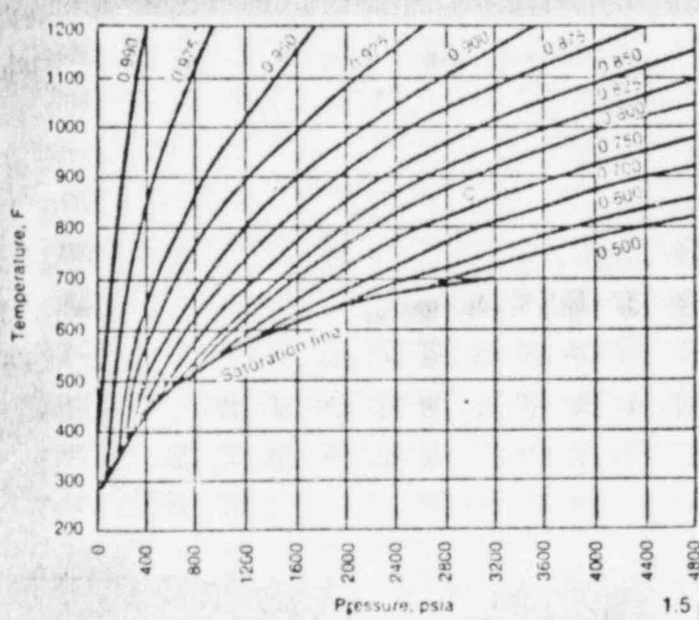


FIGURE 10
COMPRESSIBILITY FACTORS
FOR SUPERHEATED STEAM

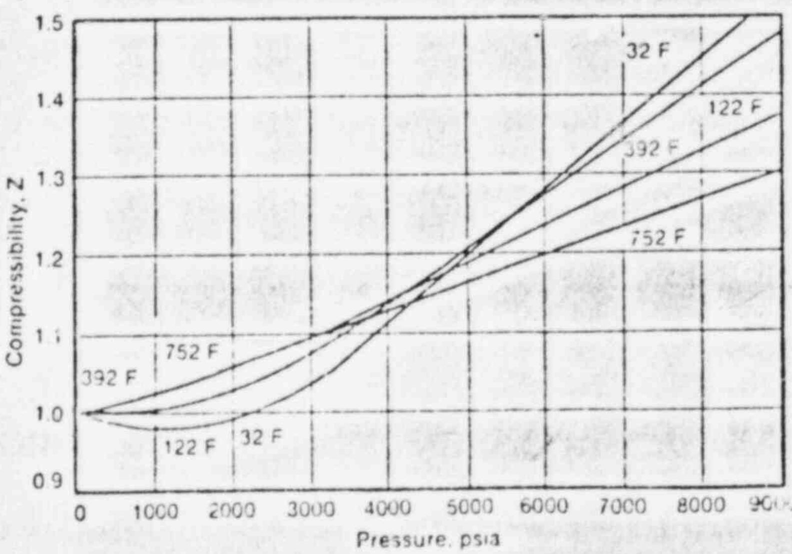


FIGURE 11
COMPRESSIBILITY FACTORS
FOR NITROGEN

PROPERTIES OF WATER AT VARIOUS TEMPERATURES

(Referred to Water at 68 F. Weighing 62.316 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	0.9821	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	2.8330
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	36.85	42.56	45.00	48.63	51.04	54.05	57.05	63.04	69.01	74.98	[illegible]	86.92	92.88	[illegible]
10	h	1146.6	1175.1	1193.9	1221.9	1240.6	1268.7	1287.5	1335.1	1383.4	1432.5	1482.4	1533.2	1585.0	1637.6
	s	1.7927	1.8341	1.8595	1.8950	1.9172	1.9488	1.9689	2.0160	2.0596	2.1002	2.1383	2.1744	2.2086	2.2413
	v		21.11	22.36	24.21	25.43	27.25	28.46	31.47	34.47	37.46	40.45	43.44	46.42	49.41
20	h		1172.2	1191.6	1220.3	1239.2	1267.6	1286.6	1334.4	1382.9	1432.1	1482.1	1533.0	1584.7	1637.4
	s		1.7545	1.7808	1.8170	1.8396	1.8716	1.8918	1.9392	1.9829	[illegible]	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	1.8363	1.8903	1.9219	1.9602	1.9964	2.0308	2.0635
	v				4.663	4.937	5.333	5.589	6.218	[illegible]	7.446	8.052	8.656	9.259	9.860
100	h				1205.7	1227.6	1258.8	1279.1	1329.1	1378.9	1423.9	1479.5	1530.8	1582.9	1635.7
	s				1.6258	1.6518	1.6869	1.7085	1.7581	[illegible]	[illegible]	1.8329	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						1.6038	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	2578	3178
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	79169	110835	142502	175928
66"	2951	9837	21642	37381	59023	88534	123940	159362	196743
72"	3867	12292	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	3681
14"	136	341	704	1204	1863	2681	3454	4045	4545
16"	169	422	873	1492	2309	3323	4280	5012	5632
18"	247	617	1276	2181	3374	4856	6255	7325	8230
20"	286	714	1476	2524	3906	5620	7240	8478	9526
24"	375	938	1939	3315	5129	7381	9508	11135	12511
30"	715	1788	3696	6319	9776	14068	18121	21221	23844
36"	1104	2760	5704	9752	15087	21711	27967	32751	36799
42"	1711	4279	8843	15118	23390	33659	43358	50774	57050
48"	1867	4667	9645	16490	25513	36713	47292	55381	62226

Table 10

FLOW COEFFICIENTS C_v

CLASS 600 STD. RATING

Valve Size	DEGREES OF DISC OPENING								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	5	16	31	51	84	122	151	169	182
4"	8	23	43	70	116	169	209	234	252
6"	26	78	147	242	397	579	717	803	864
8"	35	104	197	324	532	775	960	1076	1157
10"	62	185	350	576	947	1379	1709	1915	2059
12"	85	255	481	793	1302	1897	2350	2633	2831
14"	104	312	589	971	1595	2323	2876	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

For control valves watch for torque reversals in non-preferred direction

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

No less than 15° for control

CLASS 150 VALVES

FIGURE 12
2" THRU 6"

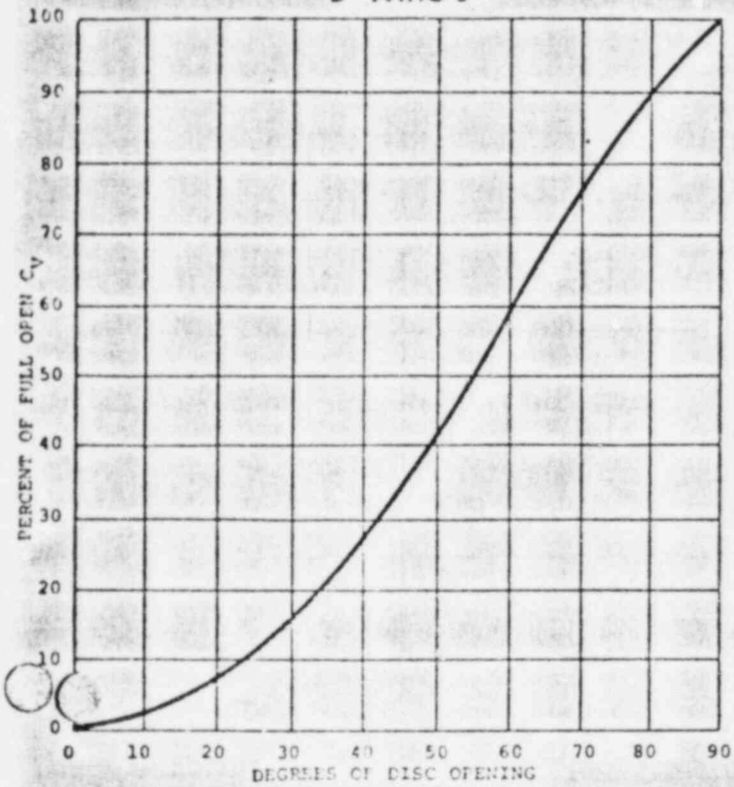


FIGURE 13
8" AND LARGER

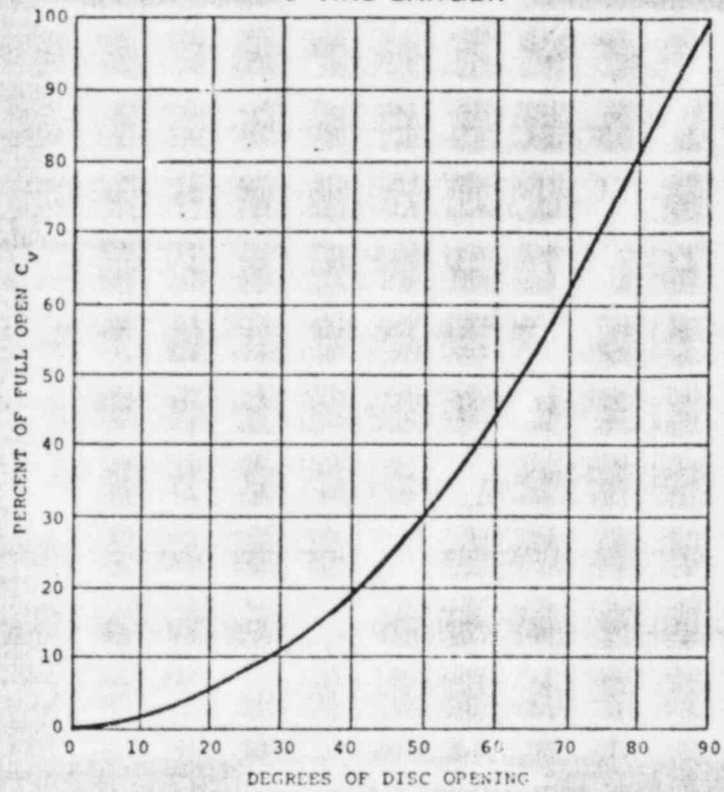


FIGURE 14
CLASS 300 VALVES
ALL SIZES

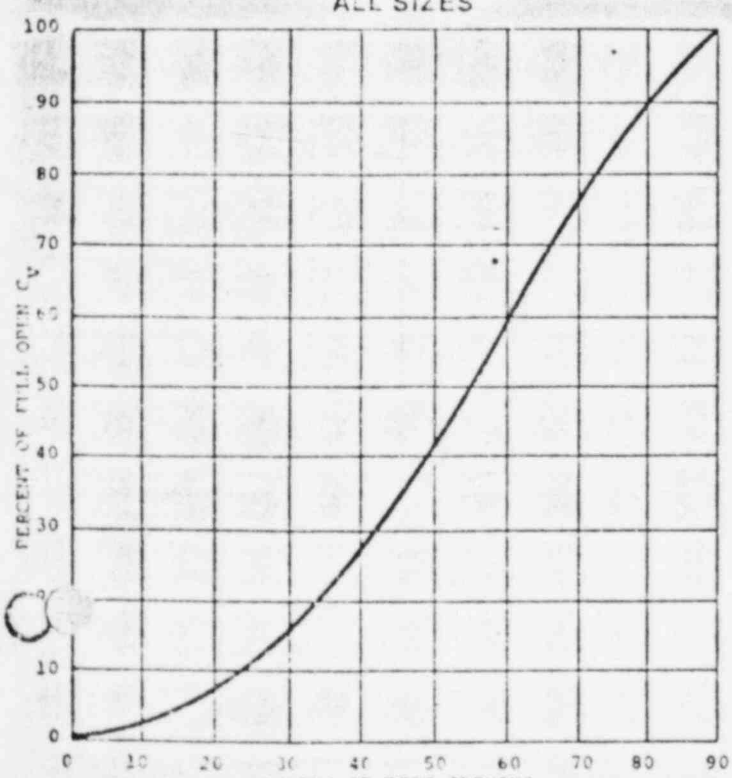
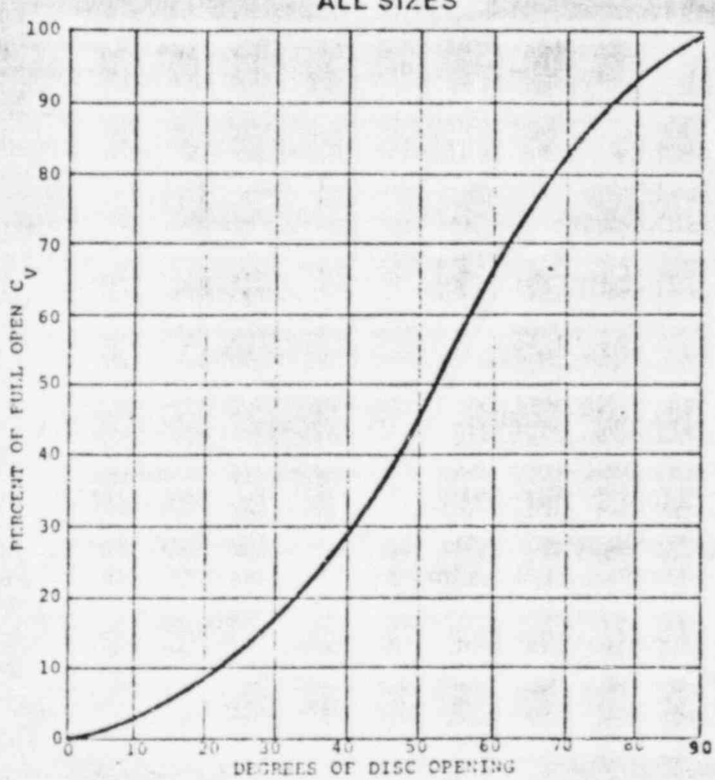


FIGURE 15
CLASS 600 VALVES
ALL SIZES



ENCLOSURE (3)

Derivation of Hydrodyramic Torque
Curves

HYDRODYNAMIC TORQUE

OF

HIGH PERFORMANCE TRUNNION VALVES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Where:

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

P - density of the fluid medium

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

V - velocity of fluid medium

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

All of the above testing pertains to liquid flow. An intense effort is presently underway at Posi-Seal to investigate the airodynamic Torques of high performance Trunnion Valves.

FIGURE No.: 1
SCHEMATIC
OF
HIGH PERFORMANCE TRUNION VALVE

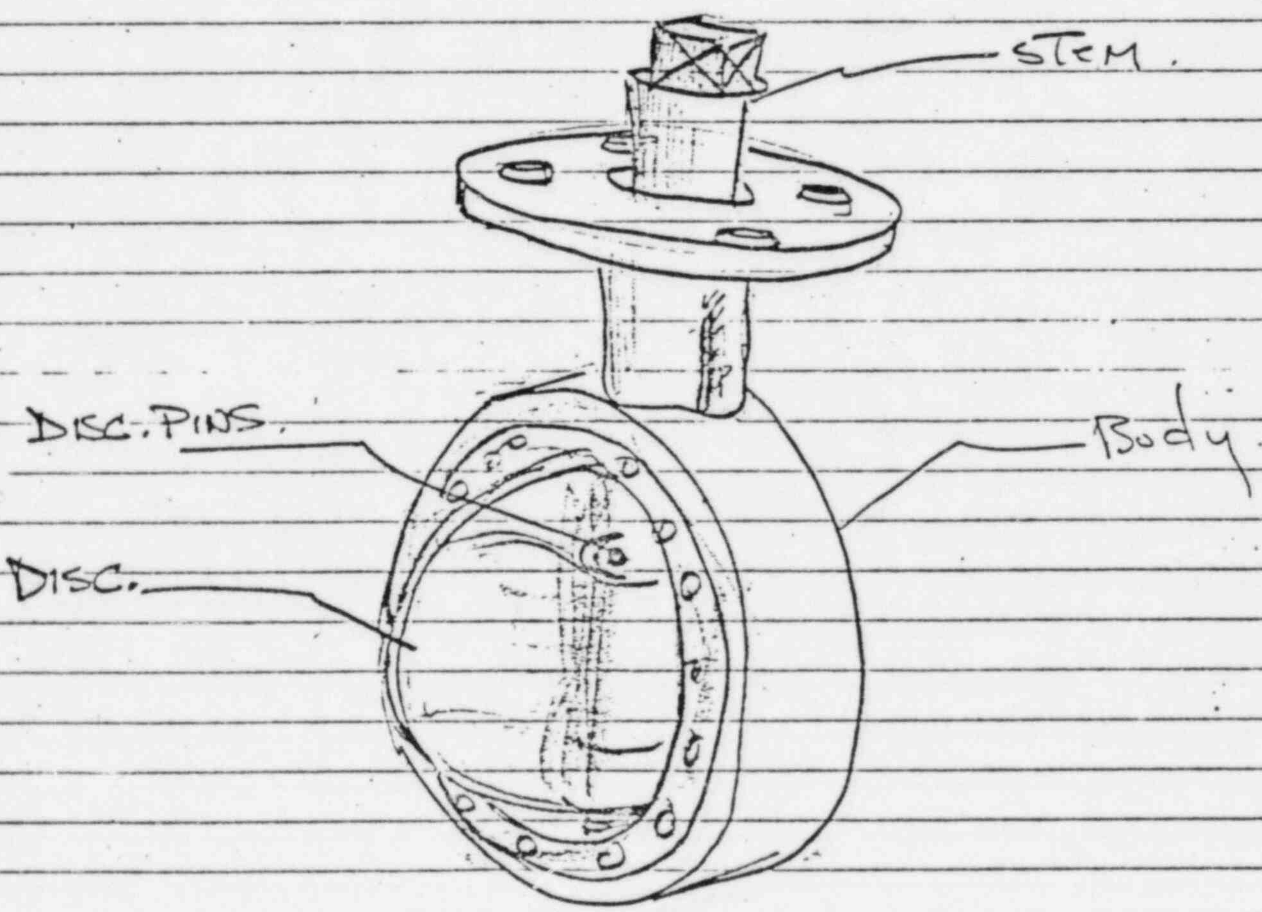
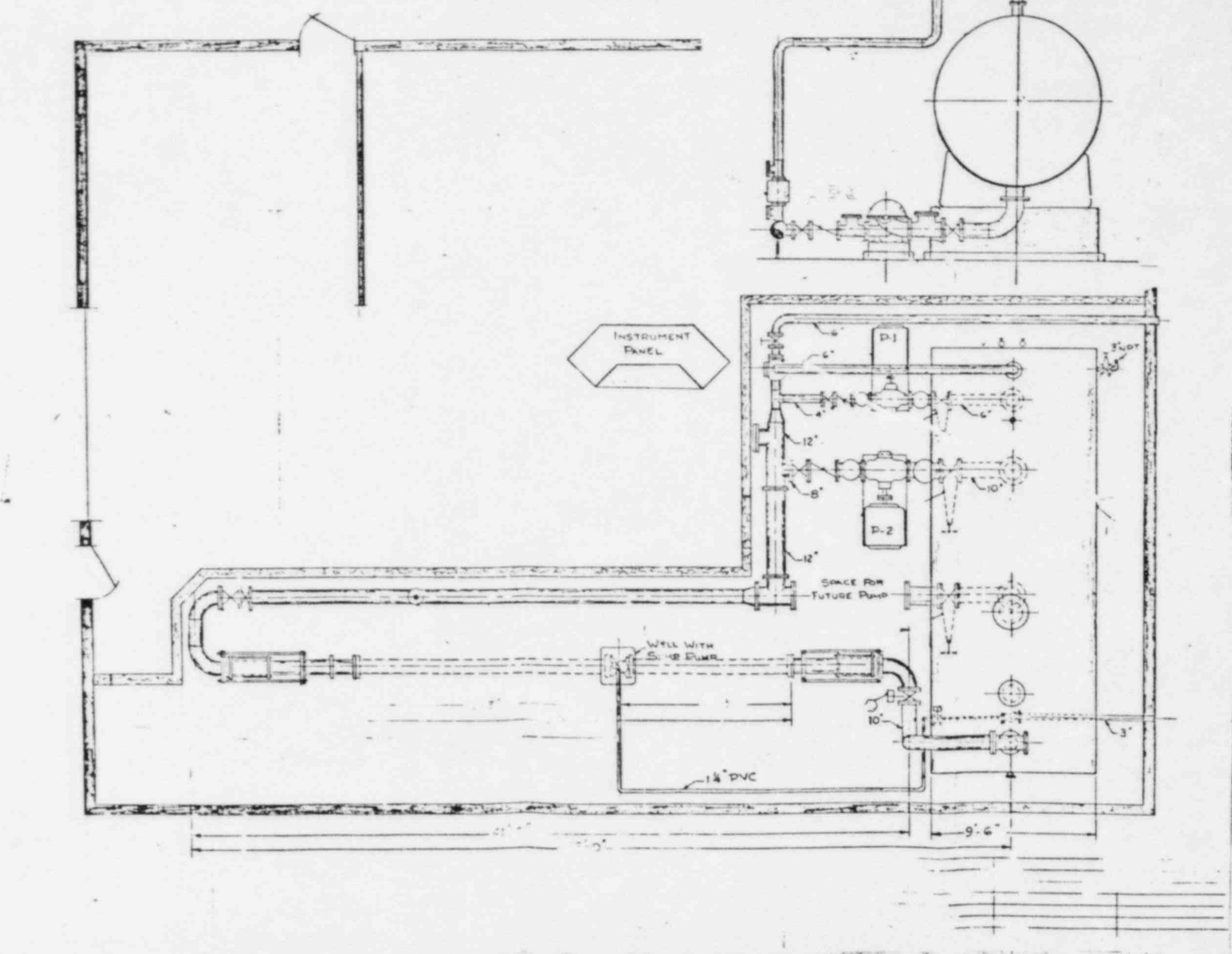
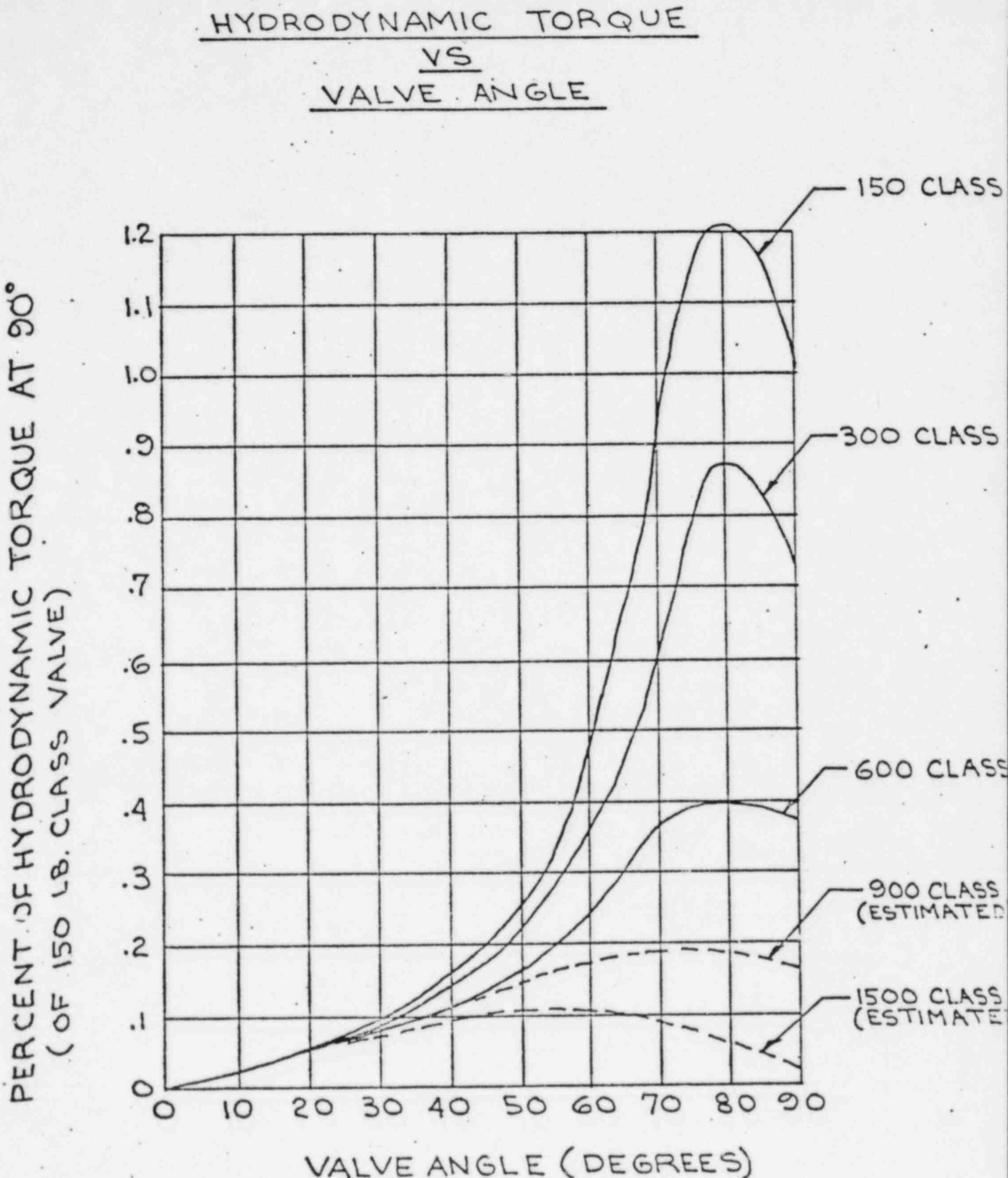


