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Test Report on an Allis-Chalmers
6" STREAMSEAL Butterfly Valve in Air
concerning Nuclear Containment Isolation Valves

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## Contents

Introduction:

The purpose of this program was to observe and document the performance of an Allis-Chalmers Streamseal 6" Butterfly Valve. The testing performed was under specified air pressure conditions, to determine torque coefficients applicable to this type of valve. The test program is intended to serve as a model for larger valves manufactured by Allis-Chalmers, presently installed in various installations around the country. The coefficients thus developed by the testing method may then be applied to the larger on-site valves to determine the required actuator capacity under dynamic conditions, and to determine shaft stress levels.

The test procedure was designed to obtain data concerning four areas of investigation:

1. Valve closure rate versus time under dynamic conditions. IE: Constant or variable closure rate.

2. Flow direction through valve. How valve performance and shaft torques are affected by flow direction, & $\Delta P$ across the valve. What effects the change in pressure across the valve has on performance, and if actual conditions conform to prior published performance data for valve sizing.

3. The effect of the piping system on the valve installations. How the existence of piping, elbows, sudden enlargements, affects valve performance, closure times and shaft stresses.

4. The effect of valve disc and shaft orientation to the fluid mixture egressing from the containment.

Summary:

The information contained within this report is the result of a series of test runs performed on an Allis-Chalmers 6" Streamseal Butterfly Valve, in response to utility inquiries regarding various valves installed in Nuclear Power plants. With the information contained herein, an accurate assessment of a given Allis-Chalmers butterfly design in isolation containment service may be obtained within the range of specified inlet pressures. The uppermost concern in this analysis is the determination that both valve actuator and shaft size are adequate to perform as required during pressure conditions specified by the utility. A series of tests were performed over a range of inlet pressures from 60 psig to 10 psig. Through data collection and calculation, a tabulation of torque coefficients ($C_T$) was obtained, that enabled prediction of valve torques for the same pressure conditions, for any size Allis-Chalmers butterfly valve of the same disc thickness/diameter ratio and of similar design. Application of the $C_T$ value will yield a maximum applied shaft torque and will allow comparison of maximum allowable shaft torques and actuator capacities under specified inlet conditions.

Procedure:

The procedure outlined below describes the testing and evaluation of one Allis-Chalmers Streamseal Butterfly Valve, equipped with a Limitorque Electric Motor Actuator Model No. H0BC/SMC-04 with a minimum rated output of 150 ft-lbs. at 5.2 seconds for 90 degrees rotation. The valve was tested by mounting it in the blow-down stack of the Low Pressure Turbulence Tunnel installation located at NASA Facility Langley Research Center, Hampton, VA. All data was collected by monitoring incoming signals transmitted to equipment located in the adjacent tunnel control room.

Testing consisted of data gathering with the valve secured in two mounting installations, various valve positions relative to the elbow centerline, and with three types of valve configurations incorporating distinct disc thickness ratios. Refer to Figs. 7&8 for comparative thickness. This approach allowed study of valve performance under various expected mounting profiles, to obtain the maximum amount of information within the capacity of the test facility.

The procedure intended to present the valve with similar conditions as experienced by valves installed in the actual facilities. As variations in performance for butterfly valves are known to be affected by valve mounting configuration, valve position in the line, and disc thickness, the valve was mounted in a series of positions relative to the air stream as outlined below:

A. Elbow in/pipe out installation

1. Flat Face Upstream

   a. Shaft in plane with elbow
   b. Shaft 90° out of plane of elbow

2. Curved Face Upstream

   a. Shaft in plane
   b. Shaft 90° out of plane

The above series of test positions were performed for the standard full thickness disc. For 6→20" BFV's all 150 lb. rated t/d=.29. Two thinner t/d ratios (t/d=.17, and t/d=.12) represent alternate valve constructions as dictated by the pressure rating of the full-scale valves installed in the field, for valves above 20" dia.