FIGURE NO. 2
SCHEMATIC OF POSI-SEAL
RESEARCH & DEVELOPMENT
LABORATORY



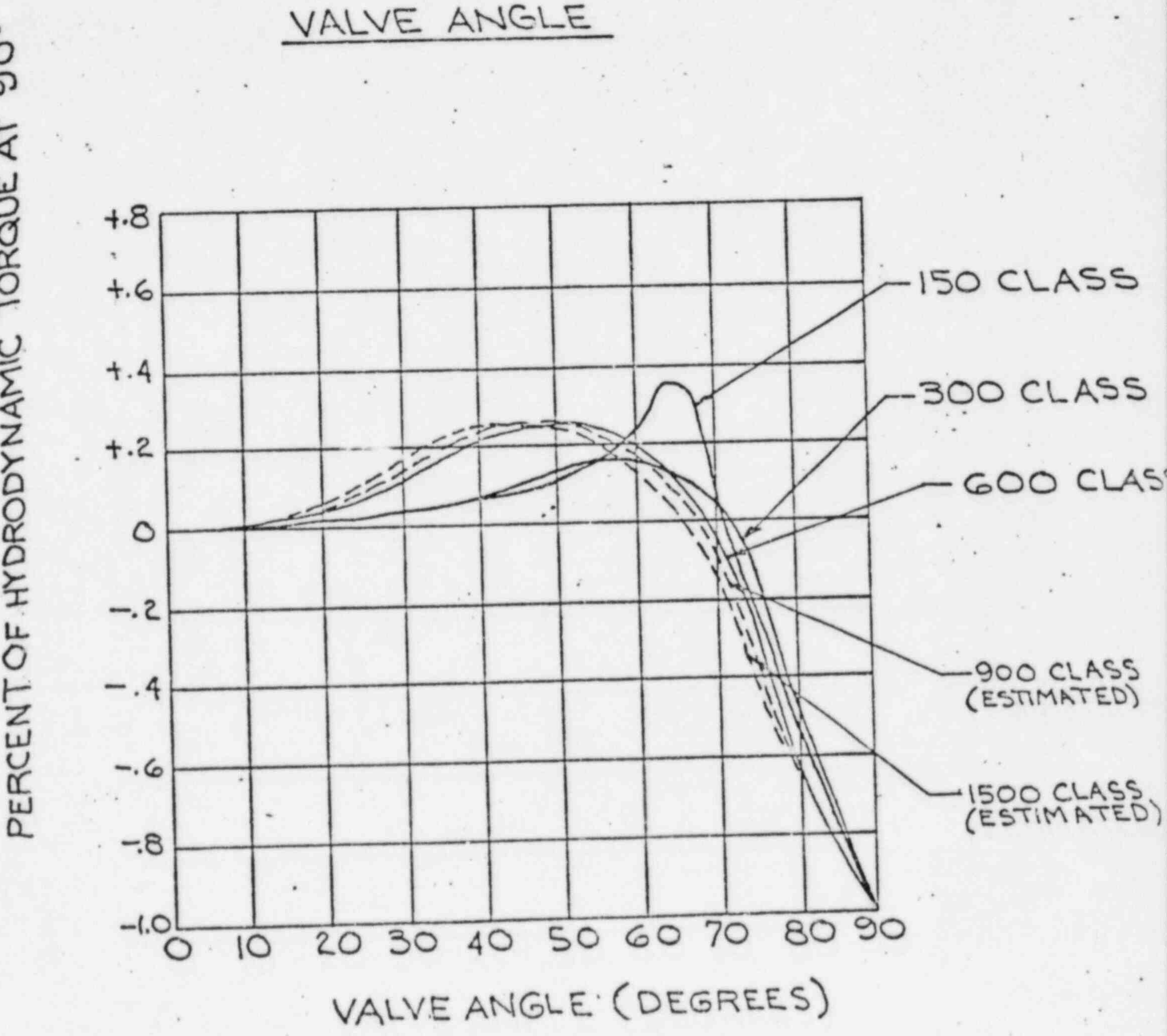


PREFERRED
DIRECTION

JANSEN

FIGURE No. 3

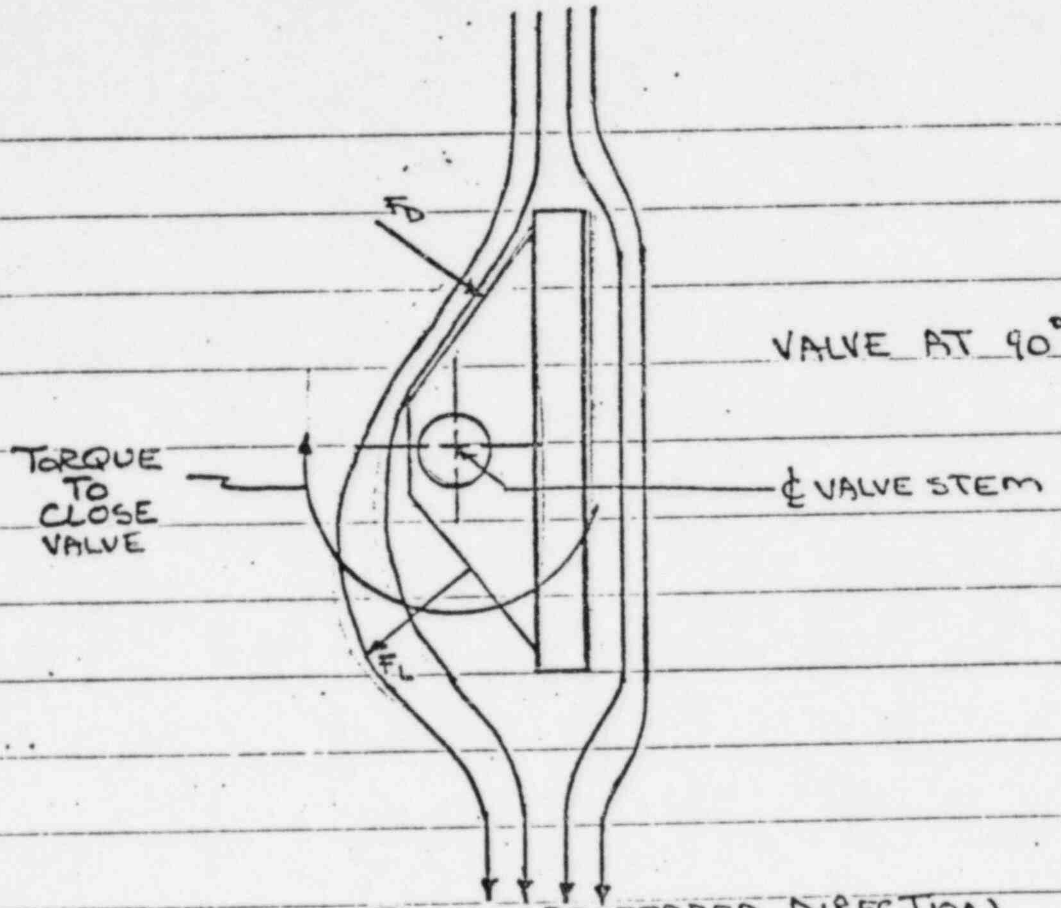
HYDRODYNAMIC TORQUE
VS
VALVE ANGLE



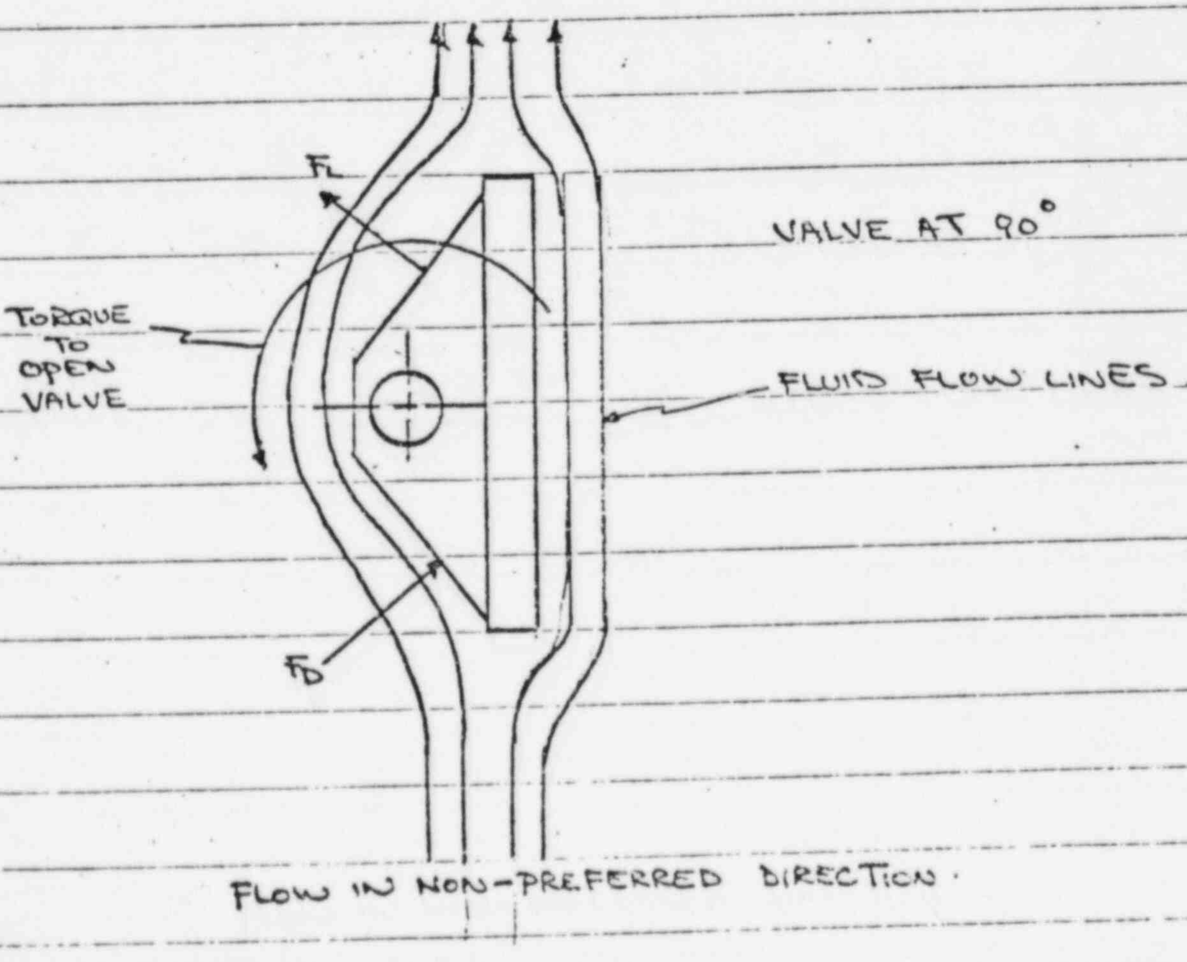
NON PREFERRED
DIRECTION

ØANSEN

FIGURE No.: 4

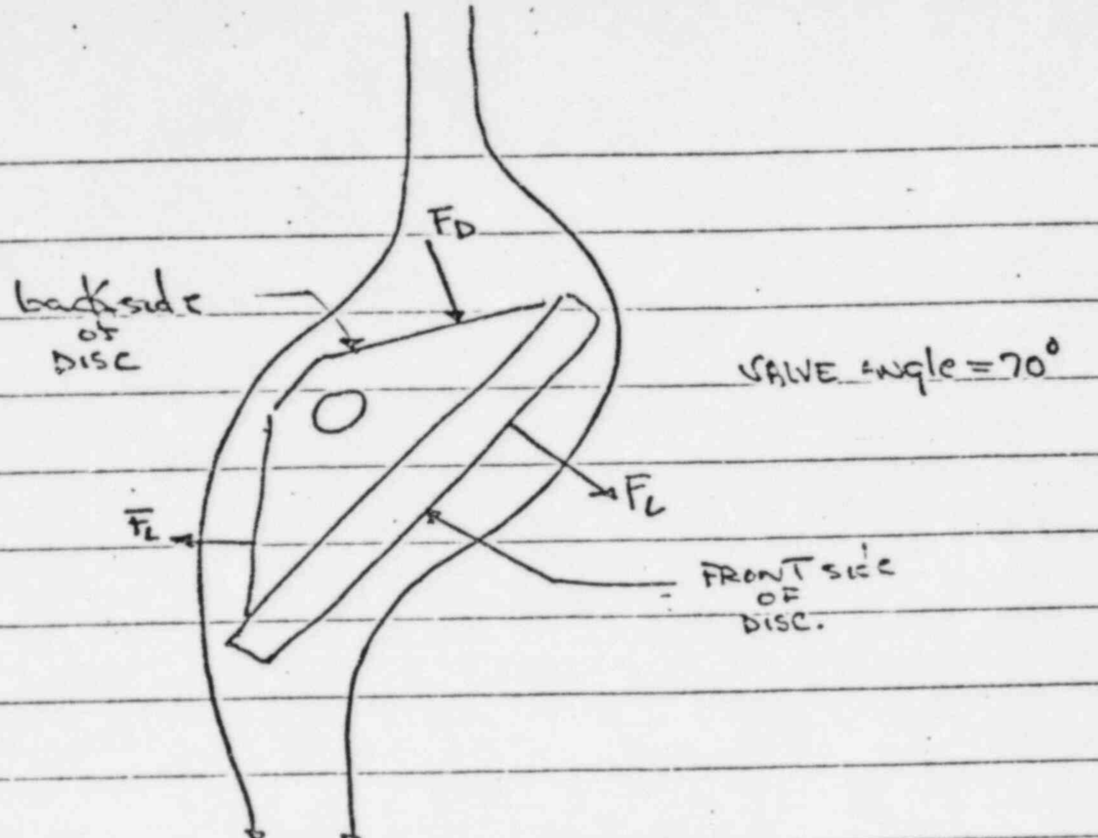


FLOW IN PREFERRED DIRECTION

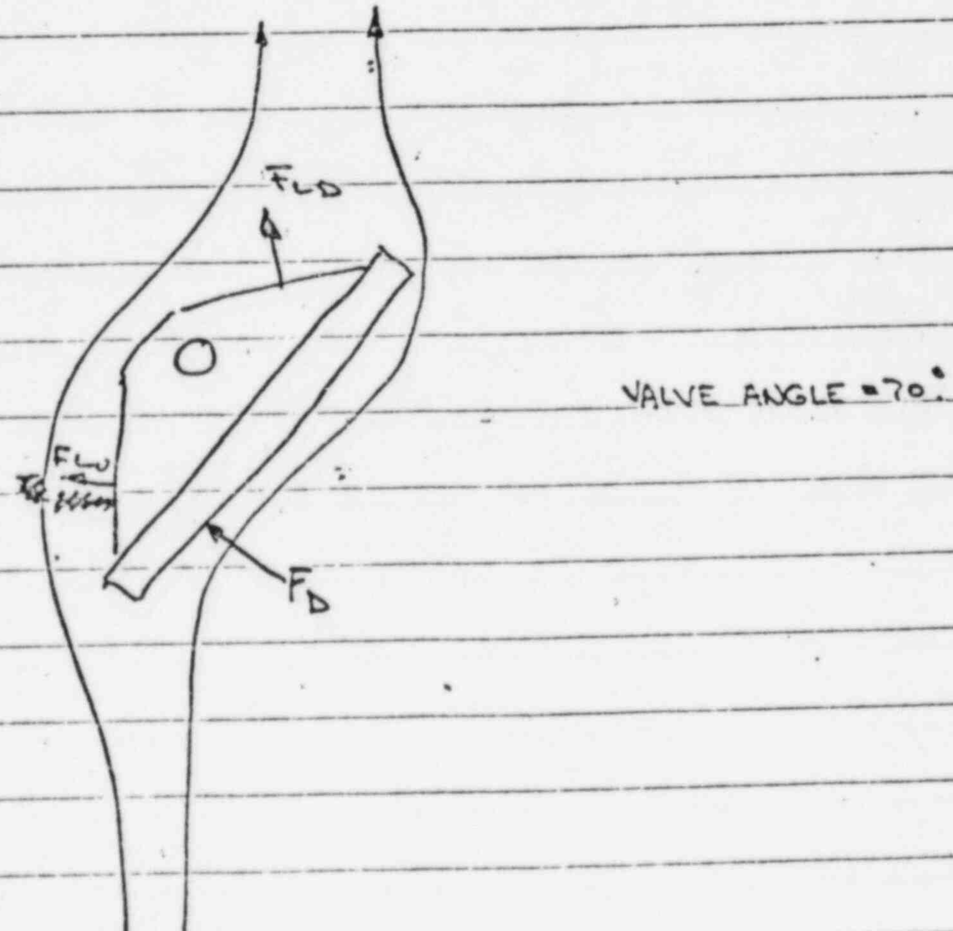


FLOW IN NON-PREFERRED DIRECTION.

FIGURE ___



FLOW IN PREFERRED DIRECTION.



FLOW IN NON-PREFERRED DIRECTION

Figure ____

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUES Page

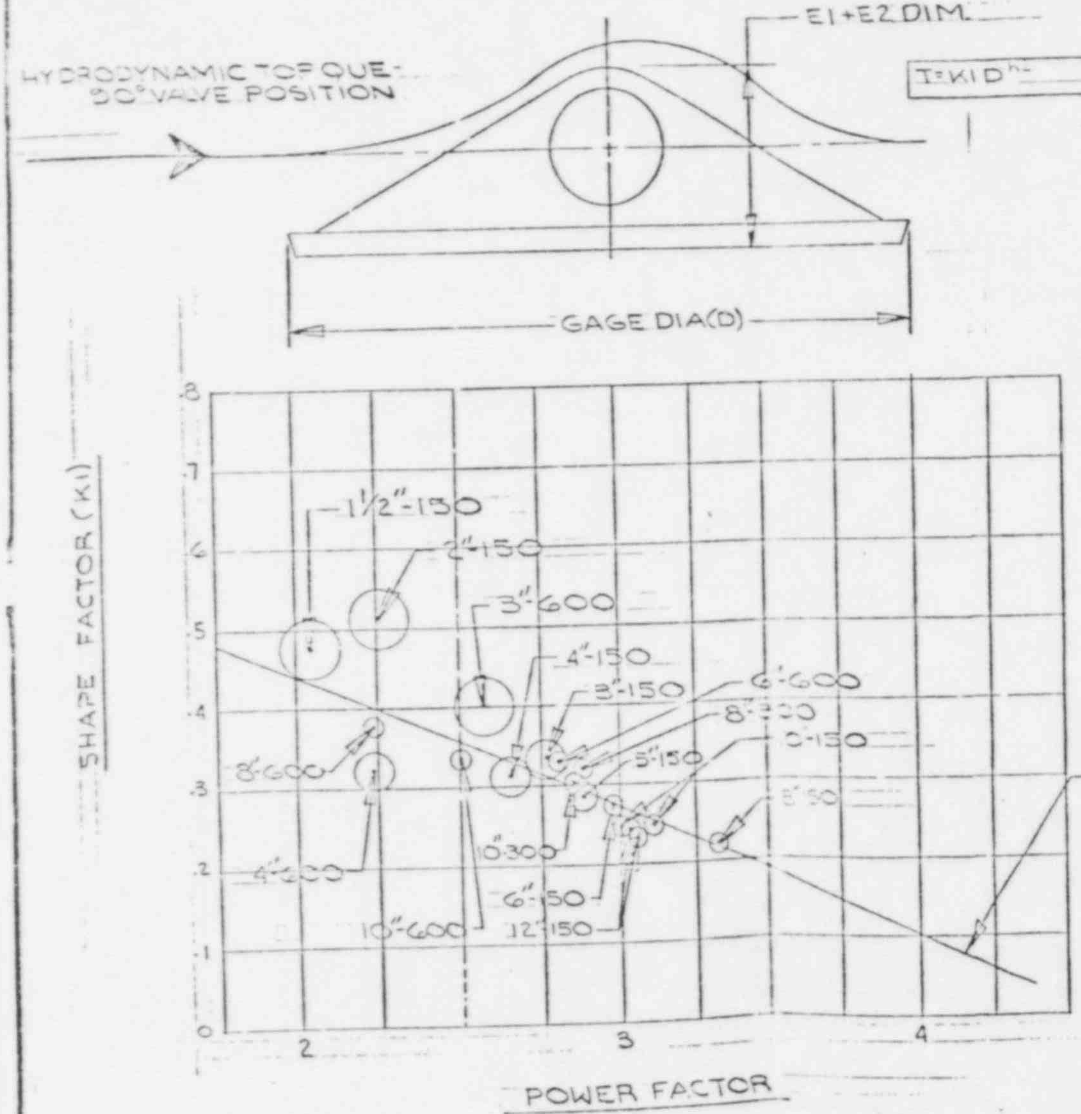
Calc. By PREFERRED DIRECTION Checked By ØANSEN 8/7/78

ANGLE	VALVE SIZE - % TORQUE @ 90°					
	10"-150 (2)	12"-150 (2)	8"-150	10"-150 (1)	12"-150 (1)	AVG.
90	(245) 1.0	(~~469~~)(333) 1.0	(214) 1.0	(317) 1.0	(350) 1.0	1.0 [1.
80	(312) 1.27	(425) ~~2.5~~ 1.28	(139) .65	(326) 1.03	(434) 1.24	1.21 [1.
70	(227) .93	(345) 1.04	(83) .39	(234) .74	(322) .92	.91 [.9
60	(122) .50	(186) .56	( )	(118) .37	(183) .52	.49 [.5
50	(59) .24	(104) .31	( )	(59) .18	(77) .22	.24 [.2
40	(30) .12	(87) .26	( )	(32) .10	(34) .10	.15 [.15
30	(16) .07	(33) .10	( )	(25) .08	(24) .07	.08 [.0
20	(9) .03	(26) .08	( )	(14) .04	(18) .05	.05 [.0
10	(3) .01	(11) .03	( )	(8) .02	( ) .03	.02 [.0

(8)

DELETE NOT GOOD DATA.

SHAPE FACTOR VS POWER FACTOR



$T = K1\,D^{K2}$

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

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

K2 = POWER FACTOR
$= B_0 + B_1\,K1$

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

OR: $K2 \quad \frac{LN[T/K1]}{LND}$

$B_0 = +4.6098$
$B_1 = -5.9150$
[PER LEAST SQUARES REGRESSION ANALYSIS]

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

FIGURE 7

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES. Page

Calc. By PREFERRED DIRECTION Checked By QHANSEN 8/8/78

ANGLE	VALVE SIZE - % TORQUE @ 90°					
	5"-150	6"-150	8"-300	10"-300	AVG (ALL)	AVG (EX. 10"s-0)
90	(28) 1.0	(54.62) 1.0	(95.45) 1.0	(180) 317 1.0	1.0	1.0 [1.0
80	(30) 1.07	(60.44) 1.11	(103.6) 1.08	(271.5) 1.5	1.19	1.09 [1.1
70	(18) .64	(41.15) .75	(77) .81	(205.5) 1.14	.84	.73 [.75
60	(9) .32	(27.64) .51	(39.2) .41	(141) .78	.505	.41 [.41
50	(5.2) .19	( ) X 45°	(30.3) .32	(79) .44	.32	.26 [.25
40	(3.35) .12	(8.54) .16	(18.1) .19	(39) .22	.17	.16 [.15
30	(2.05) .07	(6.32) .12	(9.6) .10	(22.5) .13	.11	.10 [.1
20	(1.115) .04	(4.35) .08	(4.35) .05	(13.5) .08	.06	.06 [.06
10	(-.465) -.02	(.88) .02	(3.5) .04	(4.5) .03	.02	.01 [.01

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

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES. Page

Calc. By: PREFERRED DIRECTION Checked By: ØANSEN 8/5/78

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

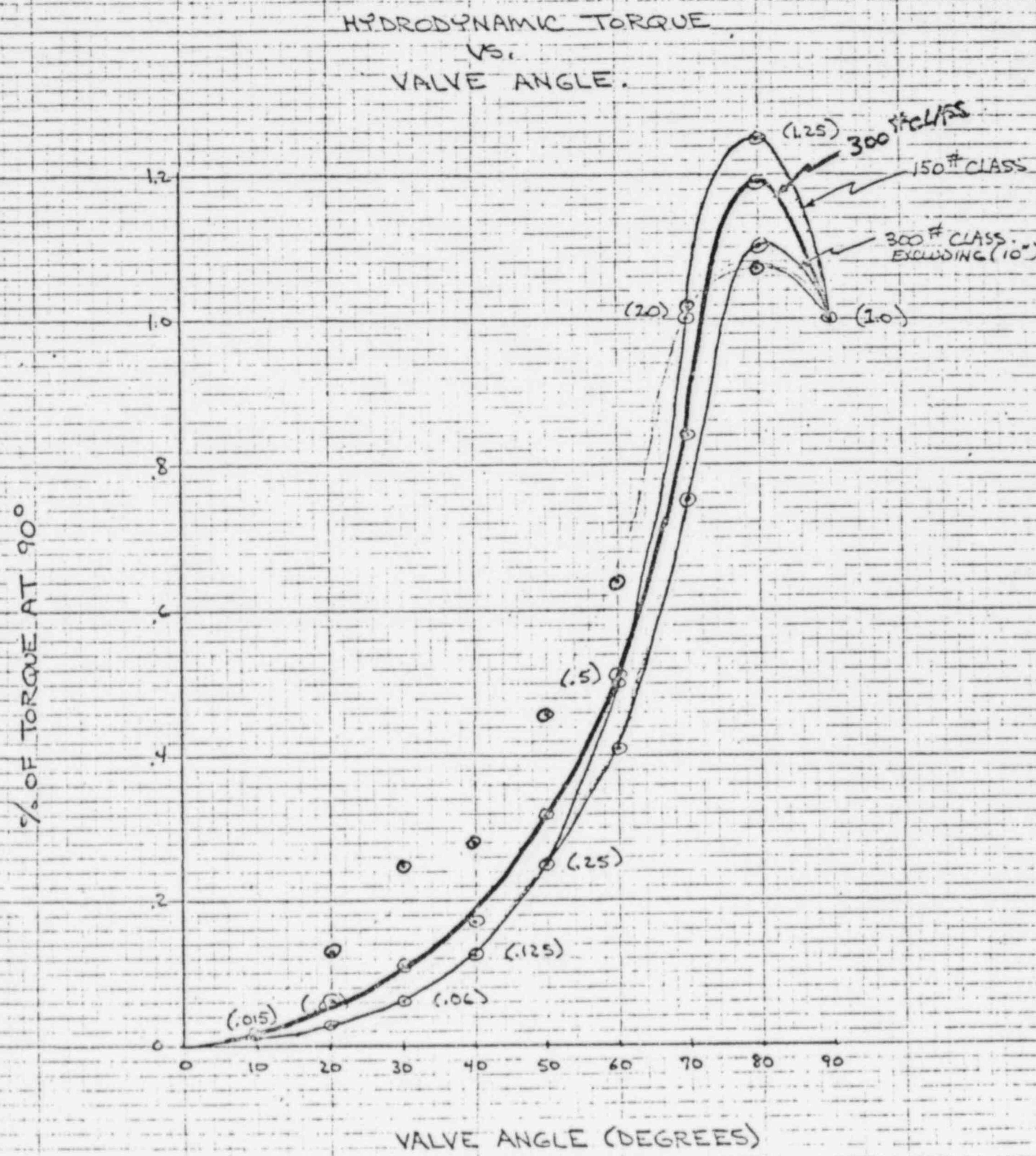
* BASED ON NO PREFERRED DIRECTION.