An elbow inlet/pipe outlet installation was dictated by the physical constraints of the test area (See Fig. No. A ), and by cognizance that certain installations would present piping configurations less than an ideal straight pipe in/

straight pipe out arrangement. Therefore it was considered appropriate for purposes of the test program that an elbow inlet installation represented a worse-case situation, thereby covering most conditions expected to be experienced in the field. It is known that different torque behavior will be experienced by the valve, as a function of disc angle of attack to the flowstream, with an elbow inlet installation, due to flow separation as the fluid curves about the inner radius of the elbow. In addition to changes in torque characteristics relating to flow separation near elbow, the flow through an elbow will require an acceleration of the fluid on the outside radius in an attempt to keep pace with the fluid on the inside radius. This effect causes a velocity difference across the cross section of the elbow, and hence a pressure difference occurs in the elbow. Also, this test program confirmed that a higher torque will be experienced by the valve shaft when the curved side of the disc (body seat downstream) is facing the upstream side of the flow. The forces on the valve shafting were minimized when the flat (body seat upstream) face of the disc was installed upstream, along with the shafts inplane with the elbow radius. See Figs 9 & 10. An offset disc exhibits the above characteristics due to the assymetry of profile that the disc presents to the flowstream. Unlike a lens type disc with a symmetrical profile and consequent unidirectional torsional loading, an offset disc will apply a distinctly positive or negative rotational loading to the shaft depending on whether the disc geometry presented to the flowstream will be the curved side of the disc upstream (body seat downstream) or the flat side upstream (body seat upstream). This effect will tend to make the disc attempt to close in the case of the curved side being upstream, or conversely tends to open with the flat face upstream. Torque coefficients generated from this data will exhibit a positive sign when the valve tends to close, and a negative sign when the valve tends to open. See Figs. 9 & 11.

The testing procedure consisted of obtaining a maximum pressure level of 60 psig with the tunnel pressurization system, opening the tunnel shut-off valve, (See Fig. A ) and subjecting the test valve to tunnel pressure with the test valve disc in the open position (90°).

While the test valve was under pressure conditions, a series of three open to close cycles were performed. The valve was then returned to the open position, and the tunnel pressure allow to decay to the next 10 psig pressure increment, where the triple cycling was again performed. In this manner the valve was tested, while recording data, until tunnel pressure had decayed to below 10 psig. A series of data plots were obtained for each pressure level. For each disc thickness and shaft/elbow plane relationship, a test number was assigned. Disc thickness is expressed as a t/d ratio meaning the ratio of the disc thickness to the disc diameter. This expression then identifies a particular profile that a disc would present to the flowstream in the wide open position. The test number identified valve disc geometry and method of valve installation (See Addendum I From this data, a shaft torque for a given ΔP was calculated for a given inlet pressure, and therefore a corresponding $C_T$ for the condition was obtained. All three disc ratios were tested in this manner.

Measured Variables:

Five variables pertaining to shaft torque calculation were measured and recorded during the testing process. (Refer to Appendix # I for typical examples of recorded data). The initial variable of interest was the pressure drop across the valve, therefore an upstream pressure variable $P_{T1}$, and a downstream pressure variable $P_{T2}$ were recorded. For both pressure variables, static and velocity head (total line pressure) (expressed mathematically

$$\text{Pressure} \quad P = P_S + \rho \frac{V^2}{2g}, \text{ where } P_S = \text{static}$$

$$\text{pressure and } \rho \frac{V^2}{2g} = \text{dynamic pressure}$$

or velocity head were measured. Points of pickup were at the extreme upstream end of the elbow flange for upstream pressure $P_1$, and midway along the length (5 diameters) of exit pipe for downstream pressure $P_2$. Pressure pick-up was by means of double orifice totaling pitot tubes (Prandtl type) leading to strain-gage diaphragm type pressure transducers located sufficient distance from the point of pickup to minimize distortion due to system vibration.

Secondly, torque measurement as a function of flow velocity (or valve disc angle) was a requirement. Therefore strain gages of good commercial quality were mounted on the shafts in an area between the valve disc and the valve actuator. The strain gauges were connected in a temperature compensated wheatstone bridge network to the strip chart recorder amplifier, calibrated to obtain microstrain readings corresponding to a unit torsional deflection of 420 microstrain per inch of chart recorder deflection. By previous calculation, it was determined that for 304 stainless steel with a torsional yield strength of 15000 psi, a maximum permissable torsional deflection of 615 microstrain could be obtained before exceeding the theoretical yield limit. The 615 microstrain correspond to a chart recorder excursion of 1.5 inches, and in no test case was that value exceeded. The 615 microstrain value is a constant for all shafting diameters, and was approached only with the smallest necked down shaft diameter (1/2"). Necking the shaft was required in this small size valve, so as to accomodate the smaller t/d ratios investigated in the test program within the physical limitations of the valve body and disc. In all cases however, even with the greatest pressure drop (ΔP) across the valve, and therefore the highest velocities influencing torsional loading on the disc/shaft assembly, no excessive torque conditions were experienced. This effect can therefore apply indirectly to larger valves with larger shaft diameters as it expresses itself as a change in magnitude of the final calculated $C_T$ value. The microstrain relationship is expressed in terms of the applied torque,

$$\text{IE: } E = \frac{T}{E_S \, \pi \, R^3}\text{; where}$$

$E$ = microstrain (inches x $10^{-6}$)

$T$ = in-lbs.