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title ______ Page ______

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



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUES Page

Calc. By NON-PREFFERRED DIRECTION Checked By ¢ANSEN 8/16/78

ANGLE	VALVE SIZE - % OF TORQUE AT 90°			
	6"-600	8"-600	10"-600	AVG.
90	-46.775 ~~-72.5~~ (-1.0)	-75 (-1.0)	-129.45 (-1.0)	(-1.0)
80	-20.57 ~~-357.5~~ (~~-.534~~ -.44)	-52.5 (-.7)	-101.2 (-.782)	-.641
70	+2.93 ~~+50~~ (~~+.069~~ +.063)	-8.25 (-.11)	+8.75 (+.068)	+.007
60	+11.936 ~~+250~~ (~~+.345~~ +.255)	+13.1 (+.175)	+28.75 (+.222)	+.217
50	+12.435 ~~+250~~ (~~+.345~~ +.266)	+17.1 (+.228)	+28.885 (+.223)	+.239
40	8 (+.171)	+18.05 (+.241)	+25.9 (+.2)	+.204
30	+.191 (+.004)	+14.65 (+.195)	+9.1 (+.070)	+.09
20	-3.1095 (-.066)	+13.9 (+.185)	+2.6 (+.02)	+.046
10	-2.212 (-.047)	+7.2 (+.095)	+1.15 (+.009)	+.021

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUES Page

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

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

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) ~~+.536~~ +.253		+.228
50	(+43.5) +.115	(+15.05) +.085	(+37) +.079		+.093
40	(+15.5) +.041	(+8.35) +.047	(+29) +.062		+.05
30	(+14) +.037	(+4.775) +.027	(+21.5) +.046		+.037
20	(+2) +.005	(+3.125) +.018	(+24) +.051		+.025
10	(0) +0	(+2.165) +.012	(+2) +.004		+.005

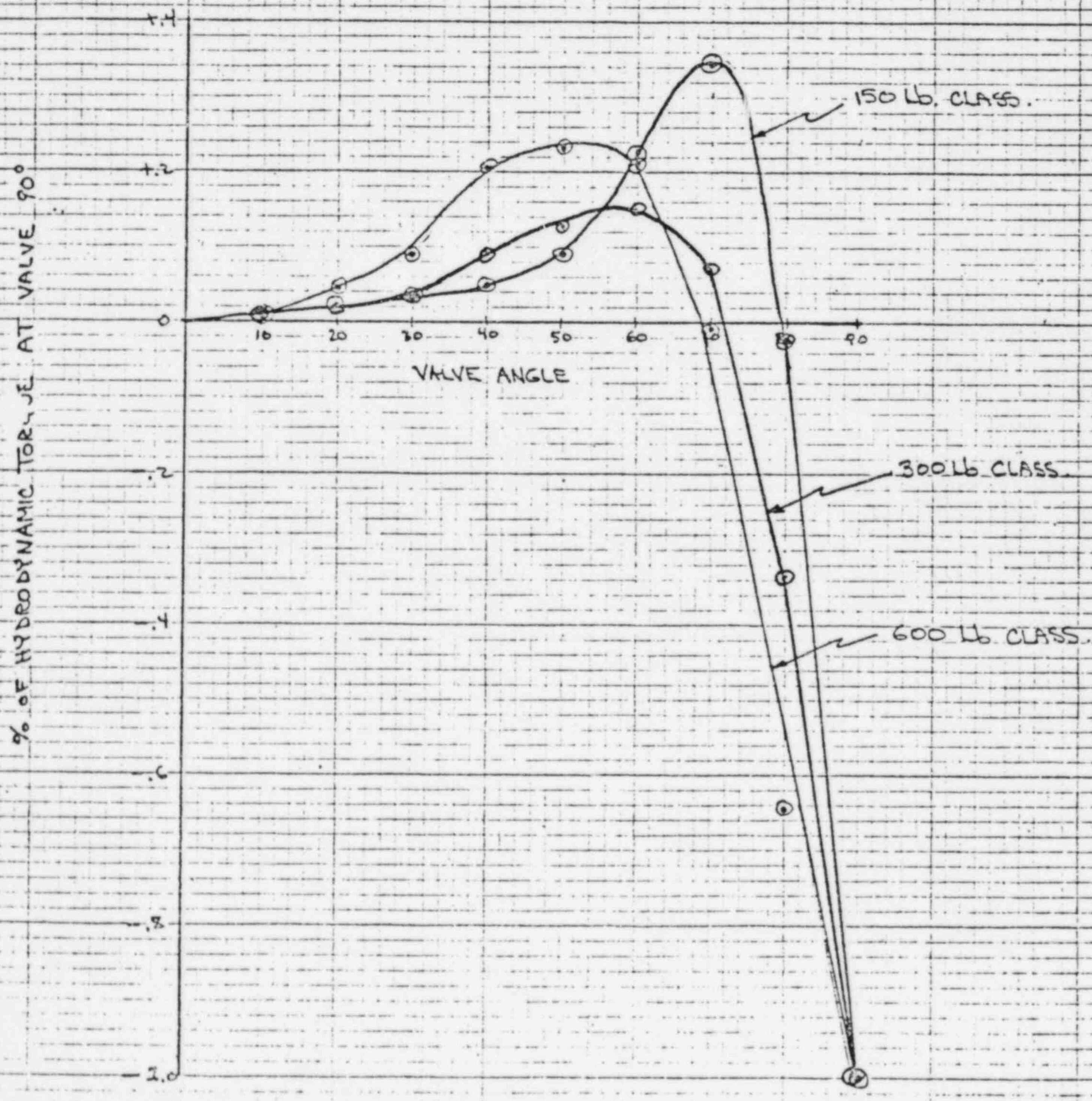
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title NON PREFERRED DIRECTION Page

Calc. By Checked By

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE



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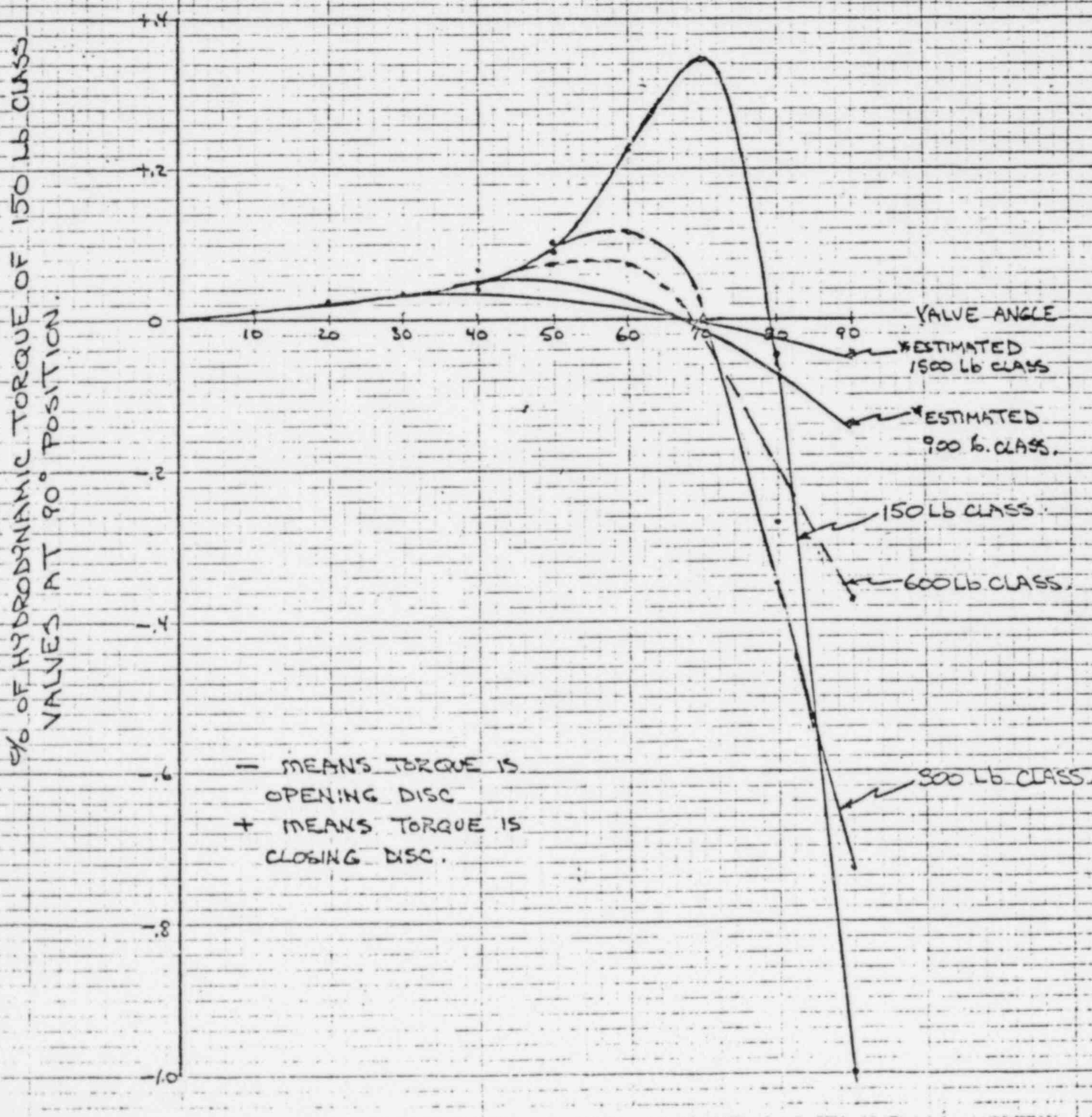
ENGINEERING CALCULATIONS

NON-PREFERRED DIRECTION Page

Calc. By Checked By

HYDRODYNAMIC TORQUE
VS.
VALVE ANGLE.



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE DETERMINATION Page ______

Calc. By Jansen 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	(in/#)/PSI
OPENING	0					
	10		42		+45	1.1
	20		41		+55	1.3
	30		39		+60	1.5
	40		36		+75	2.1
	50		33		+85	2.6
	60		31.5		+100	3.2
	70		27	27	+140 125	5.2
	80		22		+155	7.0
	90		19		+140	7.4
CLOSING	90		19		+120	6.7
	80		22		+140	6.4
	70		25	27	~~+145~~ 110	4.1
	60		34		+100	2.9
	50		42.5		+80	1.9
	40		40.5		+60	1.5
	30		42		+30	0.7
	20		45		+10	0.2
	10		46		0	0
	0					

PACKING TORQUE : +10 IN-LB OPENING

: +5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

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

VALVE SIZE : 150

VALVE DIRECTION: ~~STEM UPSTREAM~~ STEM DOWNSTR

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		43		+45
	20		41		+45
	30		38.5		+40
	40		36		+45
	50		32		+55
	60		35		+60
	70		25		0
	80		19		−75
	90		23		−90
CLOSING	90		23		−90
	80		18.5		−75
	70		21		−40
	60		27.5		−10
	50		36		+10
	40		28.5		0
	30		30.5		−15
	20		32		−15
	10		32		−15
	0				

PACKING TORQUE : 20 IN-LB OPENING

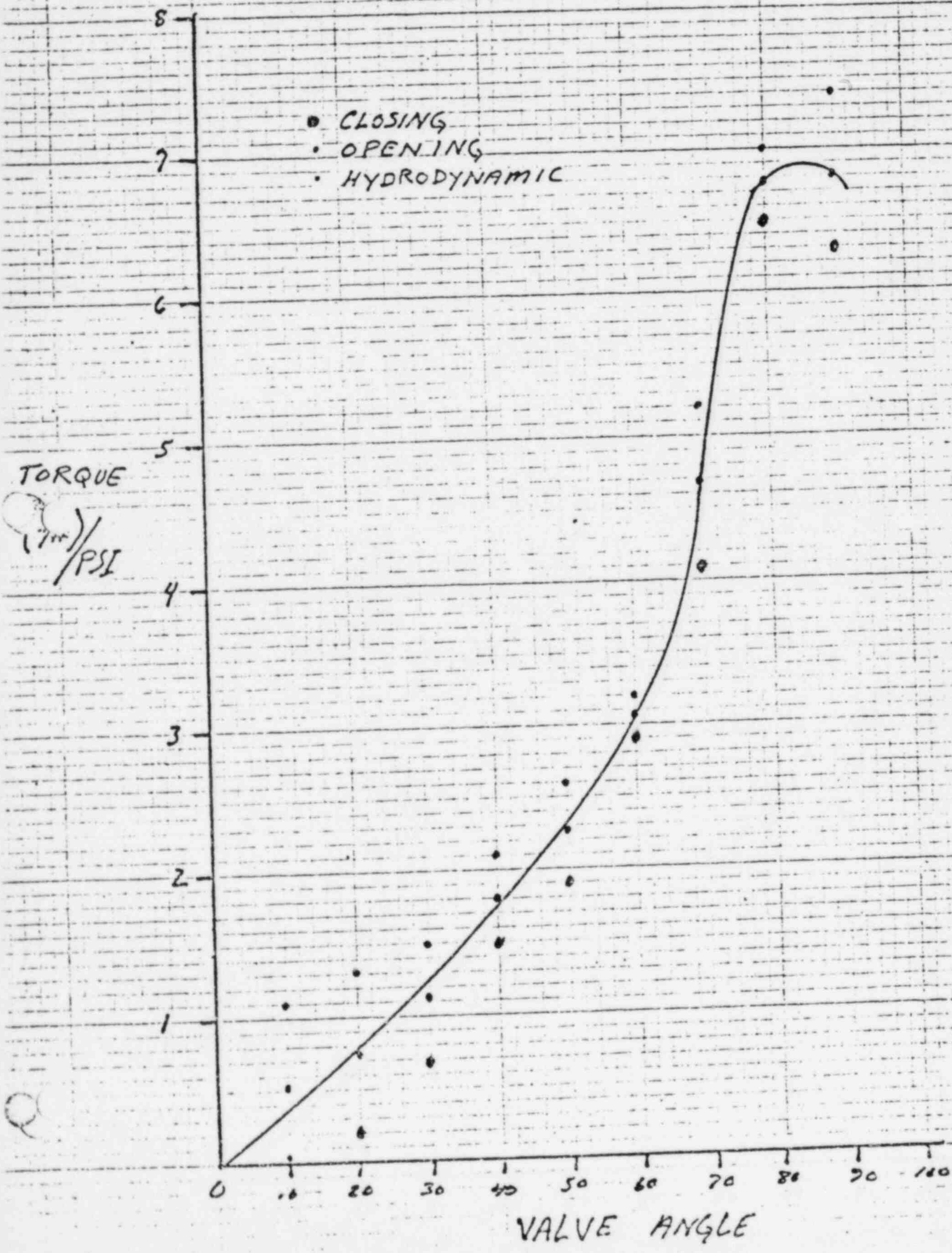
: 0 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

e 3-150LO HYDRODYNAMIC TORQUE CURVE Page

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



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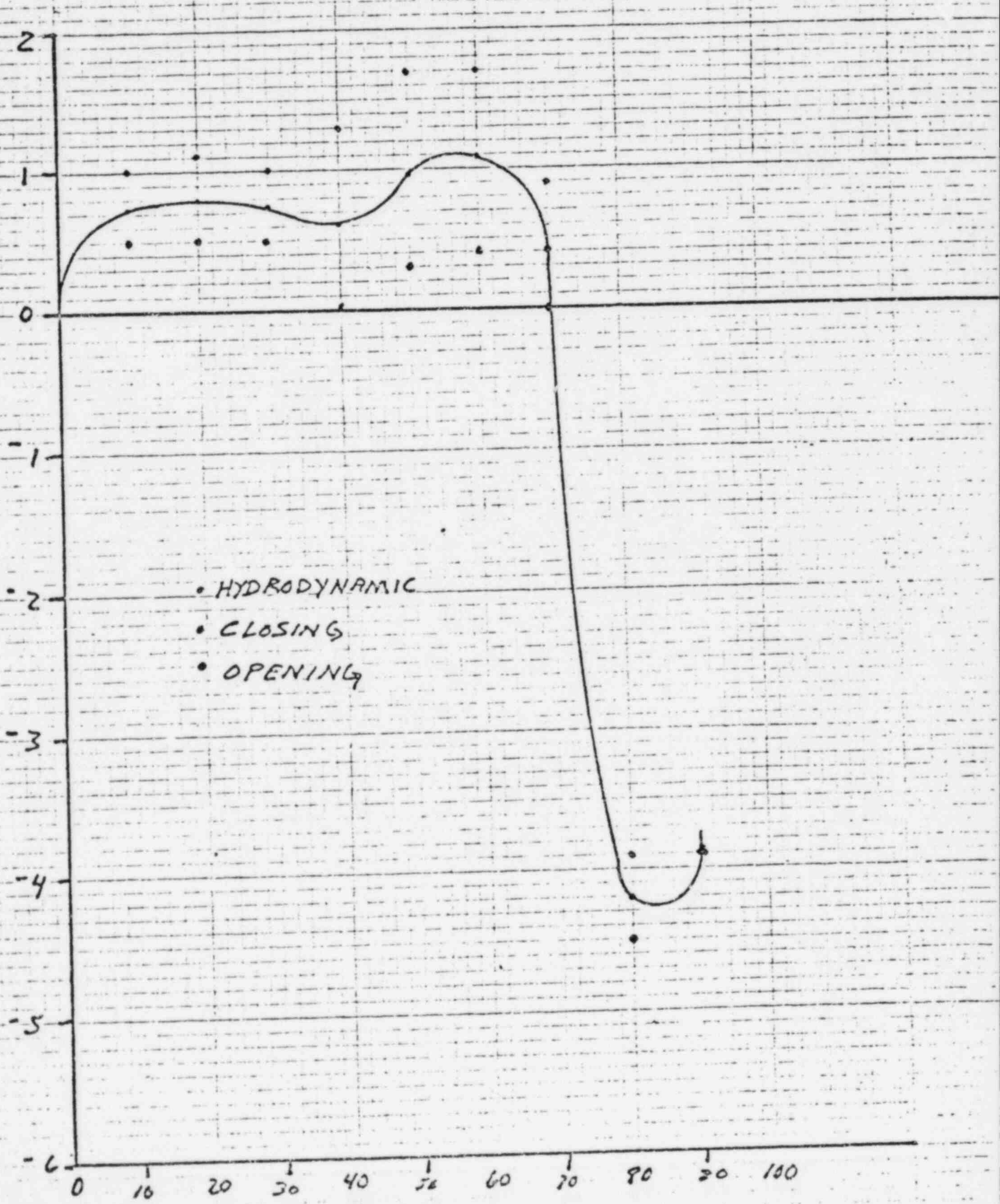
ENGINEERING CALCULATIONS

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

c. By [signature] DATE: 12/5/77 Checked By

VALVE SIZE : 4"-150

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

VALVE SEAL TYPE : TEFLON / BUNA

WATER TEMPERATURE (TANK) : 65 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		46.5		+50	1.07
	20		42.5		+75	1.76
	30		37		+75	2.03
	40		31		+75	2.42
	50		32		+100	3.12
	60		25.5		+125	4.90
	70		17.5		+140	8.00
	80		11.5		+150	13.04
	90		8.7		+125	14.37
			X		X	
CLOSING	90		8.5		+75	8.82
	80		11		+125	11.36
	70		16.5		+125	7.57
	60		27		+125	4.63
	50		31.5		+85	2.70
	40		35		+50	1.43
	30		36.3		+40	1.10
	20		37.8		0	0
	10		38.8		−60	−1.55
	0		X		X	

PACKING TORQUE : 5 IN-LB OPENING

: 5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 3

Calc. By Ray Marshall DATE: 11-17-77 Checked By

VALVE SIZE : 4"-150

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

VALVE SEAL TYPE : TEFLON/BUNA

WATER TEMPERATURE (TANK) : °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE – TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		30.5		~~+35~~ +40	1.3
	20		32		+40	1.
	30		30.5		+45	1.
	40		30.5		+60	1.
	50		35		+80	2.
	60		27		+50	1.
	70		18		+49	2.
	80		11		-10	-
	90		8.5		-55	-
			X		X	
CLOSING	90		8.7		-80	-
	80		11		-30	-2
	70		17.5		0	
	60		27		+15	.5
	50		35		+45	1.
	40		43.5		+25	.
	30		29.5		+10	.
	20		27		-5	.
	10		28		0	
	0		X		X	

PACKING TORQUE : 10 IN-LB OPENING

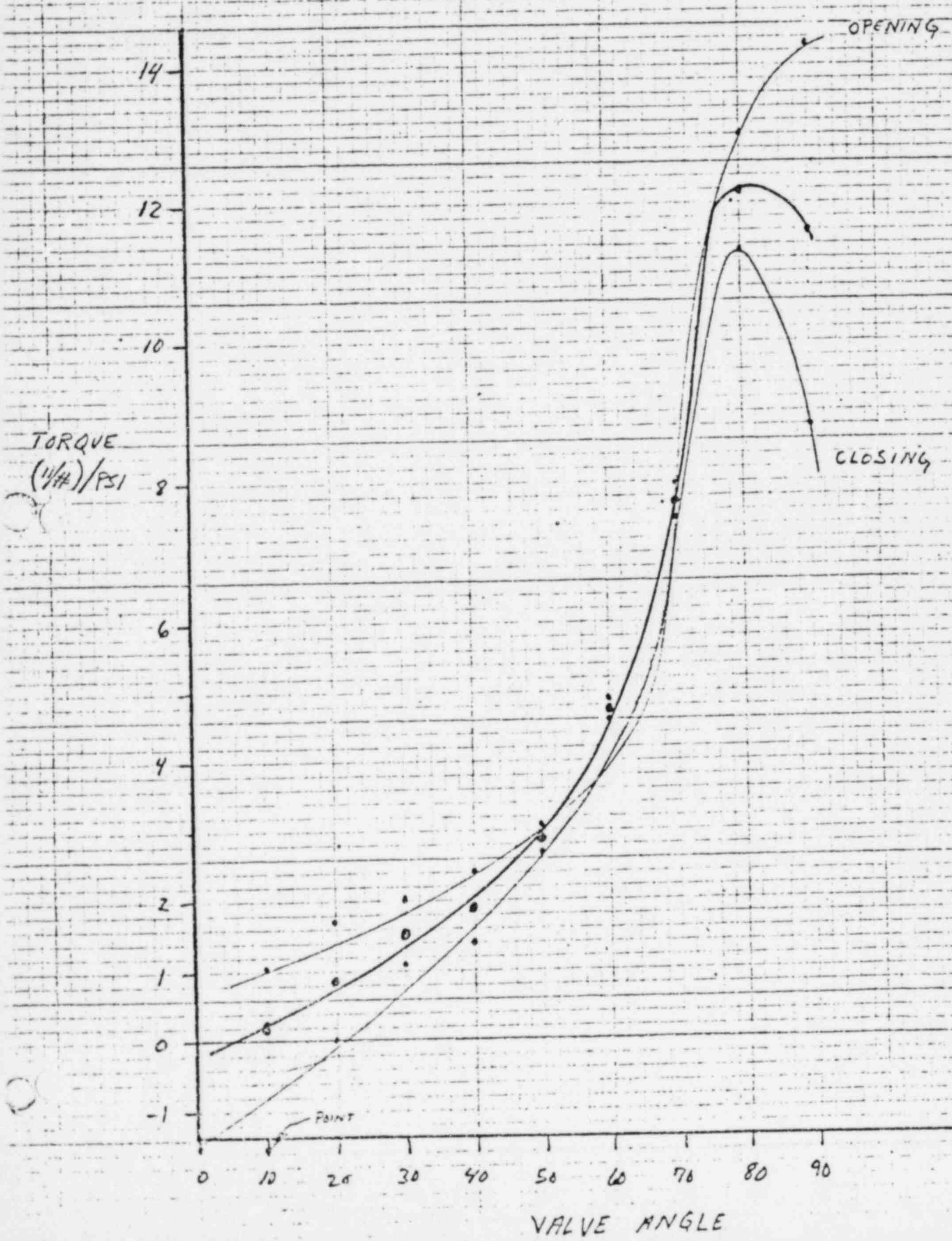
: 5 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: 4" 150LB HYDRODYNAMIC TORQUE CURVE (STEM UPSTREAM) Page ______

Calc. By: C. LIVORSI Checked By: ______

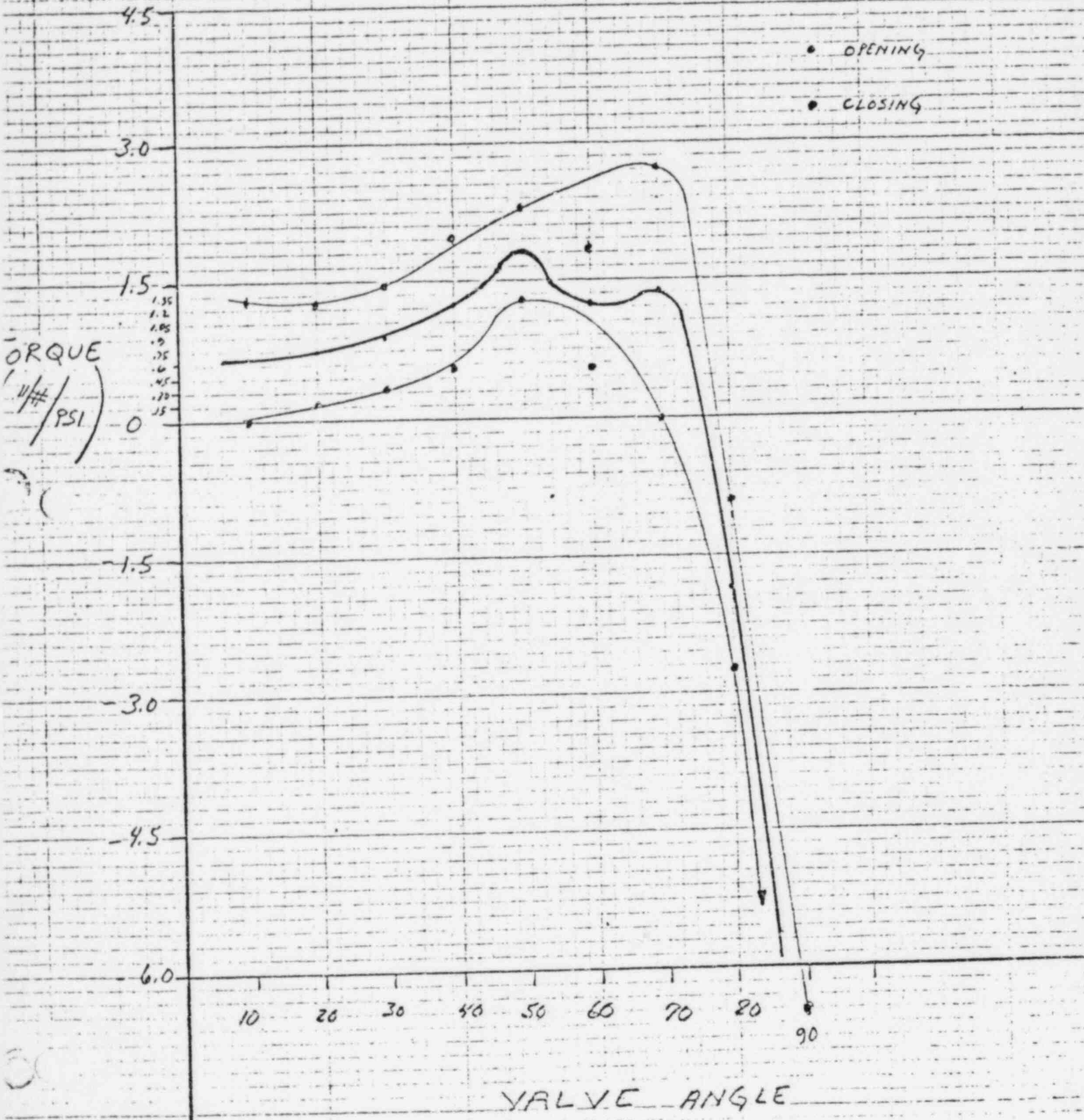


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 4" 150LB HYDRODYNAMIC TORQUE CURVE Page 2 of

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



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By J CORY DATE: Checked By

CONST. UPSTREAM PRESS.