$E_S$ = Torsional modulus for stainless steel = $12 \times 10^6$ psi

$R$ = Shaft Radius in inches.

Solving for torque yields: $T = .393\ E\ D^3$; where the shaft diameter D is expressed in feet; and the value of E may be determined by reading the microstrain plot.

Thirdly, a temperature probe was connected just downstream of the $P_1$ pressure pickup to enable temperature readings in °F to be recorded. It was felt that recording temperature during valve cycling would be pertinent, if it became necessary to calculate mass flow across the valve for any given pressure drop. Therefore the fourth channel (T) was recorded and is noted in the data listings (See Fig. A ).

Fourth, a position potentiometer, as an integral part of the motor actuator, was connected to the recorder amplifier, and a plot of 90° open to close, valve disc rotation was recorded. This plot enabled a relationship between position versus the other measured variables to be recorded, thereby tying together all variables as an expression of disc angle. It then becomes a relatively simple task to read pressure drop, torsional loading and temperature change as a function of position angle.

Torque Calculations:

The standard formula for applied dynamic torque for butterfly valves:

$$T_d = C_T \times D^3 \times \Delta P \qquad \text{EQ. 1.}$$

where: $T_d$ = Dynamic value torque in ft-lbs.

$C_T$ = Torque coefficient determined from test data.

$\Delta P$ = Total pressure drop measured acorss valve (psi).

$D$ = Valve bore diameter (ft.)

Valve torque coefficients ($C_T$) were compute by solving the above formula for $C_T$, and by utilizing test data for valves of $T_d$ (ft-lbs.) and $\Delta P$ (psi). Therefore, $C_T$ values for the 6" Streamseal valve may be expressed:

$$C_T = \frac{T_d}{\left(\frac{6}{12}\right)^3 \Delta P} = \frac{8\ T_d}{\Delta P} \qquad \text{EQ. 2.}$$

Therefore, by utilizing $C_T$ values calculated from test data, and plugging in appropriate pressure.and dimensional values in

EQ. 1 an accurate value for the dynamic torque for a known pressure drop may be obtained. Pressure drops used in calculating torque in a specific application may be obtained from the test data as long as inlet pressure corresponds with the inlet pressure of the valve in question.

To obtain total dynamic torque in a specific instance, bearing torque ($T_b$) must also be considered. Although not a big factor at high values of inlet pressure ($P_{T1}$), it begins to figure significantly for low values of inlet pressure, and may even become the dominating factor for low inlet pressure values. Bearing torques are to be considered in light of disc behavior under pressure conditions in a given application. Depending on disc orientation in the line, bearing torque will be subtractive as a function of the disc tending to close ($+C_T$) or additive if the disc tends to open ($-C_T$) under flow conditions.

Bearing torque is calculated thus:

$$T_b = 4.71 \times D^2 \times d \times f \times \Delta P$$

where: $T_b$ = Bearing torque (ft-lbs.)

$D$ = Valve dia (ft.)

$d$ = Shaft dia. (in.)

$f$ = Friction Coefficient (.12 for bronze)

$\Delta P$ = Pressure drop (psi)

Total torque applied to the shaft therefore is the algebraic sum of the dynamic torque plus the bearing torque. This torque value is the quantity required to overcome forces operating on both the valve disc and the shaft. The total torque required to move the disc against a given inlet pressure is a function of a number of variables operating simultaneously: Disc Angle, Pressure Drop, Disc Geometry (t/d ratio), Shaft Diameter, Shaft Disc orientation relative to upstream piping components, and degree of pressure recovery downstream of the valve. Pressure recovery downstream of the valve was determined during testing, as presenting a less severe loading to the disc structure than the methods employed in this program, and therefore was not included as it was considered that the methods employed presented a worst case situation to applications encountered in the field.

Calculating Torque Values for Field Applications:

Procedure for calculating torque values for larger valves Ref to Appendix 1 .

1. Determine t/d ratio for valve: $\frac{\text{Disc Thickness (in.)}}{\text{Disc Diameter (in.)}}$

greatly influence the torsional loading on the shaft. Consistently lower torque values were observed with the flat face of the disc located on the upstream side (when closed) of the valve. Higher torques were observed when the curved face of the disc was presented to the upstream flow. As expected, peak torques were experienced by the valve in all cases when the valve achieved an angle of approximately 70°-75° open, with the shaft torque diminishing as the disc approached 0° open.

Another consideration that must be taken into account in determining peak shaft torques, is the relative position of the shaft to the plane of an upstream fitting or elbow. An increase in applied shaft torque was observed when the valve was mounted at 90° to the plane of the elbow on the inlet side. See Fig. 12.

As is characteristic of butterfly valves, the disc will exhibit a tendency to close or to open under flow conditions, as mentioned above. If the curved face of the valve disc is facing upstream the valve will tend to close, and conversely, if the flat face is upstream the valve will tend to open. With the lower t/d ratios, torque reversal will occur in most instances, especially for higher values of pressure drop. $C_T$ values generated calculation incorporating these torque figures will indicate the tendency for the valve to close by being positive (+) when tending to close, and negative (-) when tending to open.

## Conclusions

The test program has demonstrated that torque characteristics exhibited by the streamseal butterfly valve are very dependent on a number of considerations. Initially, a determination of the location of the valve relative to upstream conditions must be evaluated. The existence of an elbow or other interference in flow direction, in the immediate upstream vicinity, will be a factor in determining the placement of the shafts relative to the plane of the elbow. A reduction of shaft torque due to flow separation will be achieved by placing the valve shaft centerlines in the same plane as the elbow radii.

Second, upstream facing disc geometry is important, as it too has a direct bearing on the intensity of the torque applied to the shaft. Curved side facing upstream will apply a greater torque to close the valve than if the flat side of the disc were facing upstream.

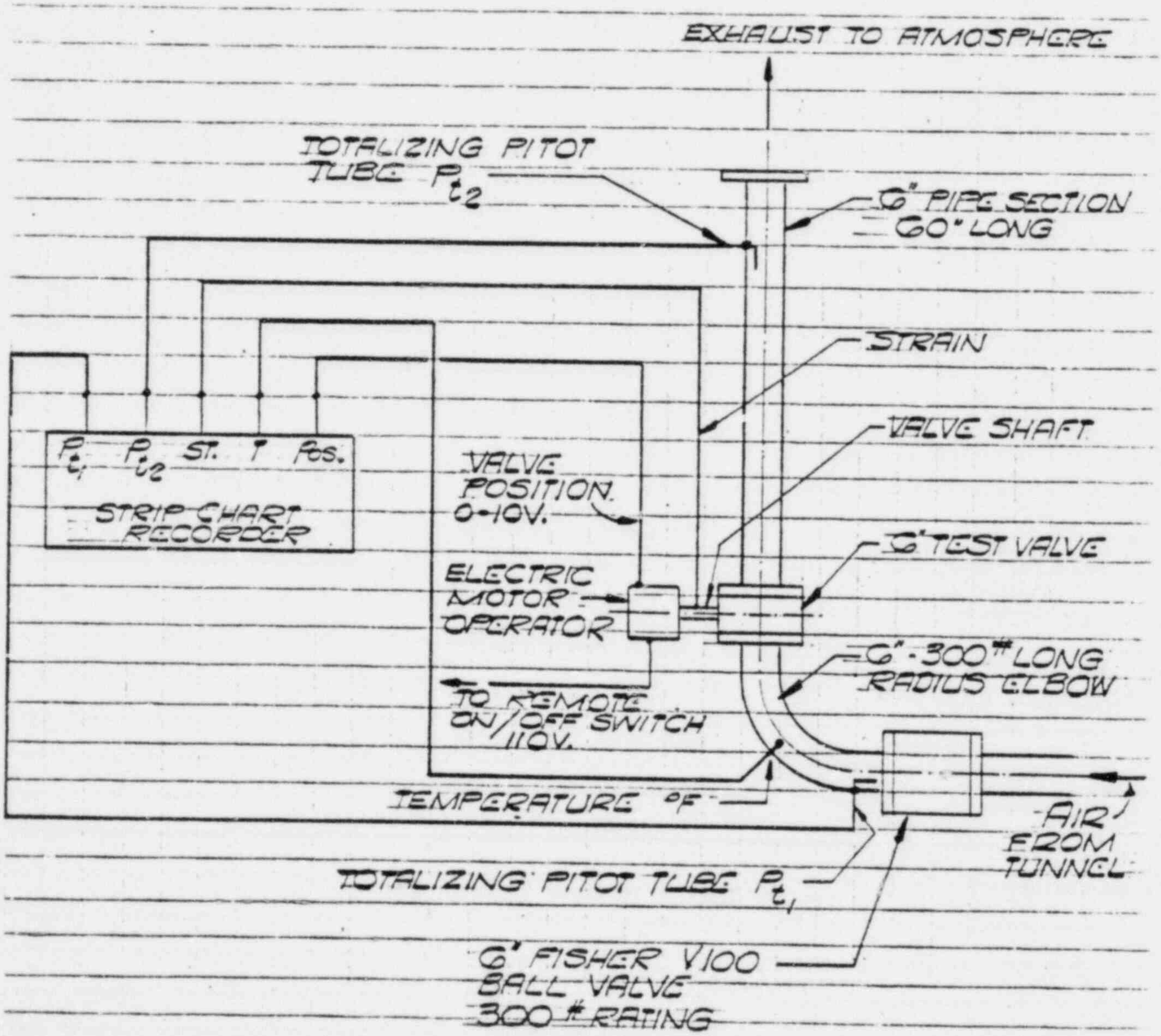
Third, as was previously known the t/d ratio influences the magnitude of the applied shaft torque, whereas the thicker the disc cross section, the greater the aerodynamic effects and consequent increase in applied torque. The t/d ratio also gives a clue as to the relative shaft diameter. That becomes important when determining the bearing torque, as a greater shaft diameter necessitates a greater disc cross section. Shaft diameters must be considered not only for the ability to withstand dynamic forces, but must also be sized with respect to static shear forces under full load shut-off conditions. Hence an ideal t/d ratio is one that optimizes the minimum aerodynamic effects of the disc cross section to adequate shaft diameters supporting both static and dynamic loads.