VALVE SIZE : 6" - 150 - 300

VALVE DIRECTION : STEM UPSTREAM / ~~STEM DOWNS~~

VALVE SEAL TYPE : TEF / BUNA

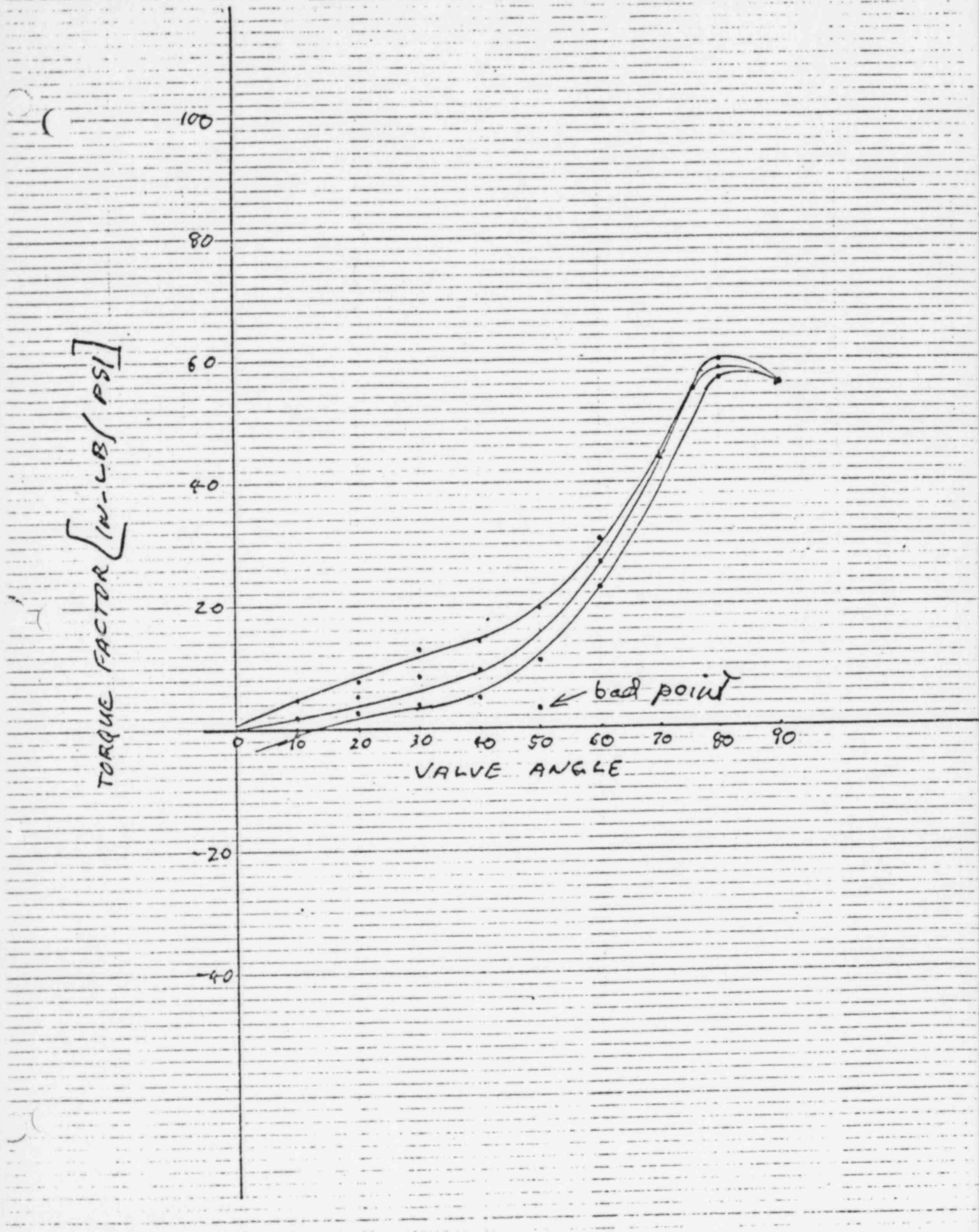
WATER TEMPERATURE (TANK) : 37 °F

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
	20	18.6	14		0
	30	18.6	13.5 ~~13~~		~~55~~ 50
	40	18.1	13.8		70
	~~50~~ 45	18.7	15		100
	60	18.7	14		300
	70	18.5	12.5		500
	80	18.3	11.5		700
	90	18.4	11		600
OPENING ~~CLOSING~~	90	18.6	12.8		700
	80	18.4	12.5		750
	70	18.4	13 12.8		550 700
	60	18.4	13		440
	~~50~~ 45	19	15		300
	40	18.4	12.5		150
	30	18.4	14		125
	20	18.3	11.5		100
	10	18.1	13.6		80
	0				

PACKING TORQUE : IN-LB OPENING

: IN-LB CLOSING


TORQUE FACTOR [IN-LB / PSI]
100
80
60
40
20
-20
-40
0
10
20
30
40
50
60
70
80
90
VALVE ANGLE
bad point

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By DATE: Checked By

VALVE SIZE : 6" - 150 - 300

VALVE DIRECTION : STEM UPSTREAM / STEM DOWNSTREAM

VALVE SEAL TYPE : TEFLON / BUNA

WATER TEMPERATURE (TANK) : 86 °F

DISC TYPE & DWG : 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0					
	10		38.5		180	
	20		19		150	
	30		6.2		80	
	40		7.8		110	
	50		8.2		160	19.5
	60		6.5 23		200 540	34.8
	70		8.75 15		400 650	45.7
	80		8.5 11.2		530 650	62.3
	90		9.1 8.5		500 500	54.9
CLOSING	90		9.1 8.5		510 500	
	80		11.5 11		700 600	60.8
	70		16.7 16.2		730 750	43.7
	60		14.5	22.6	350 520	24.1
	50		14.5		150	3.4
	40		12.5		60	
	30		15		60	
	20		34		90	
	10		50.5		−25	
	0					

PACKING TORQUE : IN-LB OPENING

: IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By R. ΦANSEN DATE: 9/20/77 Checked By

VALVE SIZE : 6" - 150/300

VALVE DIRECTION : ~~[illegible]~~ / STEM DOWNSTR

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	[illegible]
OPENING	0		X		X	
	10		44.5		+175	3
	20		30.0		+75	2
	30		11		+75	[illegible]
	40		11		+90	[illegible]
	50		10.2		+45	[illegible]
	60		9.7		+45	[illegible]
	70		5.7		+15 2.6	75
	80		9.2		−275	−
	90		8.4		−550	−
			X		X	
CLOSING	90		8.5		−550	−[illegible]
	80		9.0		−260	−
	70		~~22.5~~		~~+200~~	0'
	60		23.5		+200	[illegible]
	50		22.5		+85	[illegible]
	40		18.5		−15	−
	30		19.0		−5	−
	20		31.5		−110	−3
	10		28.5		−150	−5
	0		X		X	

PACKING TORQUE : 10 IN-LB OPENING

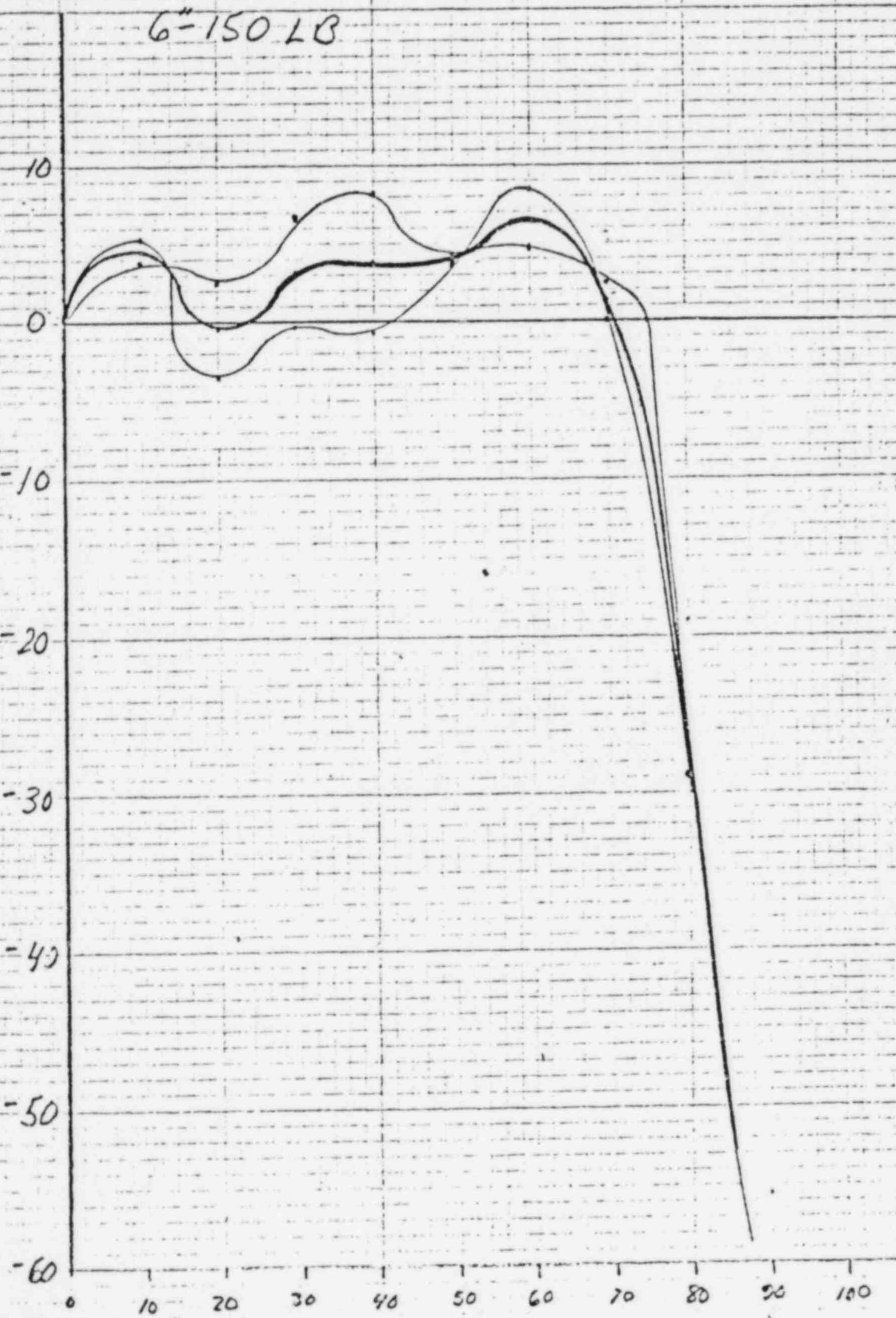
: 10 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE Page

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



Title *HYDRODYNAMIC TORQUE DETERMINATION* Page *5*

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

VALVE SIZE : 8" - 150LB

VALVE DIRECTION : STEM UPSTREAM

VALVE SEAL TYPE :

WATER TEMPERATURE (TANK) : 71 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE — TENDING TO OPEN IN-LB	(
OPENING	0	69.5	65.		400	
	10		59.5		100	1
	20		56		425	7
	30		51.5		550	1
	40		43		725	1
	50		31		775	2
	60		18		740	4
	70		8.5		700	9
	80		4.5		650	1
	90		2.5		600	2
CLOSING	90		2.0		375	1
	80		3.0		400	1
	70		6.0		500	4
	60		12.5		550	
	50		26.5		575	
	40		38.5	37 400	400	
	30		37.5	47 350	300	
	20		41.5	54 400	300	
	10		54.5		100	
	0				375	

PACKING TORQUE : 160 IN-LB OPENING

: 80 IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION Page 6

Calc. By C. Lirorsi DATE: Checked By

both pumps

VALVE SIZE : 8" - 150

VALVE DIRECTION : ~~[illegible]~~ / STEM DOWNST

VALVE SEAL TYPE :

WATER TEMPERATURE (TANK) : 70 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				900 '/#
	10		58		350
	20		56		350
	30		51		375
	40		40		415
	50		28.5		450
	60		15		460
	70		7.5	ΔP @ 75° = 8.5	450
	80		5.3	T @ 75° = 600	410
	90		2.6	ΔP @ 85° = 4.5	450
				T @ 85° = 0	
CLOSING	90		3.0		550
	80		3.0	ΔP @ 85° = 2.5	0
	70		7.5	T @ 85° = -300	500
	60		16	ΔP @ 75° = 5.5	550
	50		28	T @ 75° = 375	400
	40		39.5		250
	30		46		100
	20		54.5		0
	10		58		100
	0				900 '/#

PACKING TORQUE : 150 IN-LB OPENING
: 100 IN-LB CLOSING

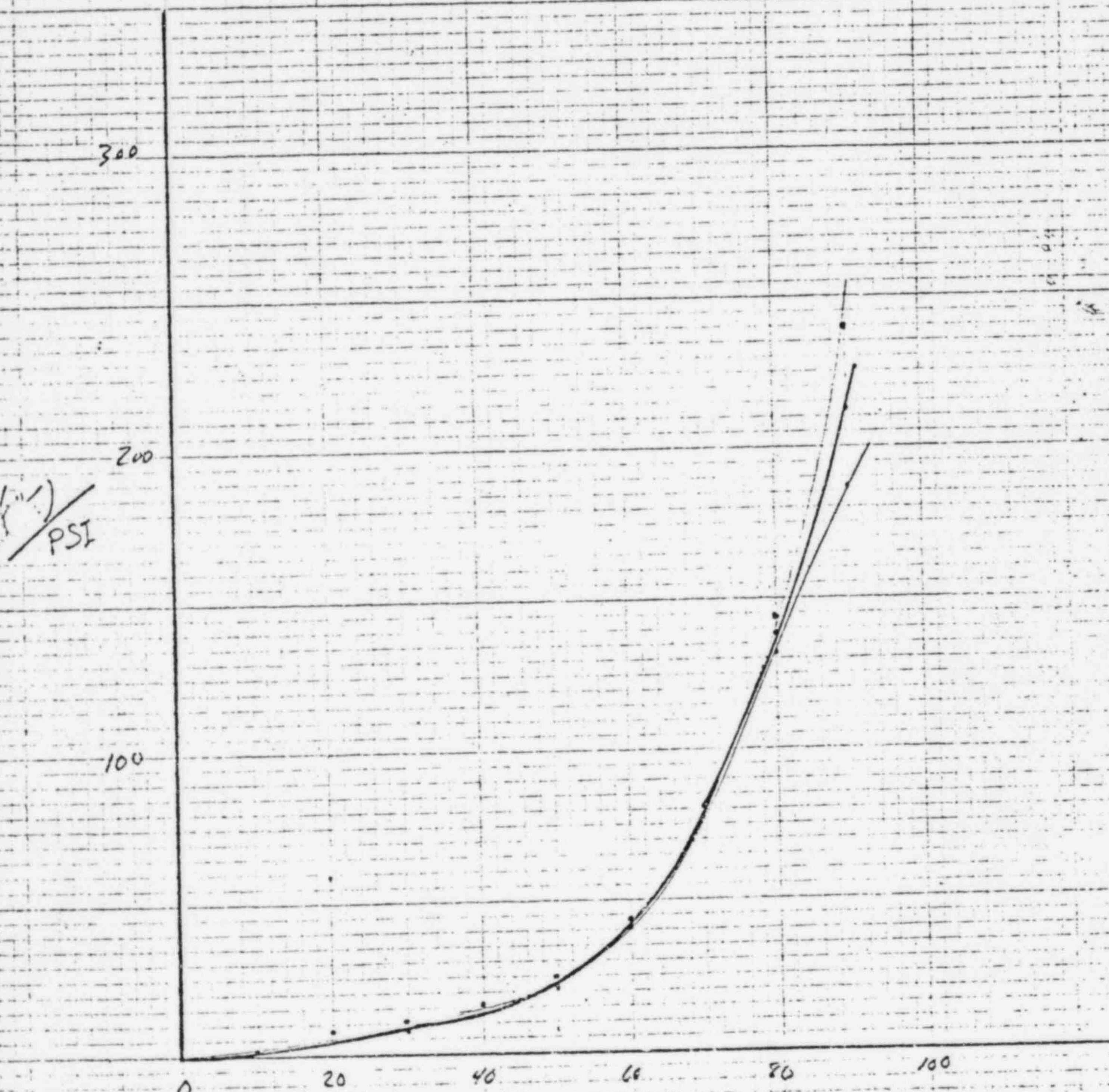
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" 150 LB

HYDRODYNAMIC TORQUE (PREFERED) Page

Calc. By C. LIVORSI Checked By



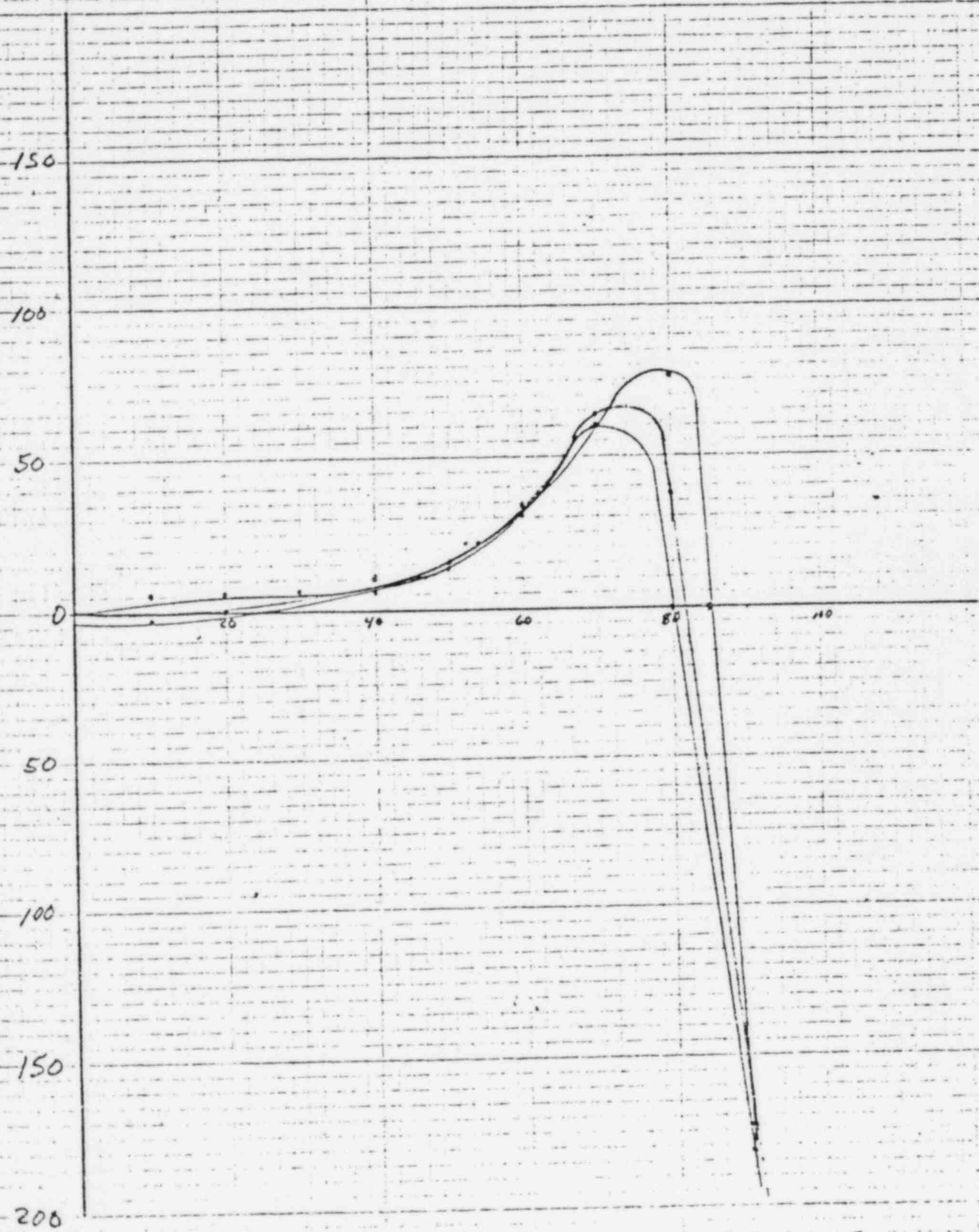
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8"-150

Ti HYDRODYI MIC TORQUE CURVE (UNPREFERED) Page

Calc. By C. LIVORSI Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION (#1) Page

By RO DATE: 6/17/97 Checked By

VALVE SIZE: 10" - 150

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

VALVE SEAL TYPE: TEFLON BUNA | DISC TYPE: 2

WATER TEMPERATURE (TANK): 78° °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	IN-# / ΔPSI
OPENING	0	54.9	~~2616~~ 51	0	+1250 / 1150 / 1200	
	10	54.9	50.5	395	850	16.8
	20	30	25.5	895	550	21.6
	30	16	11.5	1030	350	30.4
	40	8.5	3.6	1100	150	41.7
	50	25	15	3560	~~850~~ 900	60
	60	18.5	6.3	3590	850	134.9
	70	16.0	3.2	3590	800	250
	80	15.0	2.2	3580	800	363.6
	90	41	.75 to 1	2685	600	600
		~~40~~	~~1.5~~	~~2673~~	− 390	[illegible]
CLOSING	90	40	1.5	2673	− 150	75
	80	40	≈ 2.0	2863	− 250	125
	70	41	3.0	2720	− 275	91.7
	60	41	4.0	2620	− 300	75
	50	42	7.0	2538	~~[illegible]~~ − 350 − 400	57.2
	40	45	17.0	2260	− 375	22
	30	51	32.0	1800	− 325	10
	20	~~[illegible]~~ 54	51	1195	0	
	10	61	56	360	0	
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION (#2) Page

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

VALVE SIZE: 10"-150

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

VALVE SEAL TYPE: TEFLON / BUNA | DISC TYPE: 2

WATER TEMPERATURE (TANK): 80 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	IN-LB/ΔPSI
OPENING	0	38.8	16.5	218	329	
	10	~~44.5~~ [illegible]	~~19~~ [illegible]	~~[illegible]~~ 109	~~200~~ ~~500~~ [illegible]	
	20	57.5 ~~44.5~~	10.5 ~~20.5~~	~~1070~~ 578	~~600~~ 400	
	30	42.8 41.4	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	259
		↓	↓	↓		
CLOSING	90				300	171.4
	80	16.3	2.0	3583	650	325
	70	17.3	3.0	3597	700	233
	60	19.8	6.0	3599	725	120.8
	50	25.5	~~17.5~~ 13.0	3572	800	
	40	49.5	14.0	2140	450	
	30	57.2	11.0	1180	300	
	20	62.1	14.0	732	300	
	10	65.9	15.0	311	200	
	0					

PACKING TORQUE: 50 IN-LB OPENING

: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION 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	37.5/37.5			850/750 ~~4000~~
	10	~~45~~ 45.7/46.3	38/23.5	300/232	700
	20	17.5 45.2	17.5		450
	30	8.5 →			900
	40	17.5 →			575
	50	7.0 →			675
	60	5.0 →			625
	70	25 →			725
	80	20 →			550
	90	15 →			
CLOSING	90		1.5		400
	80		2.0		575
	70		3.0		650
	60		6.0		600
	50		13.0		450
	40		26.0/18.5		300 150
	30		23		−100
	20		23		−275
	10		33.5		−600
	0				

PACKING TORQUE: 50 X IN-LB OPENING

: 50 X IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION #4 Page

Calc. By DATE: 6/20/77 Checked By

CAVITATION measurements - control valve wide open.

VALVE SIZE : 10" - 150

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

VALVE SEAL TYPE : TEFLON / BUNA

WATER TEMPERATURE (TANK) : 77 °F

DISC TYPE & DWG : 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		51		1200
	20		50.5		1400
	30		43.5		1575
	40		28.5		1450
	50		13.5		1100
	60		6.25		925
	70		3.0		825
	80		2.25		800
	90		2.0		550
CLOSING	90		1.75		375
	80		2.25		600
	70		3.5		625
	60		6.75		650
	50		14.25		525
	40		29.5		275
	30		44.5		-200
	20		51.5		-550
	10		58.5		-1100
	0				

PACKING TORQUE : 50 X IN-LB OPENING

: 50 X IN-LB CLOSING

Title HYDRODYNAMIC TORQUE DETERMINATION Page ______

Calc. By Damon DATE: 6/21/77 Checked By ______

VALVE SIZE: 10" - 150

VALVE DIRECTION: ~~[illegible]~~ / STEM DOWNSTR

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
	20		28		650
	30		11.5		425
	40		13.0		525
	50		10.5		700
	60		6.5		775
	70		3.5		550 157
	80		1.7		−175
	90		1.7		−625
CLOSING	90		1.8		−700
	80		1.8		−50
	70		3.0		+200
	60		6.5		+450
	50		13.5		+275
	40		~~[illegible]~~ 8.5		−75
	30		16.5/19/30.5		−50 / −50 / −275
	20		17.5		−325
	10		18.5		−350
	0				

PACKING TORQUE: 50 IN-LB OPENING
: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page ____

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

Full open - Control valve.

VALVE SIZE: 10"-150

VALVE DIRECTION: ~~UPSTREAM~~ / STEM DOWNS

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		−400
	20		51.0		−700
	10		58.5		−800
	0				

PACKING TORQUE: 50 IN-LB OPENING

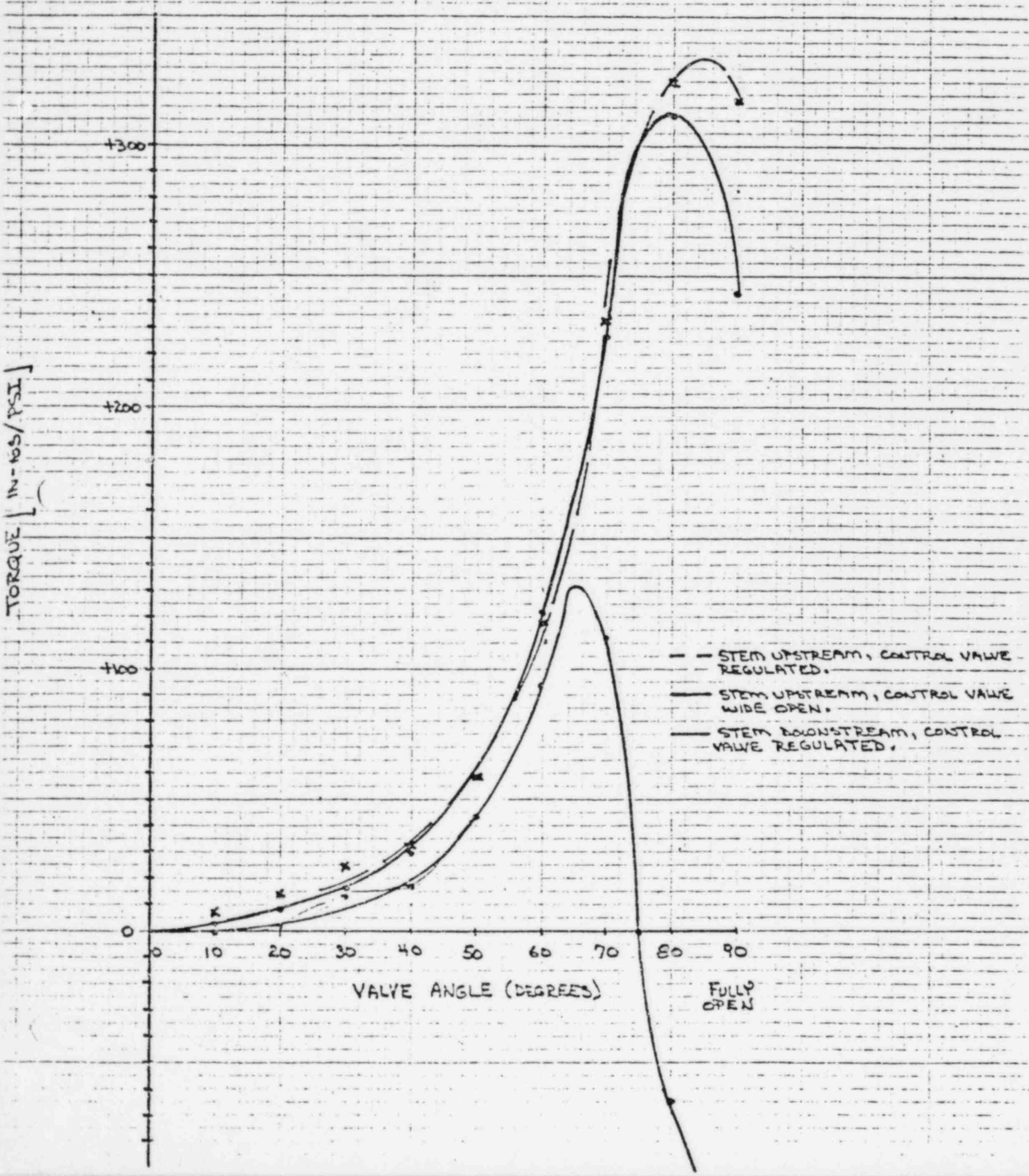
: 50 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title TORQUE VS. VALVE ANGLE 10"-150 Page

Calc By R. [illegible] 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 DOWNS ☐

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0				
	10	50	1400	28	
	20	36.5	1300	36	
	30	20.5	850	41	
	40	20.5	1000	49	
	50	8.5	850	100	
	60	3.5	825	236	
	70	2.3	750	326	
	80	1.5	700	467	
	90	1.0	500	500	
CLOSING	90	1.0	200	200	
	80	1.0	400	400	
	70	1.5	475	317	
	60	3.5	450	129	
	50	8.0	425	53	
	40	17.5	325	19	
	30	36.5	225	6	
	20	48.5	0	0	
	10	55	-550	-10	
	0				

PACKING TORQUE: 150 IN-LB OPENING

: 200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page 2

Calc. By C. Livorsi DATE: Checked By

VALVE SIZE: 12" 150

VALVE DIRECTION: ☒ STEM UPSTREAM / ☐ STEM DOWN

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN
OPENING	0	62 55	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	-1200		

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 DOWNST ☒

VALVE SEAL TYPE: TEFLON

WATER TEMPERATURE (TANK): 67 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN
OPENING	0	62	1000		
	10	21	550	26	
	20	5	300	60	
	30	10	450	45	
	40	7.7	450	58	
	50	5.5	350	63	
	60	4.0	650	162	
	70	1.9	450	236	
	80	1.2	200	166	87° = 0
	90	.8	-300	-375	
CLOSING	90	.8	-450	-562	
	80	.8	-100	-125	
	70	1.6	200	125	
	60	4.0	300	75	
	50	9.5	100	11	
	40	16	0	0	
	30	30	-50	-2	
	20	44	-550	-13	
	10	53	-1150	-22	
	0	63	100	-2	

PACKING TORQUE: 125 IN-LB OPENING

: 150 IN-LB CLOSING

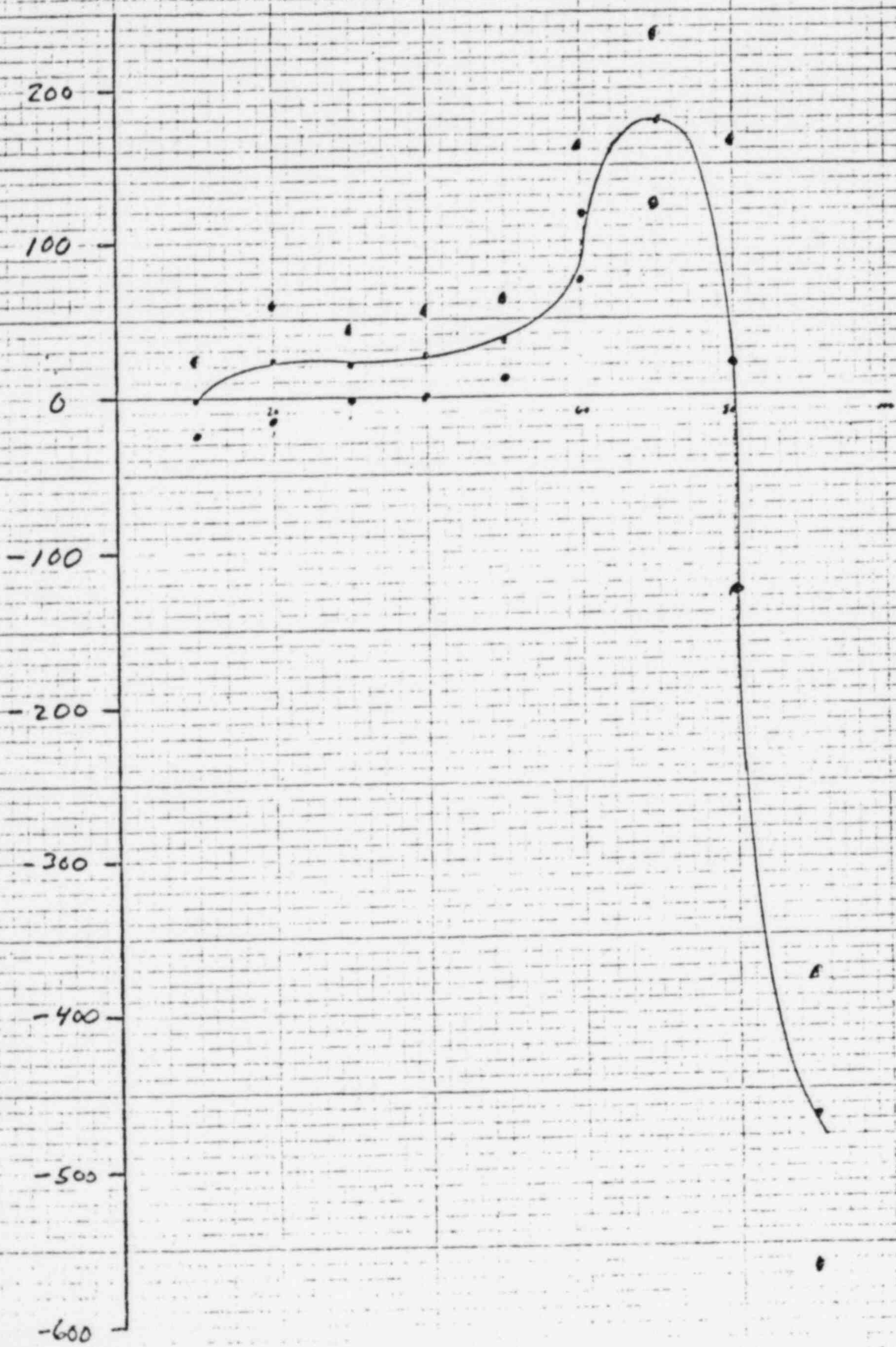
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE CURVE 12" 150 Page

By C. LIVORSI Checked By

STEM DOWNSTREAM

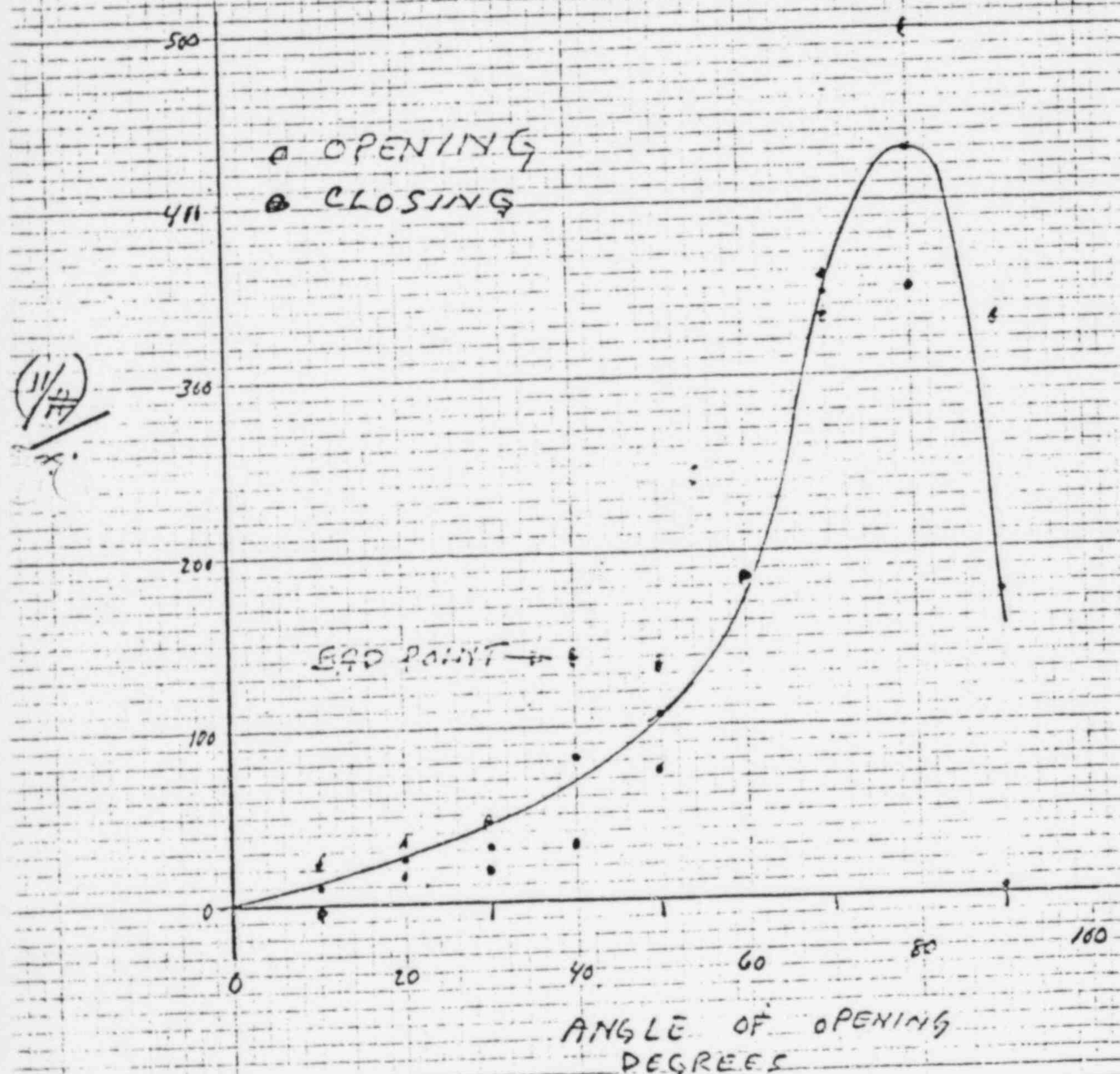


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" - 150 STEM UP STREAM HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI Checked By

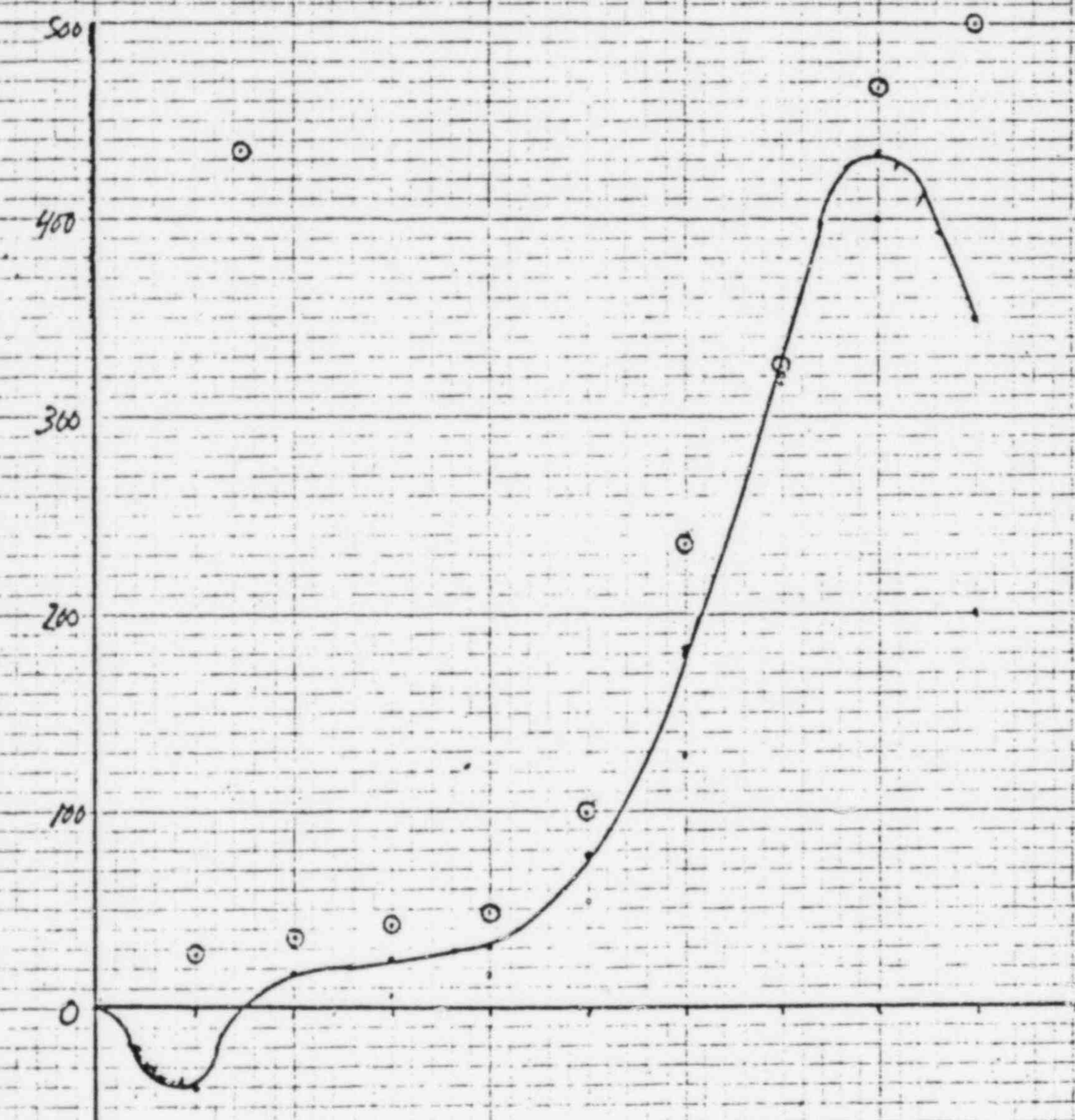


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 12" 150 (PREFERED) HYDRODYNAMIC TORQUE CURVE Page

By C. Livorsi Checked By



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By DATE: Checked By

VALVE SIZE: 14"-150

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTREAM ☐ ☒

VALVE SEAL TYPE:

WATER TEMPERATURE (TANK): 65 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE — TENDING TO OPEN		
OPENING	0						
	10	49.5	525	11	21.5	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 ~~[illegible]~~ OPENING

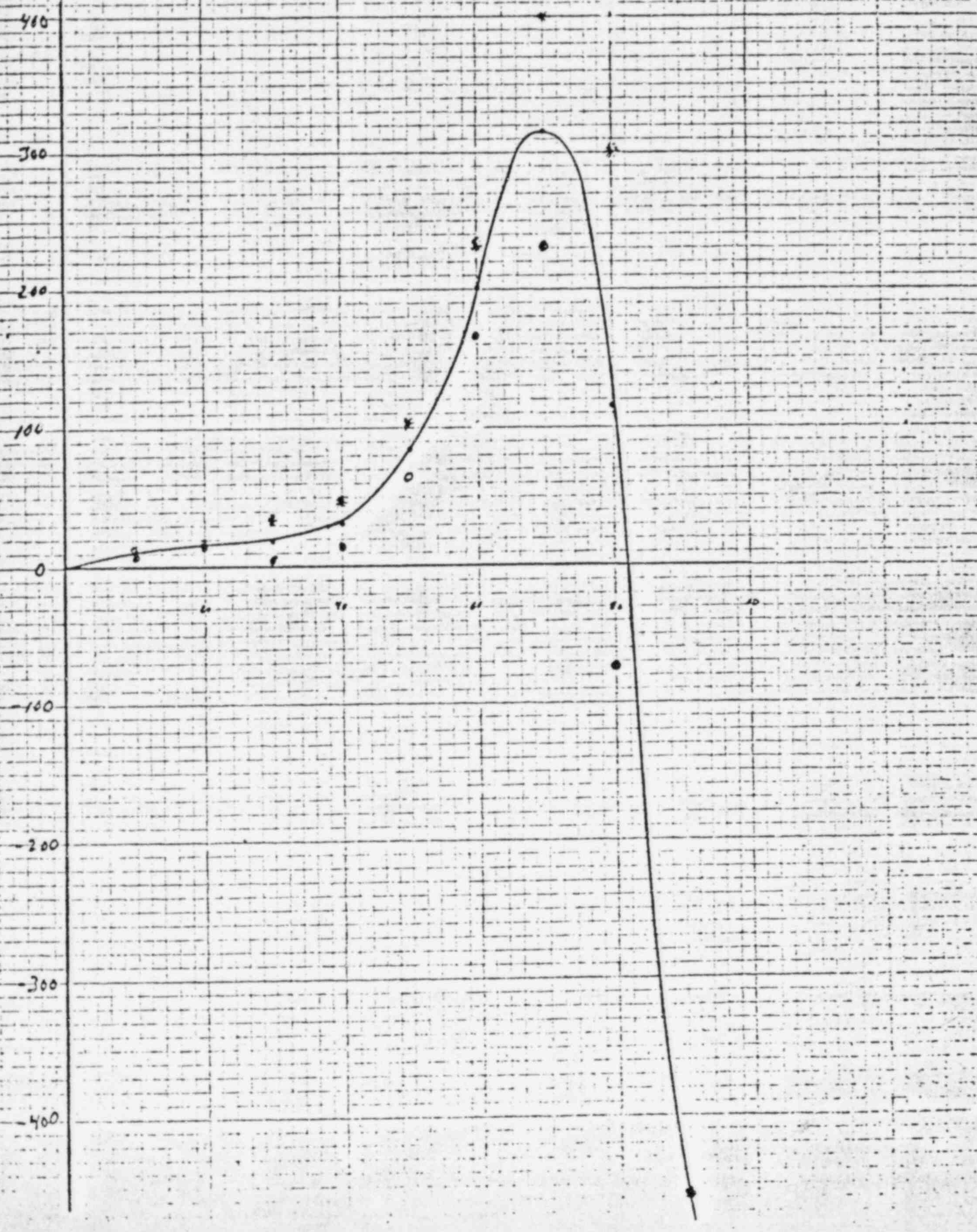
: 5 FT-LB ~~[illegible]~~ CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 14"-150 STEM DOWN STREAM Page