In consideration of the above, it is indicated that the worst case, with the highest applied shaft torque under any given pressure drop would be when the valve is close mounted to an elbow, at right angles to the plane of the radius and installed with the curved side upstream. Decreasing levels of shaft torque are indicated as each of the above parameters (Refer to Fig. 12) are changed or modified until the lowest level of shaft torque is attained when the shafts are in plane to the elbow, and the flat side of the disc is facing upstream (Refer to Fig 9). Therefore a pertinent recommendation would be to mount the butterfly valves in question as described in the latter case above whenever possible. A further conclusion can be made, that for a specific application accurate calculation of torques under existing conditions and recalculation of expected torques when the conditions are modified can be effected by employing the data given by curve plot, tabulation and formulas given in this report.

| CUSTOMER NASA/LANGLEY RESEARCH CENTER | DATE 12-20-79 | SHEET 1 OF 1 |
|---|---|---|
| SUBJECT 6" BUTTERFLY VALVE AIR TESTS | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET | CALCULATED BY GILGORE |



SCHEMATIC OF TEST SET UP ELEVATION.



Appendix I

STREAMSEAL 6" BFV Valve Tests

| Test # | t/d | Upstream Face | Inlet Pressure PSIA (Range) | Valve Inst. | Valve Position | Fig. No. |
|---|---|---|---|---|---|---|
| 21 | .29 | Flat | 75-25 | Pin/Pout | In Plane | 9 |
| 22 | .29 | Curved | 75-25 | Pin/Pout | In Plane | 11 |
| 23 | .29 | Curved | 75-25 | Pin/Pout | 90° to RT. | 12 |
| 24 | .29 | Flat | 75-25 | Pin/Pout | 90° to RT. | 10 |
| 25 | .12 | Flat | 75-25 | Pin/Pout | In Plane | 9 |
| 26 | .12 | Curved | 75-25 | Pin/Pout | In Plane | 11 |
| 27 | .12 | Curved | 75-25 | Pin/Pout | 90° to RT. | 12 |
| 28 | .12 | Flat | 75.4-25 | Pin/Pout | 90° to RT. | 10 |
| 29 | .17 | Flat | 75-28 | Pin/Pout | In Plane | 9 |
| 30 | .17 | Curved | 75-28 | Pin/Pout | In Plane | 11 |
| 31 | .17 | Curved | 76.4-28 | Pin/Pout | 90° to RT. | 12 |
| 32 | .17 | Flat | 75.4-28 | Pin/Pout | 90° to RT. | 10 |

POOR ORIGINAL

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|---|---|---|
| CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 1 OF 7 |
| SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | | CALCULATED BY WHG |

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS LITHO IN U.S.A.—A-C FORM 6715-1