Calc. By C. LIVORSI Checked By



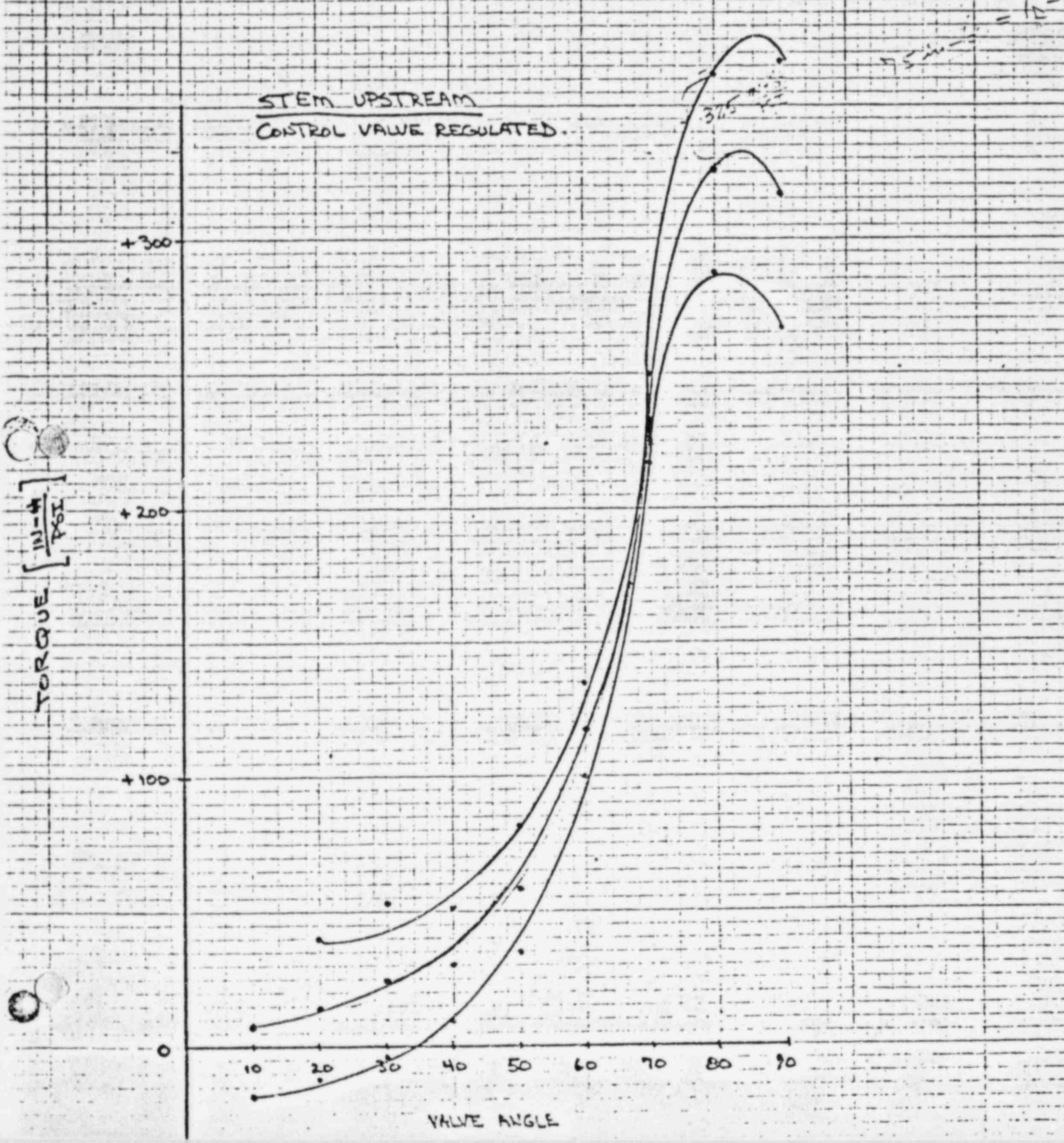
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: TORQUE VS. VALVE ANGLE Page

Calc. By: R. QANSEN Checked By

10" - 150



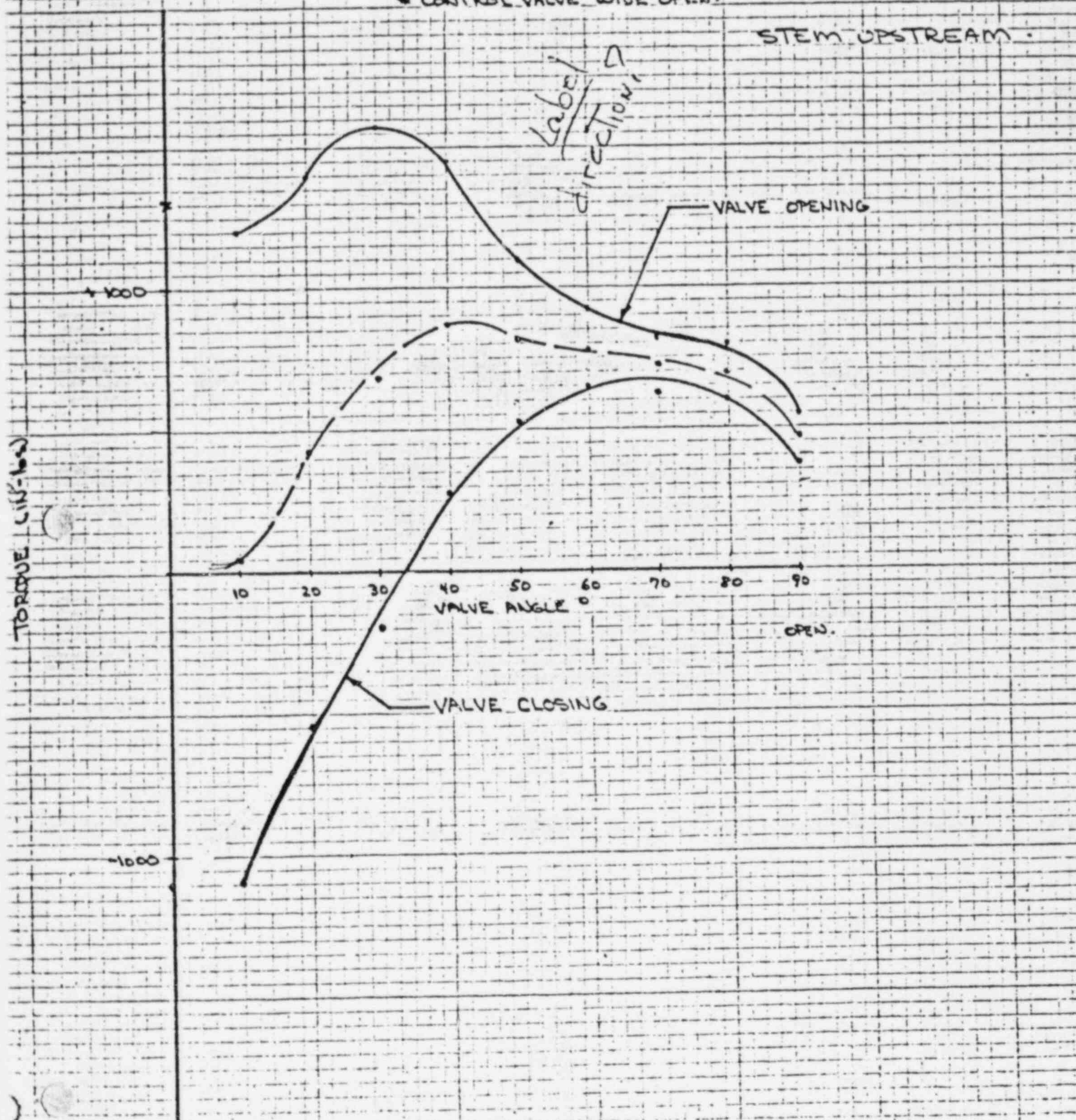
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title VALVE TORQUE - 10" - 150 Page

Calc. By Checked By

* CONTROL VALVE WIDE OPEN.



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 DOWNSTR ☐

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

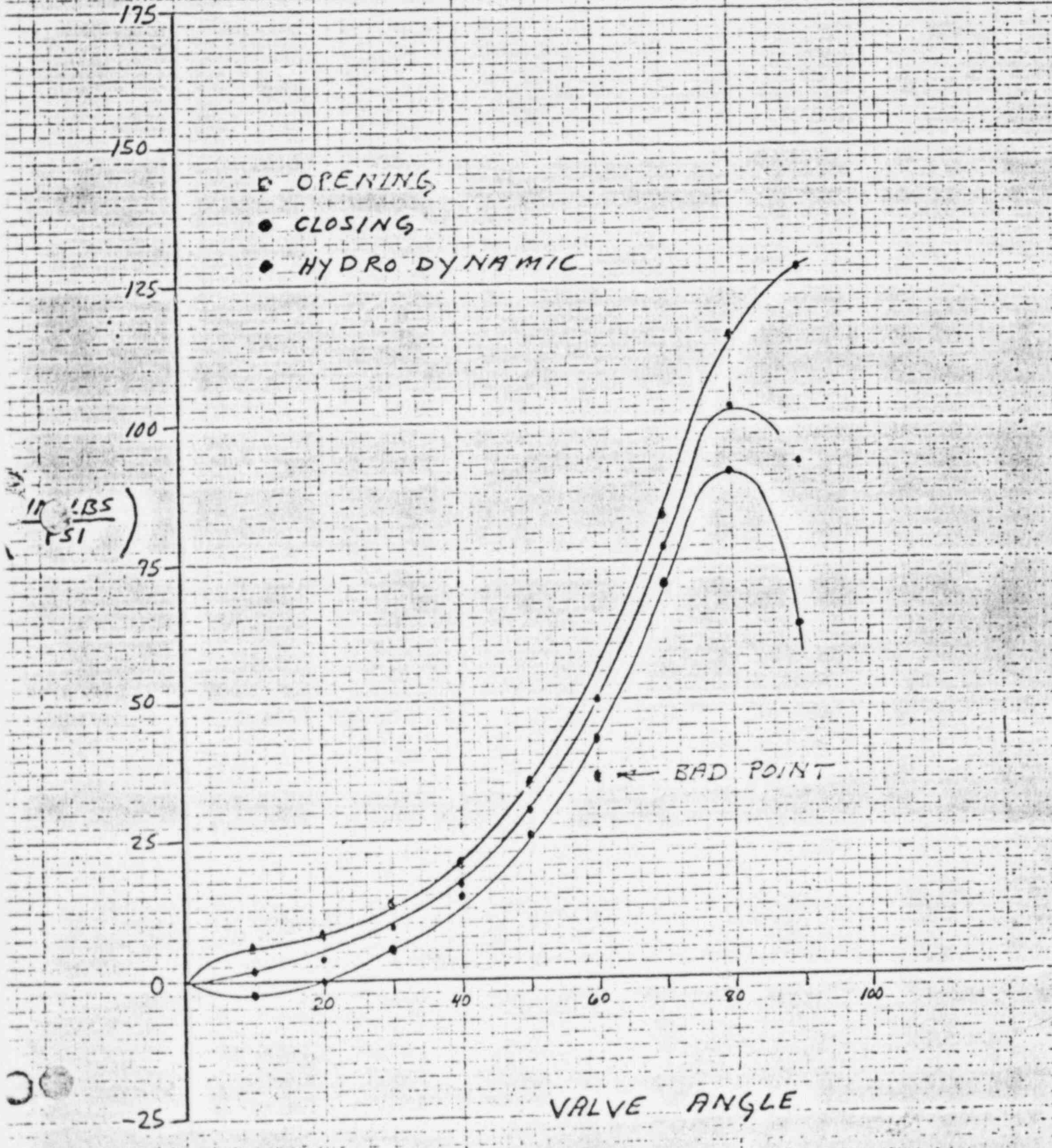
: 200 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 8" 300LB HYDRO DYNAMIC TORQUE CURVE Page

By C. LIVORSI Checked By

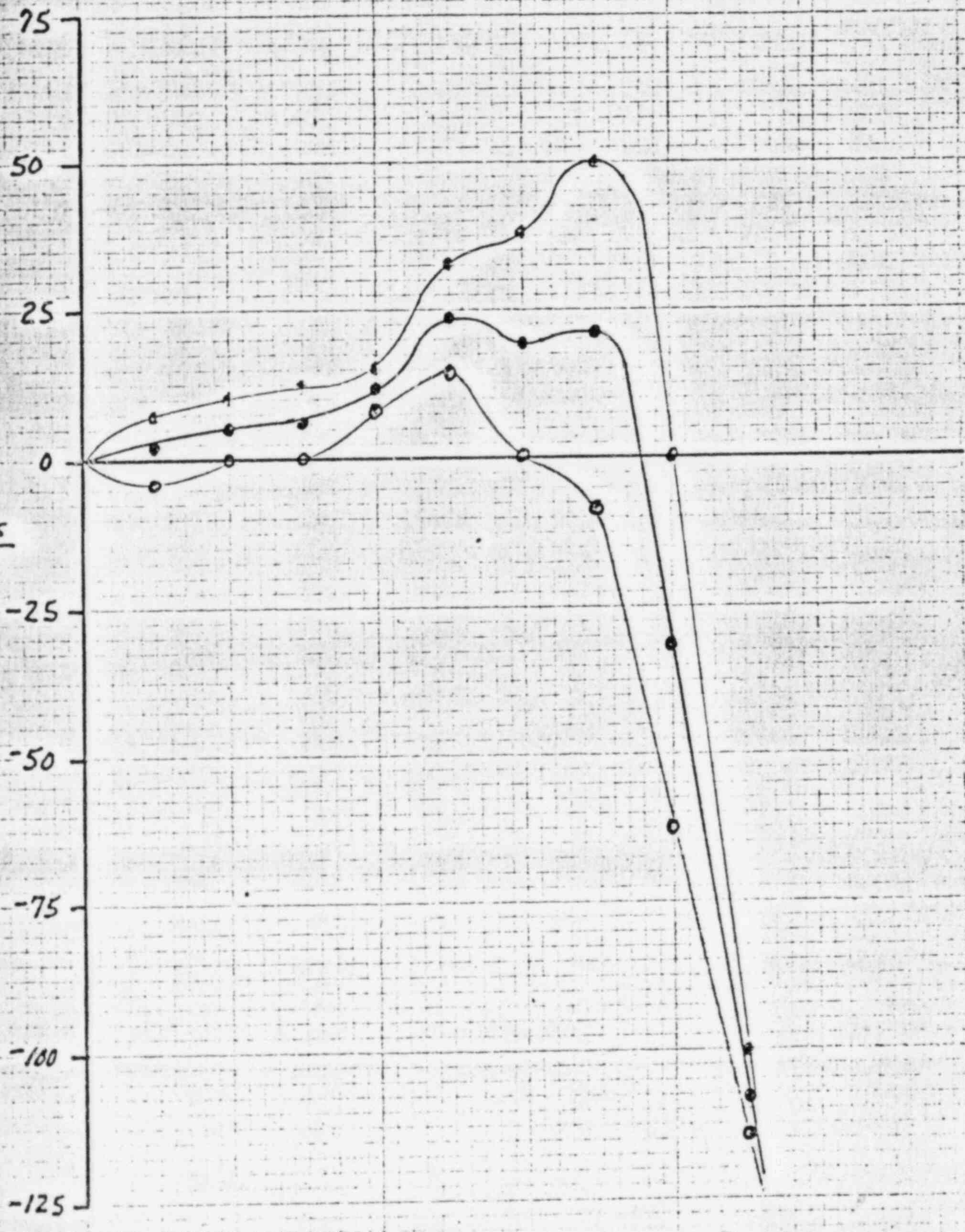


POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: 8" 300 HYDRODYNAMIC TORQUE CURVE Page

Calc. By: C. LIVORSI (UNPREFERED) Checked By



Title HYDRODYNAMIC TORQUE DETERMINATION Page

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

* with Control valve Regulated.

VALVE SIZE : 10"-300

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

VALVE SEAL TYPE: TEFLON/BUNA.

WATER TEMPERATURE (TANK): 82 °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		40		+650	6
	20		26		+425	6
	30		31		−300	5
	40		21		−600	−29
	50		10		650	+65
	60		7		625	+89
75° 0 TORQUE	70		4.5		250	+56
	80		3		−250	−83
	90		3		−500	−167
			X		X	
CLOSING	90		3		−800	−265
	80		3		−550	−183
	70		4.5		−300	−67
	60		7		0	0
	50		12.5		+200	+16
	40		25		50	+2
	30		37.5		−300	−8
	20		26		−375	−
	10		42		−500	−12
	0	X			X	

PACKING TORQUE : 175 IN-LB OPENING

: 250 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ∅ANSEN DATE: 8/1/77 Checked By

VALVE SIZE: 10" 300

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

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				
	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				

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 DOWNSTREAM~~

VALVE SEAL TYPE : TEFLON/BUNA

WATER TEMPERATURE (TANK) : 87 °F

DISC TYPE & DWG : 2

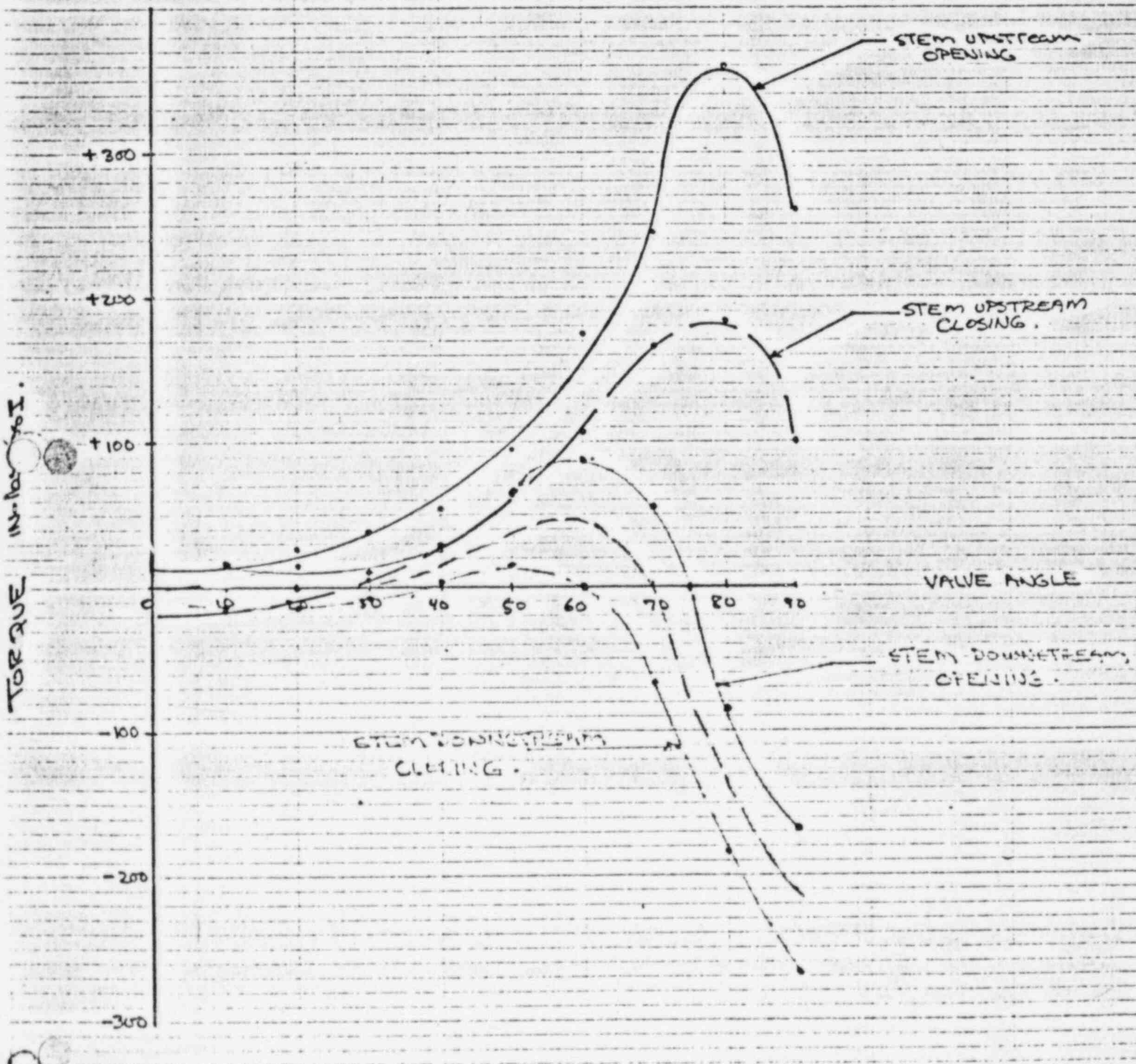
	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0		X		X	
	10		36		−600	47
	20		26		−700	[illegible]
	30		35		−1350	[illegible]
	40		22.5		−1200	55
	50		11		1050	95
	60		6		1050	175
	70		4.5		1100	24[illegible]
	80		2.5		900	360
	90		2.5		−650	[illegible]
			2.		2.	
CLOSING	90		2.5		250	160
	80		3		550	[illegible]
	70		4.5		750	[illegible]
	60		7.5		800	[illegible]
	50		12		750	6[illegible]
	40		26		650	25
	30		12.5		75	6
	20		26		0	0
	10		55 20		−450 −300	[illegible]
	0		X		X	

PACKING TORQUE : 200 IN-LB OPENING

: 250 IN-LB CLOSING

10" - 300

TORQUE VS. VALVE ANGLE.



POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ØANSEN DATE: 3/21/77 Checked By

VALVE SIZE: 3"-600

VALVE DIRECTION: STEM UPSTREAM / STEM DOWNSTREAM

VALVE SEAL TYPE: Teflon/Buna

WATER TEMPERATURE (TANK): 67 °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0				
	10		42		+60
	20		38.5		+30
	30		36.5		+30
	40		34		+25
	50		30.5		+40
	60		39		+30
	70		31.5		0
	80		25.5		−5
	90		22.5		−40
CLOSING	90		22.5		−60
	80		25		−45
	70		31.5		−25
	60		39		−5
	50		28		0
	40		30.5		0
	30		49.5		−5
	20		49.5		−10
	10		49.5		−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 [signature] DATE: 3/21/77 Checked By

VALVE SIZE: 3"-600

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	
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	6.3
CLOSING	90		23		+140	6.1
	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 Hansen DATE: 11/14/77. Checked By

VALVE SIZE: 4"-600

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

VALVE SEAL TYPE: TEFLON / EPR

WATER TEMPERATURE (TANK): °F

DISC TYPE & DWG:

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0					
	10		49		+275	
	20		35		+275	
	30		34		+250	
	40		23.5		+175	
	50		26.5		+175	
	60		26		+250	
	70		22		+275	
	80		17		+250	
	90		16.5		+150	9.1
CLOSING	90		16.5		+75	4.5
	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

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By ϕANSEN . DATE: 1/3/77 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 DOWNSTREAM

VALVE SEAL TYPE : Teflon / Buna

WATER TEMPERATURE (TANK) : 83 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	
OPENING	0					
	10		44		+200	+4.55
	20		33		+150	+4.55
	30		29.5		+250	+8.47
	40		25		+400	+16
	50		19.5		+450	+23.08
	60		20.5		+450 +21.95	
	70		15		+250 +16.67	0 @ 75
	80		~~10.5~~/18.5		Ø −250	−13.51
	90		15.5		−650	−41.94
CLOSING	90		15.5		−800	−51.61
	80		19.0		−525	−27.63
	70		18.5		−200	−10.81
	60		26		+50	+1.92
	50		28		+50	+1.79
	40		33		0	0
	30		34		−275	−8.089
	20		32.5		−350	−10.769
	10		39		−350	−8.974
	0					

PACKING TORQUE : 175 IN-LB OPENING

: 225 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By Jansen 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: Reg. wide open

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE — TENDING TO OPEN IN-LB (Reg.)		(wide open)
OPENING	0						
	10		30.5	59.5	+200	6.6	+325
	20		33	58.5	+300	9.1	+500
	30		24	55.5	+300	12.5	+450
	40		25	49.5	+300	12	+550
	50		26.5	44.5	+400	15.1	+625 ~~+700~~
	60		20	32.5	+450	22.5	+700 ~~+625~~
	70		19.5	28.5	+650	33.3	+850
	80		19.2	19.0	+1025	53.4	+950
	90		14.8	14.8	+750	(50.7)	+900
CLOSING	90		14.8	14.8	+650	(43.9)	+575
	80		19.3	18.8	+750	38.9	+675
	70		24.2	24.4	+825	34.1	+750
	60		20.5	31.5	+225	11	+300
	50		24.5	43.5	+100	4.1	+250
	40		34.5	50.5	+25	.7	+25
	30		34.5	55.5	−50	−1.4	+25
	20		38.5	58	−75	−1.9	−100
	10		34.0	60.5	−275	−8.1	−375
	0						