Test No. 21

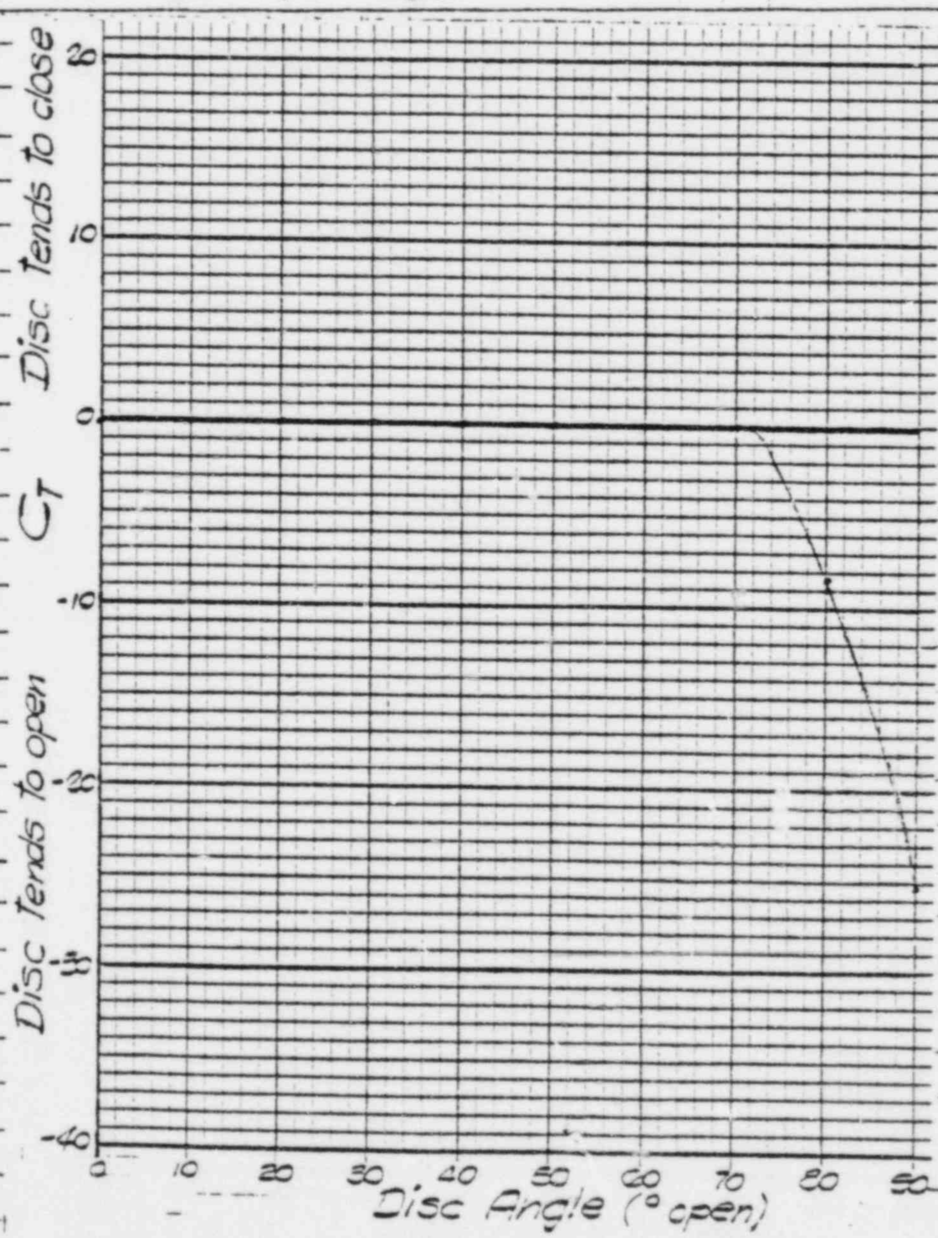
Value disc thickness to diameter ratio: .29

Initial upstream pressure: 10 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



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| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 2 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY WHG |
| | ENGINEERING CALCULATION SHEET<br>ALLIS-CHALMERS FORM 4715-1 | Test No. 21 |