PACKING TORQUE: 175 IN-LB OPENING

: 225 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

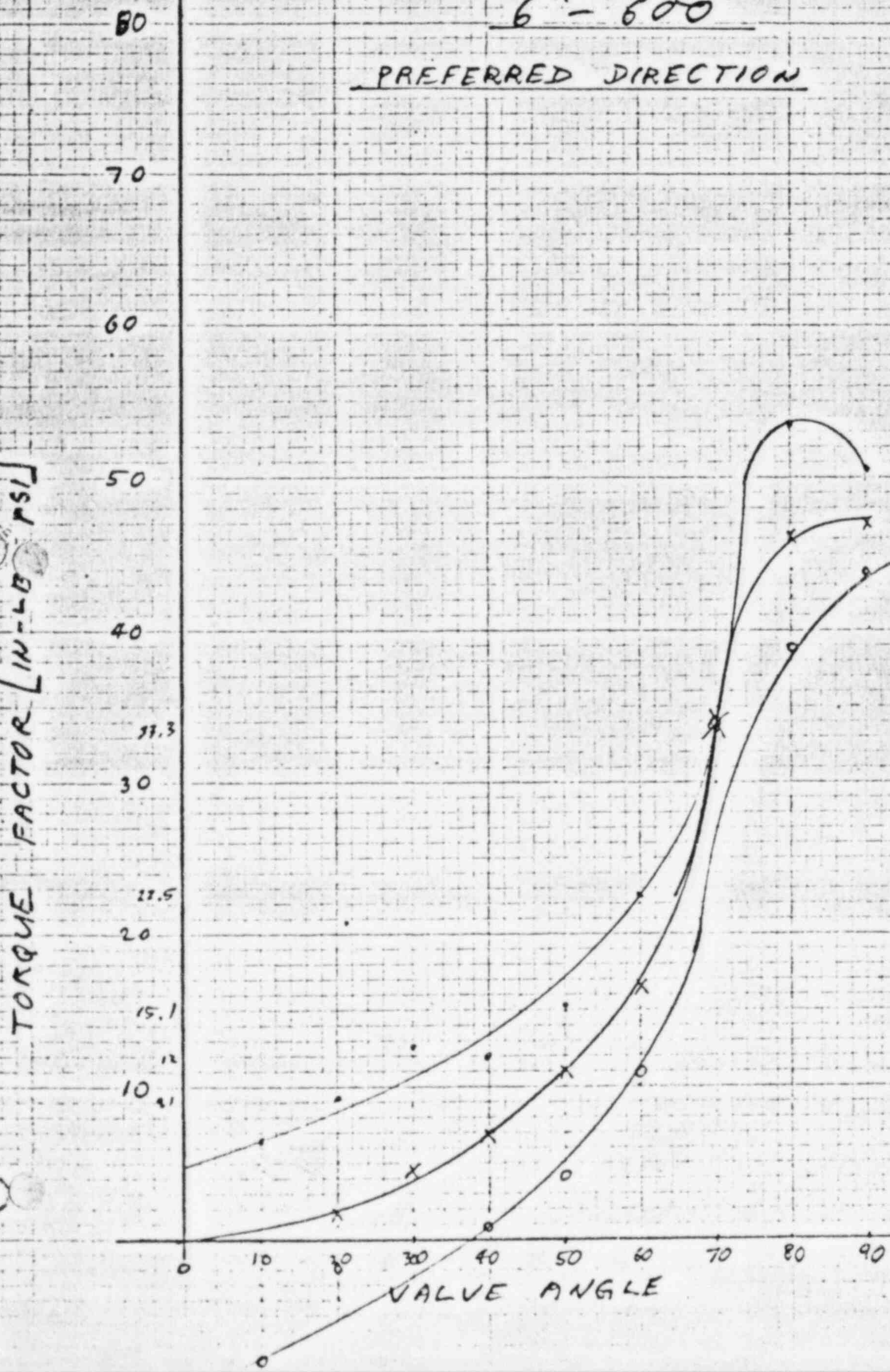
ENGINEERING CALCULATIONS

Title: HYDRODYNAMIC TORQUE V.S. ANGLE Page

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

6" – 600

PREFERRED DIRECTION



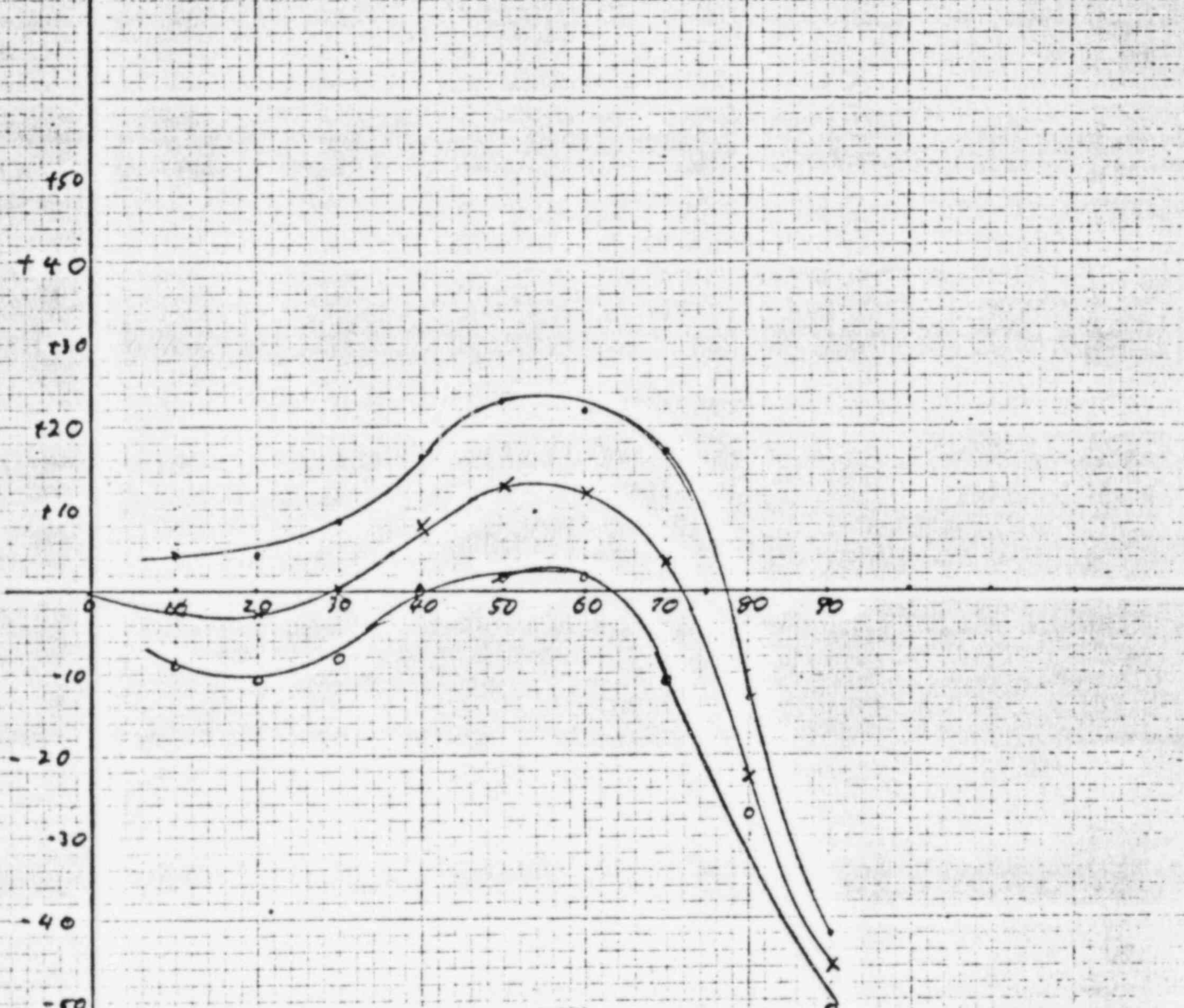
ANGLE	FACTOR
0	0
10	.8
20	2.0
30	4.0
40	7.0
50	11.0
60	17.0
70	34.0
80	46.0
90	47.0

Title HYDRODYNAMIC TORQUE V.S. ANGLE Page

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

6"-600

<u>NON</u> PREFERRED DIRECTION



ANGLE	FACTOR
0	0
10	-3
20	-3
30	0
40	7
50	12
60	12
70	4
80	-22
90	-46

-60

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 DOWNSTREAM ☒

VALVE SEAL TYPE : URATHANE

WATER TEMPERATURE (TANK) : 69 °F

DISC TYPE & DWG :

	VALVE ANGLE DEGREES	ΔP (PSIG)	TORQUE (IN-LBS)	IN-LBS / PSI	COMENTS + TENDING TO CLOSE − TENDING TO OPEN
OPENING	0	0	1600		
	10	50	500	10	
	20	11	250	22.7	
	30	11.5	300	26.1	
	40	11.0	350	31.8	
	50	9.5	325	34.2	
	60	5.7	200	35.1	
	70	6.5	125	19.2	72° TORQUE WENT
	80	5.0	-125	-25	NEG
	90	6.0	-300	-50	
CLOSING	90	6.0	-600	-100	
	80	5.0	-400	-80	
	70	7.0	-250	-35.7	
	60	11.2	-100	-8.9	
	50	18.5	0	0	
	40	23.5	100	4.3	
	30	31.0	100	3.2	
	20	39	-200	5.1	
	10	57	-250	4.4	
	0	0	-1100		

PACKING TORQUE : 150 IN-LB OPENING

: 150 IN-LB CLOSING

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 DOWNSTREAM ☐

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	1800		
	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

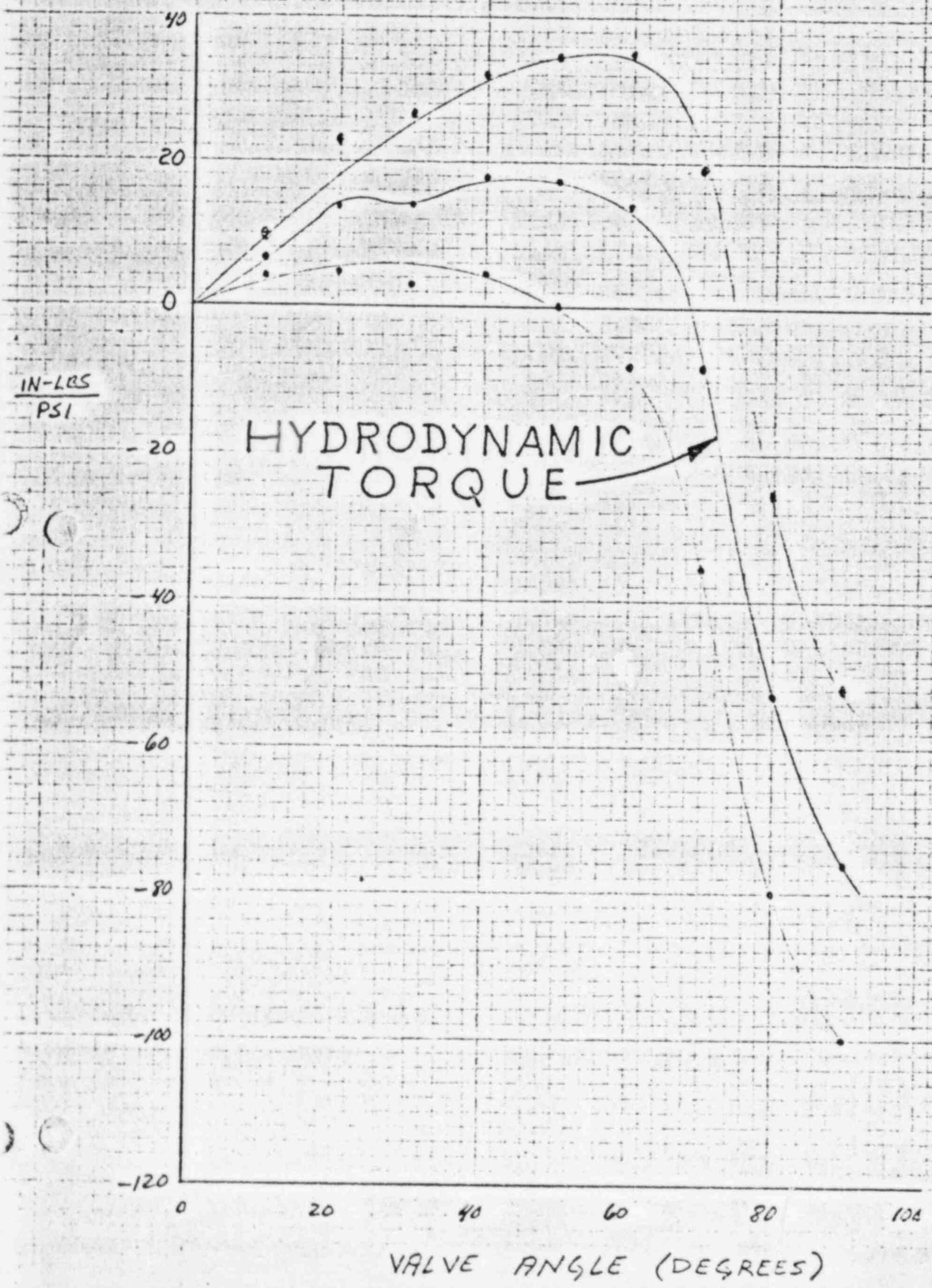
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

8" - 600LB

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

Calc. By C. LIVORSI Checked By



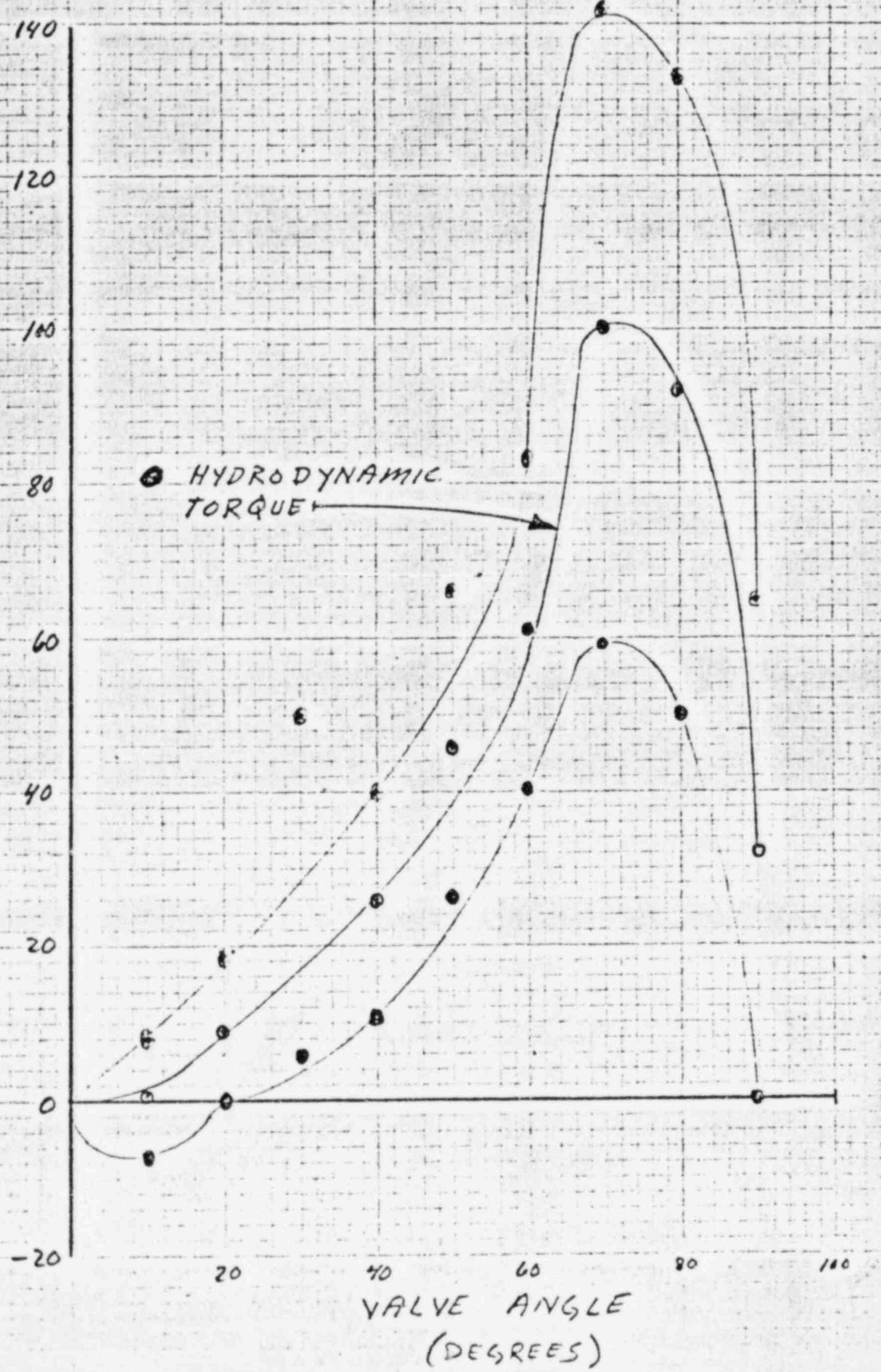
POSI-SEAL INTERNATIONAL, INC.

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 ~~Q~~ANSEN DATE: 8/3/77 Checked By

Control valve - regulated

VALVE SIZE: 10" - 600

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

VALVE SEAL TYPE: TEFLON / BUNA.

WATER TEMPERATURE (TANK): 84 °F

DISC TYPE & DWG: 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB	in#/psi
OPENING	0					
	10		~~47~~ 385		+900 ✓	23.4
	20		~~30~~ 25.5		+1200 ✓	47.1
	30		~~28.5~~ 25		~~+1580~~ 1500	60
	40		~~19.7~~ 24		~~+1500~~ 1750	72.9
	50		~~14.9~~ 14.4		~~+1500~~ 1550	107.6
	60		~~10.5~~ 9.8		~~+1450~~ 1350	137.8
	70		7.3		+1400	191.8
	80		5,2		+1200	230.5
	90		4.4		+800	
CLOSING	~~90~~ 85		4.4		0	
	80		4.4		+200	45.5
	70		5.9		+450	76.3
	60		8.8		+550	62.5
	50		13.0		+600	46.2
	40		20.8		+650	31.3
	30		33		+450	13.6
	20		40.4		+50	1.24
	10		39		−550	−14.1
	0					

PACKING TORQUE: 350 IN-LB OPENING

: 400 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By Hansen DATE: 8/5/77 Checked By

Control valve regulated.

VALVE SIZE : 10"- 600

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

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	+23.9
	20		31.5		+900	+28.6
	30		27.5		+900	32.7
	40		24.5		~~[illegible]~~ +1500	+61.2
	50		14.0		+1100	+78.6
	60		9.1		+950 +800	+104.4
	70		5.8		+600 +400	+103.4
	80		4.3 4.2		-23.81 + ~~[illegible]~~ -100	0 of 75
	90		4.4		-250	~~[illegible]~~ hydro
			X		X	
CLOSING	90		4.7		-950	-202.1
	80		4.2		-750	-178.6
	70		6.4		-550	-85.9
	60		9.6		-450	-46.9
	50		14.4		-300	-20.83
	40		26.5		-250	-9.4
	30		27.5		-400	-14.5
	20		32		-750	-23.4
	10		37		-800	-21.6
	0		X		X	

PACKING TORQUE : ~~[illegible]~~ 450 IN-LB OPENING

: ~~400~~ 450 IN-LB CLOSING

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title HYDRODYNAMIC TORQUE DETERMINATION Page

Calc. By Dawson DATE: 8/5/77 Checked By

Control valve wide open

VALVE SIZE : 10"-600

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

VALVE SEAL TYPE : TEFLON / BUNA

WATER TEMPERATURE (TANK) : 88 °F

DISC TYPE & DWG : 2

	VALVE ANGLE DEGREES	P_1 UPSTREAM PSIG	ΔP PSI	Q GPM	TORQUE + TENDING TO CLOSE − TENDING TO OPEN IN-LB
OPENING	0		X		X
	10		57		+ ~~60~~ 1500
	20		48.5		+ 950
	30		37		+ 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~~ 450 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

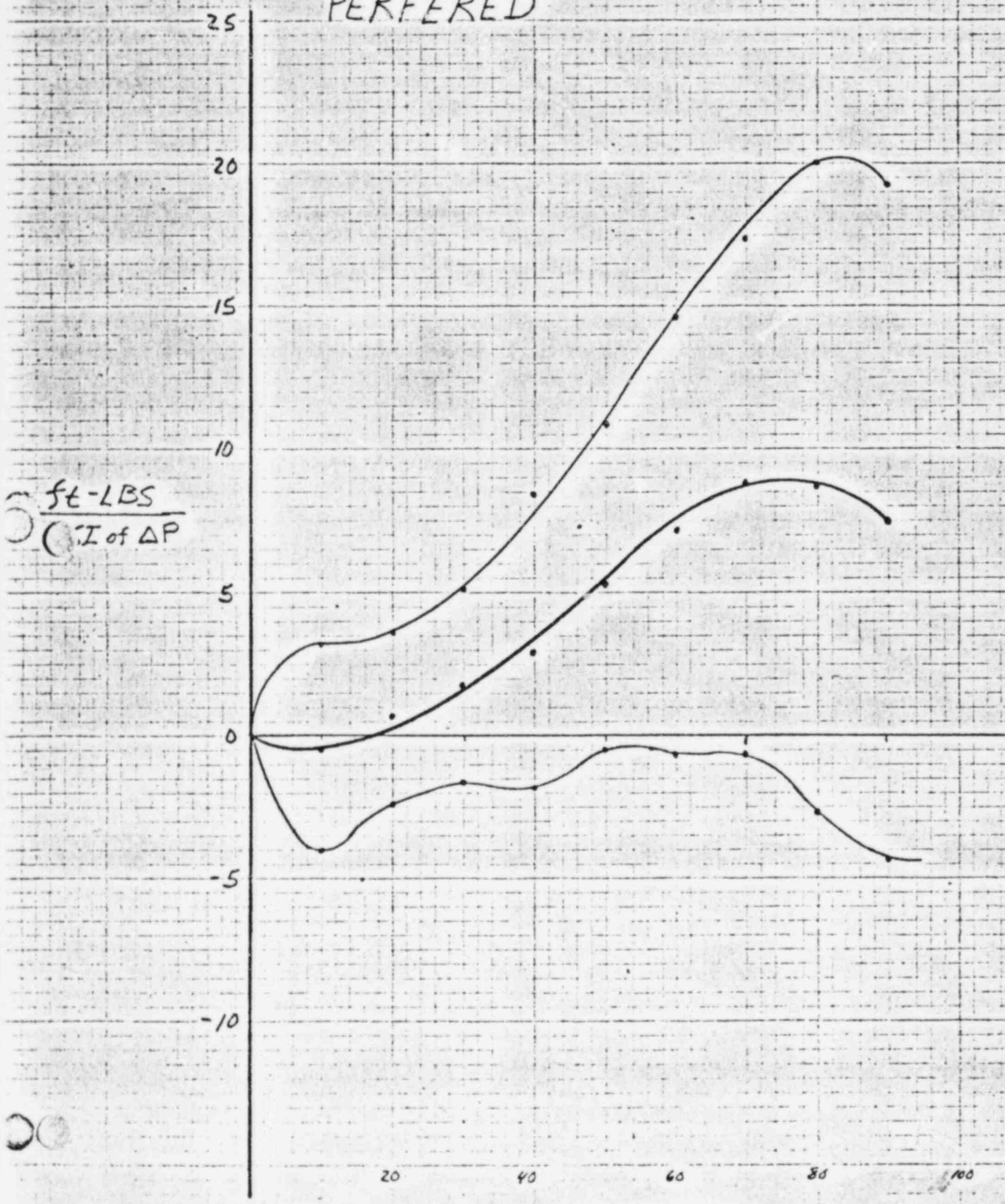
'OSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title 14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI Checked By

PERFERED



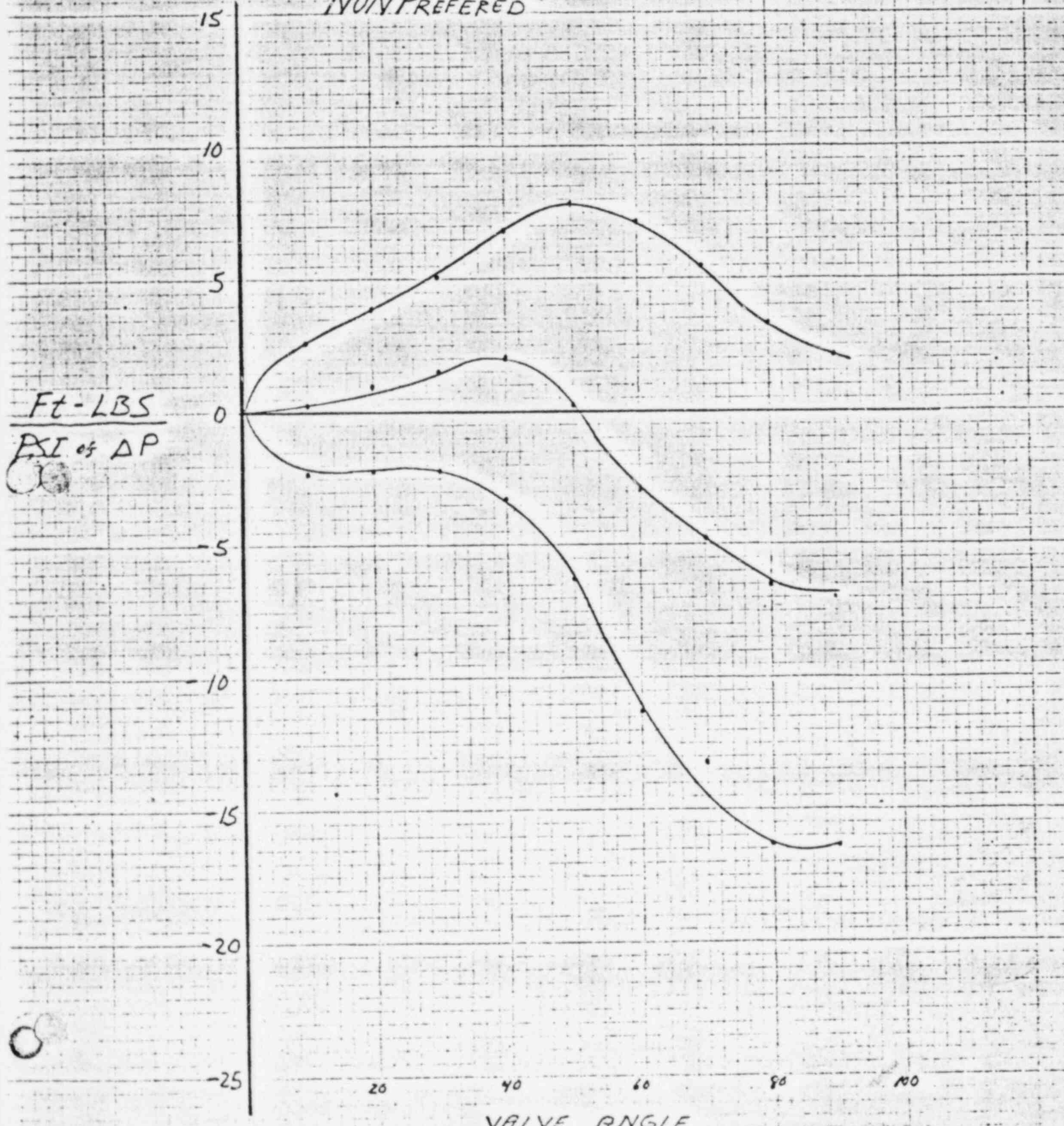
POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

14" 1500 LB HYDRODYNAMIC TORQUE CURVE Page

Calc. By C. LIVORSI Checked By

NON PREFERED



POSI-SEAL INTERNATIONAL, INC.