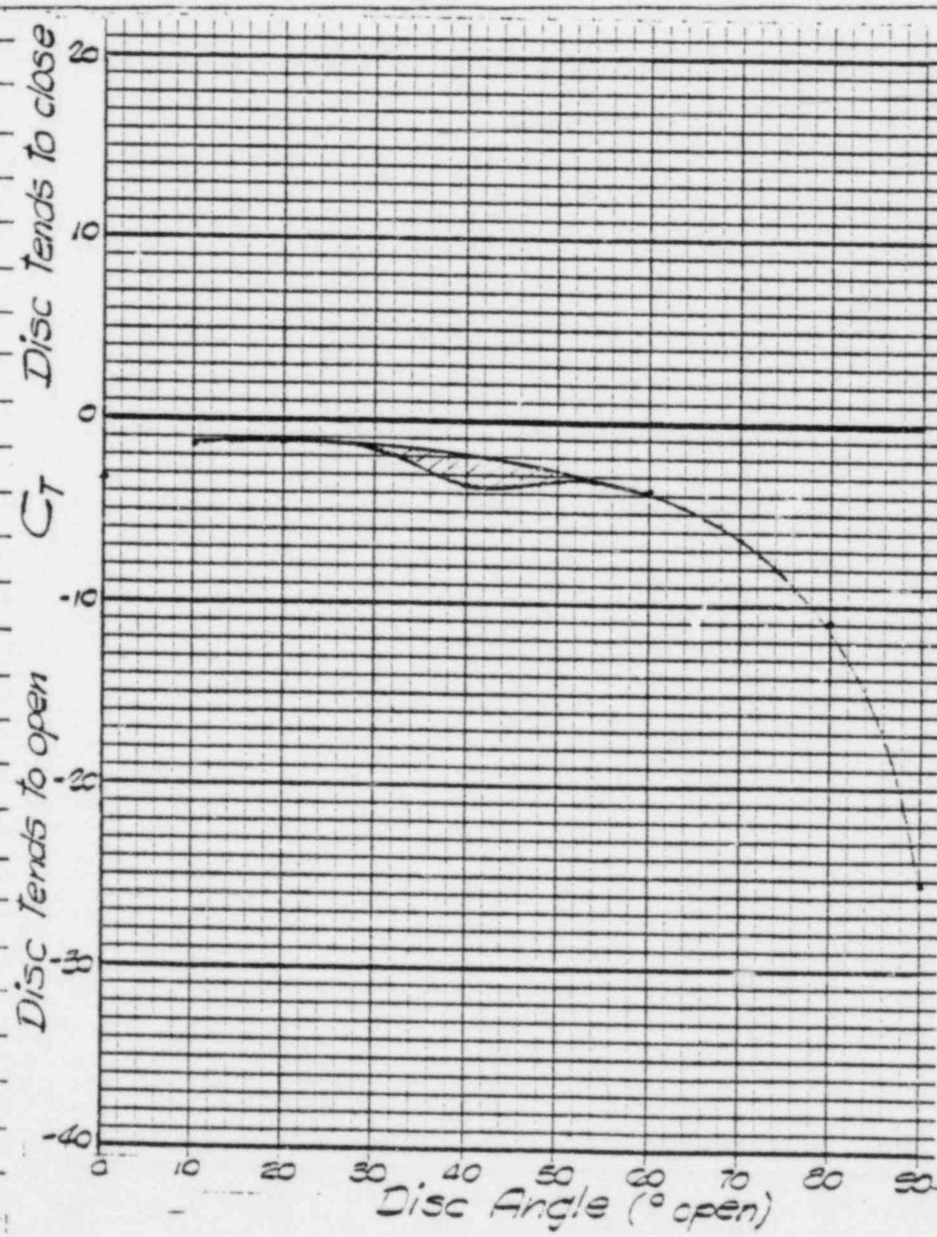
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 15 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where Td is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and ΔP is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 21 $P_{T_1}$ = 10 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 5 | 3 | 2 | -6.3 | -25.2 | 7.1 |
| 80 | 5.5 | 2.5 | 3 | -3.1 | -8.3 | 8.4 |
| 70 | 6 | 2 | 4 | 0 | 0 | 9.8 |
| 60 | 7.5 | 1.5 | 6 | 0 | 0 | 11.1 |
| 50 | 8.5 | 1 | 7.5 | 0 | 0 | 11.8 |
| 40 | 9.5 | 1 | 8.5 | 0 | 0 | 12.5 |
| 30 | 10 | 0 | 10 | 0 | 0 | 13.2 |
| 20 | 10 | 0 | 10 | 0 | 0 | 13.8 |
| 10 | 10 | 0 | 10 | 0 | 0 | 13.8 |
| 0 | 10 | 0 | 10 | 0 | 0 | 13.8 |