Innovators in Flow Control

TECHNICAL BULLETIN NO. 1A

Operating torque values and Actuator sizing

JUNE 82

TORQUE VALUES TO OPEN AND SHUT

The Posi-Seal Trunnion Valve is a low torque valve which normally reaches its highest torque when opening. This torque value will vary with the seat material and stem packing selected in addition to the maximum operating differential pressure (ΔP) across the valve.

Torque values to open and shut for standard Posi-Seal Trunnion Valves are listed in Tables 1, 2 and 3, and are denoted as T_1, T_2, and T_3.

T_1 and T_2 torque values are due to the stem packing and seat material selected and are added together to determine preload torque.

The static pressure torque factor T_3 is the static pressure torque per PSIΔP. This factor (T_3) is multiplied by the maximum operating ΔP or maximum line pressure to obtain the torque value due to pressure.

To obtain the maximum torque to open or shut the T_1, T_2, and T_3 ΔP values are simply added together.

EXAMPLE:

A. Requirement – What is the maximum opening torque of a 12" Class 150 valve with teflon chevron packing, a teflon seal ring with rubber back-up ring and a maximum ΔP of 200 PSI.

B. Solution – From Table 1

T_1 = (B) = 70 in. lbs.

T_2 = (G) = 986 in. lbs.

T_3 = 10.10 in. lbs. per PSIΔP = 10.10 x 200 = 2020 in. lbs.

Total opening torque = T_1 + T_2 + (T_3 x PSIΔP) = 70 + 986 + (10.10 x 200) = 3076 in. lbs.

Although the valve opening torque is normally the highest operating torque used in actuator sizing, it is often necessary with flowing liquids to check for total hydrodynamic torque. Refer to Section II for data on calculating total hydrodynamic torque.

TABLE I
CLASS 150 STANDARD RATING

VALVE SIZE	PRELOAD TORQUE = T_1 + T_2								STATIC PRESSURE TORQUE PER PSI T_3	
	T_1			T_2						
	A	B	C	E	F	G	H	J	316 M.S.	REXNORD
......	......	......	......	......	......	......	......	......	......	......
3"	302	28	227	122	73	61	244	280	0.24	.16
4"	338	31	254	218	131	109	436	501	0.50	.33
6"	454	42	340	510	306	255	1020	1173	1.56	1.04
8"	529	49	397	902	541	451	1804	2074	3.23	2.15
10"	680	63	510	1398	839	699	2796	3215	6.44	4.29
12"	756	70	567	1972	1183	986	3944	4535	10.10	6.73
14"	832	77	624	2424	1454	1212	4848	5575	13.66	9.11
16"	907	84	680	3164	1898	1582	6328	7277	19.44	12.96
18"	1058	98	794	3994	2396	1997	7988	9186	28.64	19.09
20"	1210	112	907	4914	2948	2457	9828	11302	40.28	26.85
24"	1512	140	1134	7564	4538	3782	15128	17397	77.48	51.65
30"	1814	168	1361	11982	7189	5991	23964	27558	147.28	98.19
36"	2268	210	1701	17426	10456	8713	34852	40080	267.76	178.51
42"	2419	672	1814	23795	14277	11897	47590	54728	390.00	....
48"	2722	756	2041	30864	18518	15432	61728	70987	569.00	....
54"	2722	756	2041	39849	23909	19924	79698	91653	734.70	....
60"	3024	840	2268	49280	29568	24640	98561	113345	1010	....
66"	3326	924	2495	59937	35962	29969	119875	137856	1351	....
72"	3629	1008	2722	71355	42813	35677	142709	164115	1754	....

CLASS 150 150PSI RATING

VALVE SIZE	PRELOAD = T_1 + T_2								STATIC PRESSURE TORQUE PER PSI T_3	
	T_1			T_2						
	A	B	C	E	F	G	H	J	316 M.S.	REXNORD
24"	1210	112	907	7194	4316	3597	14388	16546	58.96	39.31
30"	1512	140	1134	12038	7223	6019	24076	27687	123.32	82.21
36"	1663	154	1247	17420	10452	8710	34840	40066	196.28	130.85
42"	1966	546	1474	23846	14308	11923	47693	54847	317.50	....
48"	2268	630	1701	31069	18642	15535	62139	71460	477.30	....
54"	2268	630	1701	39849	23909	19924	79698	91653	612.12	....
60"	2268	630	1701	49484	29691	24742	98969	113814	760.30	....
66"	3024	840	2268	59937	35962	29969	119875	137856	1228	....
72"	3024	840	2268	71661	42997	35830	143322	164820	1468	....

Valve torque (opening) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

Valve torque (closing, on-off service) = $T_1 + T_2 + (.5T_3 \times PSI\Delta P)$

Valve torque (closing, modulating service) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

When the operating ΔP used for actuator selection is less than the maximum line pressure, contact the factory for sizing torque.

NOTES:

T_1 (A) Asbestos jam packing
(B) Teflon Chevron packing
(C) Graphite jam packing

T_2 (E) Urethane seal ring with rubber back-up ring, Metal seal ring with and without rubber back-up ring, Kel F seal ring without rubber back-up ring
(F) Teflon seal ring with Teflon back-up ring, Tefzel seal ring with rubber back-up ring
(G) Teflon seal ring with rubber back-up ring
(H) Metal seal ring with Teflon insert and rubber back-up ring
(J) Metal seal ring with urethane, Tefzel, or Kel-F insert and rubber back-up ring

TABLE 2
CLASS 300 STD. RATING

VALVE SIZE	PRELOAD TORQUE = $T_1 + T_2$								STATIC PRESSURE TORQUE PER PSI T_3	
	T_1			T_2						
	A	B	C	E	F	G	H	J	316 M.S.	REXNORD
......	....	......	....	....	....	....	....	....	....	
......	....	......	....	....	....	....	....	....	....	
3"	302	28	227	122	73	61	244	280	0.24	.16
4"	338	31	254	218	131	109	436	501	0.50	.33
6"	454	42	340	510	306	255	1020	1173	1.56	1.04
8"	756	70	567	750	450	375	1500	1725	3.84	2.56
10"	907	84	680	1242	745	621	2484	2857	7.64	5.09
12"	1058	98	794	1722	1063	886	3544	4076	12.70	8.47
14"	1210	112	907	2160	1296	1080	4321	4968	17.71	11.81
16"	1361	126	1021	3164	1898	1582	6328	7277	29.16	19.44
18"	1512	140	1134	3602	2161	1801	7204	8285	36.90	24.60
20"	1814	168	1361	4534	2720	2267	9068	10428	55.74	37.16
24"	2117	196	1588	7564	4538	3782	15128	17397	108.46	72.31
30"	2722	252	2041	10764	6458	5382	21528	24757	198.45	132.30
36"	3024	280	2268	16278	9767	8139	32556	37439	333.46	222.31
42"	3175	294	2381	23402	14041	11701	46804	53825	503.30	....
48"	4234	392	3175	30383	18230	15192	60766	69881	871.40	....

Valve torque (opening) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

Valve torque (closing, on-off service) = $T_1 + T_2 + (.5T_3 \times PSI\Delta P)$

Valve torque (closing, modulating service) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

When the operating ΔP used for actuator selection is less than the maximum line pressure, contact the factory for sizing torque.

NOTES:

T_1 (A) Asbestos jam packing
(B) Teflon Chevron packing
(C) Graphite jam packing

T_2 (E) Urethane seal ring with rubber back-up ring, Metal seal ring with and without rubber back-up ring, Kel-F seal ring without rubber back-up ring
(F) Teflon seal ring with Teflon back-up ring, Tefzel seal ring with rubber back-up ring
(G) Teflon seal ring with rubber back-up ring
(H) Metal seal ring with Teflon insert and rubber back-up ring
(J) Metal seal ring with urethane, Tefzel, or Kel-F insert and rubber back-up ring

TABLE 3
TORQUE VALUES (In. Lbs.)
Class 600 Posi-Seal Trunnion Valves

VALVE SIZE	PRELOAD TORQUE ($T_1 + T_2$)									STATIC PRESSURE TORQUE PER PSI T_3	
	T_1				T_2						
	A	B	C	D	E	F	G	H	J	316 M.S.	REXNORD
3"	342	AVAILABLE ON APPLICATION	257	95	120	72	NOT AVAILABLE IN CLASS 600	AVAILABLE ON APPLICATION	276	0.27	.18
4"	454		340	126	202	121			465	0.63	.42
6"	529		397	147	496	298			1141	1.77	1.18
8"	907		680	252	770	462			1771	4.73	3.15
10"	1058		794	294	1234	750			2838	8.85	5.9
12"	1361		1021	378	1724	1034			3965	15.89	10.59
14"	1512		1134	420	2078	1247			4779	21.29	14.19
16"	1814		1361	504	2698	1619			6205	33.17	22.11
18"	2117		1588	588	3532	2119			8124	50.64	33.76
20"	2419		1814	672	4238	2543			9747	69.4	46.27
24"	2722		2041	756	6422	3853			14770	118.4	78.93

Valve torque (opening) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

Valve torque (closing, on-off service) = $T_1 + T_2 + (.5T_3 \times PSI\Delta P)$

Valve torque (closing, modulating service) = $T_1 + T_2 + (T_3 \times PSI\Delta P)$

When the operating ΔP used for actuator selection is less than the maximum line pressure, contact the factory for sizing torque.

NOTES:

T_1
- (A) Asbestos jam packing
- (B) Teflon Chevron packing – available on application
- (C) Graphite jam packing
- (D) Teflon jam packing

T_2
- (E) Metal seal ring with and without rubber back-up ring, Kel-F ring without rubber back-up ring
- (F) Tefzel seal ring with rubber back-up ring
- (G) Not available on Class 600
- (H) Metal seal ring with Teflon insert and rubber back-up ring – available on application
- (J) Metal seal ring with Tefzel, or Kel-F insert and rubber back-up ring (urethane insert available on application)

II. TOTAL VALVE OPERATING HYDRODYNAMIC TORQUE

As previously stated the valve opening torque is normally the highest operating torque used for actuator sizing and selection. However, when flowing liquids, it is often necessary to calculate the total valve operating hydrodynamic torque.

The location of the maximum valve operating torque (total hydrodynamic torque) is a result of the overall system operating parameters in addition to the particular valve disc hydrodynamic torque characteristics.

When the ratio of thru valve ΔP to total system ΔP is high, generally above 25 percent, the maximum valve operating hydrodynamic torque will occur at or about the 70° to 80° disc open position. As this ratio decreases, the maximum valve operating hydrodynamic torque will shift towards the 0° shut position.

To allow for system operating variables it is recommended that the maximum valve operating hydrodynamic torque (TH_T) be calculated at both the 20° and 80° disc open position.

The total valve operating hydrodynamic torque (TH_T) is the summation of three torque components. These components are: stem packing torque (T_1), stem bearing friction torque (static pressure torque per PSIΔP) and the disc hydrodynamic lift and drag torque. Torque values T_1 and T_3 can be found in Tables 1 thru 3.

Extensive flow testing has shown that the disc hydrodynamic lift and drag torque values are dependent upon the direction of flow entering the valve. With liquid flow entering the valve from the stem side, with the seal retaining downstream, the disc hydrodynamic lift and drag torque value (T_4) is positive to the full open position acting to return the disc to the shut position. Liquid flow entering the valve from the opposite direction, seal retaining ring up stream, results in a torque value that remains positive, acting to return the disc to the shut position, until about the 70° to 80° open position. At this point the torque value becomes negative acting to move the disc to the full open position. With liquid flow in this direction the disc hydrodynamic lift and drag torque values are designated as T_5. Also, test results have shown that flowing liquids in this direction results in a positive T_5 value that is lower than the corresponding T_4 value with flow in opposite direction.

By utilizing torque values T_1 and T_3 along with the applicable disc hydrodynamic lift and drag torque values T_4 or T_5 listed in Tables 4 thru 9, the total valve operating hydrodynamic torque TH_T can be calculated as follows:

RETAINING RING DOWNSTREAM

$TH_T = T_1 + (T_3 \Delta P) + (T_4 \Delta P)\ G_f$

RETAINING RING UPSTREAM

$TH_T = T_1 + (T_3 \Delta P) + (T_5 \Delta P)\ G_f$

TH_T = Total valve operating hydrodynamic torque, in. lbs.

T_1 = Packing torque, in. lbs. Tables 1, 2, and 3.

T_3 = Stem bearing friction torque (static pressure torque per PSIΔP), in. lbs. Tables 1, 2, and 3.

T_4 = Disc hydrodynamic lift and drag torque, in. lbs. Flow into valve with retaining ring downstream.

T_5 = Disc hydrodynamic lift and drag torque, in. lbs. Flow into valve with retaining ring upstream.

ΔP = Differential pressure across valve, PSI.

G_f = Specific gravity of liquid at flowing conditions.

$$G_f = \frac{\text{Density of liquid at flowing conditions}}{\text{Density of water at standard conditions}}$$

EXAMPLE:

A. Requirement — What is the total valve hydrodynamic torque of a 12" CLASS 150 Valve with teflon chevron packing, flowing water into the valve from the stem side (retaining ring downstream) with a calculated ΔP of 10 PSI at the 70° disc open position.

B. Solution –

$TH_T = T_1 + (T_3 \Delta P) + (T_4 \Delta P)\ G_f$

$TH_T = 70 + [10.10\ (10)] + [692\ (10)]\ 1.0$

$TH_T = 7091$ in. lbs.

Where –

T_1 = 70 in. lbs.

T_3 = 10.10 in. lbs.

T_4 = 692

G_f = 1.0

NOTE:

When in doubt about the maximum total valve hydrodynamic torque for a specific application, contact Posi-Seal factory for assistance.

TABLE 4

CLASS 150 STD RATING

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

VALVE SIZE	T_4 VS. OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	0	0	0	0	1	2	5	6	5
4"	0	0	1	1	3	6	12	16	13
6"	1	2	4	8	13	27	51	68	56
8"	4	10	16	30	49	100	185	247	204
10"	6	16	26	49	79	161	300	399	330
12"	15	38	60	114	182	372	692	920	761
14"	23	59	94	177	283	579	1075	1430	1182
16"	41	102	164	307	492	1005	1876	2482	2052
18"	64	162	259	486	778	1590	2953	3927	3245
20"	99	248	397	746	1193	2437	4526	6019	4974
24"	214	536	858	1610	2576	5259	9768	12988	10734
30"	462	1156	1850	3469	5551	11334	21049	27988	23131
36"	1884	4710	7537	14132	22611	46164	85734	113998	94213
42"	2281	5704	9127	17114	27383	55908	103829	138058	114098
48"	3265	8164	13063	24494	39191	80016	148602	197592	163299
54"	7388	18471	29554	55414	88662	181020	336180	447008	369428
60"	11165	27913	44661	83740	133984	273552	508026	675506	558270
66"	14942	37355	59768	112066	179306	366084	679972	904005	747112
72"	22995	57488	91981	172465	275945	563388	1046293	1391225	1149773
CLASS 150 150 PSI RATING									
24"	255	637	1020	1913	3061	6251	11609	15437	12758
30"	857	2144	3431	6433	10293	21016	39030	51897	42890
36"	1792	4480	7168	13441	21505	43907	81542	108424	89607
42"	3202	8007	12811	24021	38434	78469	145729	193772	160142
48"	5412	13530	21648	40591	64946	132598	246254	327437	270609
54"	7336	18341	29346	55025	88040	179749	333820	443871	366835
60"	14428	36072	57715	108216	173146	353506	656512	872945	721442
66"	14942	37355	59768	112066	179306	366084	679872	904005	747112
72"	30124	75310	120496	225931	361490	738044	1370653	1822516	1506212

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

TABLE 5

CLASS 150 STD. RATING

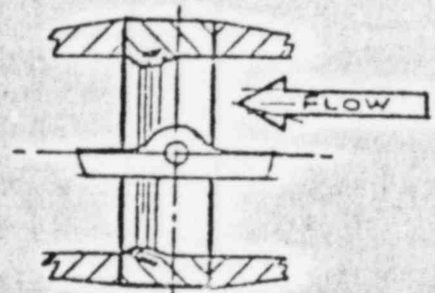
Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque — T_5

VALVE SIZE	T_5 VS. DISC OPEN POSITION								
	10°	20°	30°	40°	50°	60°	70°	80°	90°
3"	0	0	0	0	0	1	1	0	−5
4"	0	0	0	0	1	3	4	0	−13
6"	0	1	2	2	5	13	19	−1	−56
8"	2	4	8	10	18	46	69	−4	−204
10"	3	6	13	16	29	75	112	−6	−330
12"	7	15	30	38	68	175	258	−15	−761
14"	11	23	47	59	106	271	402	−23	−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									
24"	127	255	510	637	1148	2934	4337	−255	−12758
30"	428	857	1715	2144	3860	9864	14582	−857	−42890
36"	896	1792	3584	4480	8064	20609	30466	−1792	−89607
42"	1601	3202	6405	8007	14412	36832	54448	−3202	−160142
48"	2706	5412	10824	13530	24354	62240	92007	−5412	−270609
54"	3668	7336	14673	18341	33015	84372	124724	−7336	−366835
60"	7214	14428	28857	36072	64929	165931	245290	−14428	−721442
66"	7471	14942	29884	37355	67240	171835	254018	−14942	−747112
72"	15062	30124	60248	75310	135559	346428	512112	−30124	−1506212

1. T_5 values = in. lbs. per PSIΔP.
2. Except as noted, T_5 values are positive acting to shut valve.
3. Negative (−) T_5 values act to move the disc to the full open (90°) position.
4. 0 T_5 values $\cong < 1$.

TABLE 6

CLASS 300 STD RATING



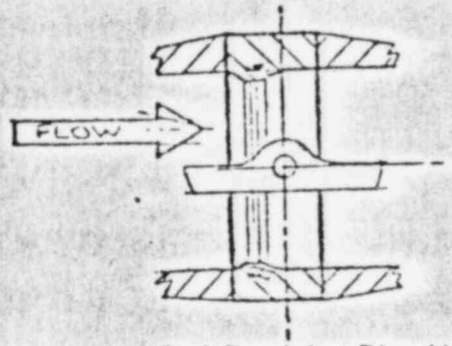
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque – T_4

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



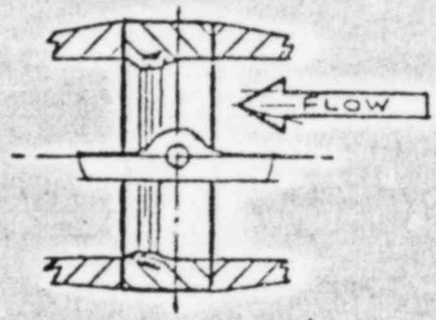
Seal Retaining Ring Upstream
Disc Hydrodynamic Lift & Drag Torque – T_5

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 $\geqq$ < 1.

TABLE 8

CLASS 600 STD RATING



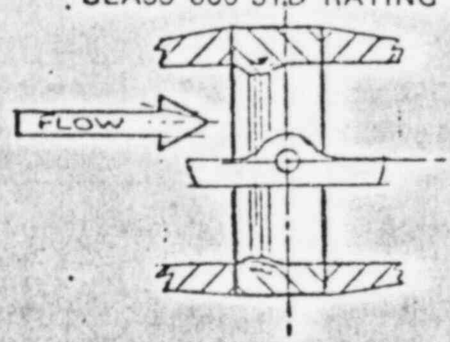
Seal Retaining Ring Downstream
Disc Hydrodynamic Lift & Drag Torque — T_4

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

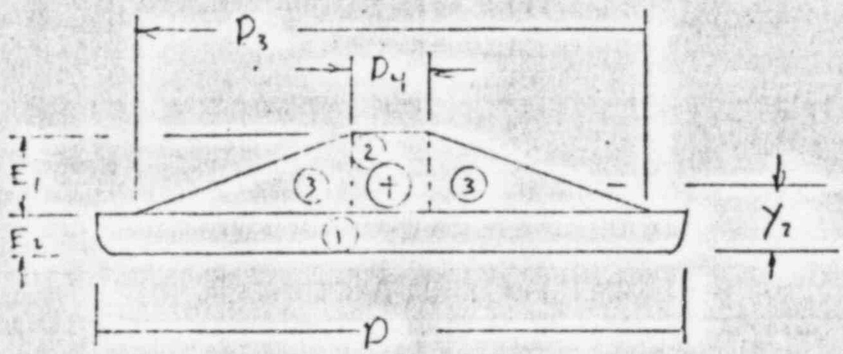
Published torque values for Posi-Seal Trunnion Valves include adequate safety factors and do not require additional safety factors. However, when sizing actuators for specific valve torque requirements, decrease the published actuator torques by at least 10% to allow for a realistic safety factor in 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.

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title: Determination of Disc Rotational Moment of Inertia Page 1

Calc. By: J. Rodriguez 9/17/82 Checked By:



$$I_1 = .000575\, D^2 E_2 \left(\frac{D^2}{16} + \left(Y_2 - \frac{E_2}{2}\right)^2 \right)$$

$$I_2 = E_1 D_4 L_3 (.00073) \left(\frac{E_1^2}{12} + \frac{D_4^2}{12} + \left(Y_2 - E_2 - E_1/2 \right)^2 \right)$$

$$I_3 = .00275\, L_3 (D_3 - D_4) E_1 \left(.0469\, L_3^2 + .0139 (D_3 + D_4)^2 + \left(\frac{D_4}{3} \ldots \right. \right.$$

$I = I_1 + I_2 + I_3$

36" 150-150

$D = 34.782$ $E_2 = 1.25$ $E_1 = 3.75$ $Y_2 = 2.625$

$L_3 = 34.128$ $D_4 = 4.75$ $D_3 = 32$

$$I_1 = .000575 (34.782)^2 (1.25) \left(\frac{34.782^2}{16} + \left(2.625 - \frac{1.25}{2} \right)^2 \right) = 69.2$$

$$I_2 = 3.75 (4.75)(34.128)(.00073) \left(\frac{3.75^2}{12} + \frac{4.75^2}{12} + \left(2.625 - 1.25 - \frac{3.75}{2} \right)^2 \right)$$

$= 1.5$

$$I_3 = .00275 (34.128)(32 - 4.75)(3.75)\left(.0469 (34.128)^2 + .0139 (32 + 4.75)^2 + \left(\frac{4.75}{3} + \frac{32}{6} \right)^2 \right)$$

$I_3 = 116.3$

$I = 187$ in-lb-sec^2

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title ______ Page 2

Calc. By J. Pelgen 8/13/82 Checked By ______

24" 150-150

$D = 22.918 \quad E_2 = 1.25 \quad E_1 = 3.062 \quad Y_2 = 2.312$

$L_3 = 22.44 \quad D_4 = 4.25 \quad D_3 = 21.75$

$I_1 = .000575(22.918)^2(1.25)\left(\frac{22.918^2}{16} + \left(2.312 - \frac{1.25}{2}\right)^2\right) = 13.5$

$I_2 = 3.062(4.25)(22.44)(.00073)\left(\frac{1.25^2}{12} + \frac{4.25^2}{12} + \left(2.312 - 1.25 - \frac{3.062}{2}\right)^2\right)$

$= .4$

$I_3 = .000275(22.44)(21.75-4.25)(3.062)\left(.0469(22.44)^2 + .0139(21.75)^2 + \left(\frac{4.25}{3} + \frac{21.75}{6}\right)^2\right)$

$= 19.3$

$I = 33.2$

10" 150

$D = 9.85 \quad E_2 = .813 \quad E_1 = 1.625 \quad Y = 1.5$

$L_3 = 9.625 \quad D_4 = 1" \quad D_3 = 4"$

$I_1 = .000575(9.85)^2(.813)\left(\frac{9.85^2}{16} + \left(1.5 - \frac{.813}{2}\right)^2\right) = .329$

POSI-SEAL INTERNATIONAL, INC.

ENGINEERING CALCULATIONS

Title ____ Page 3

Calc. By J. [signature] 9/22/82 Checked By ____

$$I_2 = (1.625)(1)(9.625)(.00073)\left(\frac{1.625^2}{12} + \frac{1}{12} + \left(1.5 - .813 - \frac{1.625}{2}\right)^2\right)$$

$$= .004$$

$$I_3 = .000275(9.625)(4-1)(1.625)\left(.0469(9.625)^2 + .0139(4+1)^2 + \left(\frac{1}{3} + \frac{4}{6}\right)\right)$$

$$= .073$$

$$I = .329 + .004 + .073 = .406$$

POSISEAL INTERNATIONAL, INC.
ENGINEERING CALCULATIONS

Title Determination of Scotch Yoke Sliding Friction Page 4
Calc. By J. [illegible] 1/15/82 Checked By

$$T = \frac{T_r}{\cos\theta\,(\cos\theta + \mu \sin\theta)}$$

$$T_{Breakaway} = \frac{T_{running}}{\cos 45^\circ\,(\cos 45^\circ + \mu \sin 45^\circ)}$$

For 26062-SR60

$T_{Breakaway} = 12198$ $T_{running} = 6970$

$$\mu = \frac{1}{\sin 45^\circ}\left(\frac{T_{running}}{T_{Breakaway}\cos 45^\circ} - \cos 45^\circ\right)$$

$$= \frac{1}{.707}\left(\frac{6970}{12198(.707)} - .707\right) = .143$$

For a 33082-SR60

$T_{Breakaway} = 27818$ $T_{running} = 15896$

$$\mu = \frac{1}{.707}\left(\frac{15896}{27818(.707)} - .707\right) = .143$$

$$\boxed{\mu = .143}$$