Test 21 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 7.5 | 4.5 | 3 | -9.4 | -25.1 | 6.4 |
| 80 | 8 | 4 | 4 | -5.5 | -11.0 | 7.8 |
| 70 | 10 | 3 | 7 | -5.5 | -6.3 | 9.8 |
| 60 | 11 | 3 | 8 | -3.9 | -3.9 | 11.8 |
| 50 | 12.5 | 2.5 | 10 | -3.9 | -3.1 | 12.5 |
| 40 | 14 | 2 | 12 | -5.5 | -3.7 | 13.2 |
| 30 | 14.5 | 1 | 13.5 | -3.1 | -1.8 | 13.8 |
| 20 | 15 | 0 | 15 | -2.0 | -1.1 | 14.5 |
| 10 | 15 | 0 | 15 | -2.4 | -1.3 | 15.2 |
| 0 | 15 | 0 | 15 | -5.9 | -3.1 | 15.2 |

| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 3 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY WHG

Test No. 21

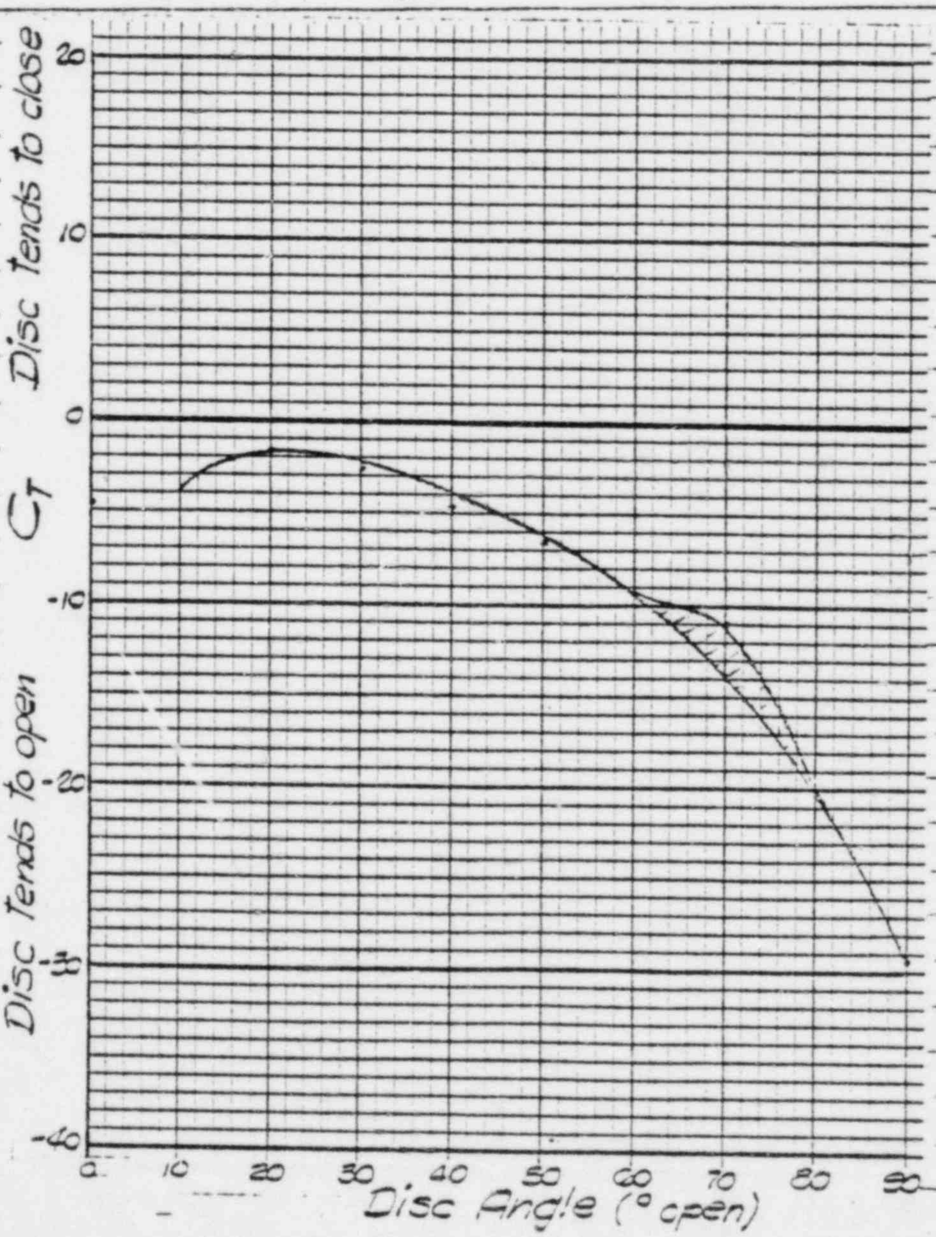
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 20 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY WHG

Test No. 21

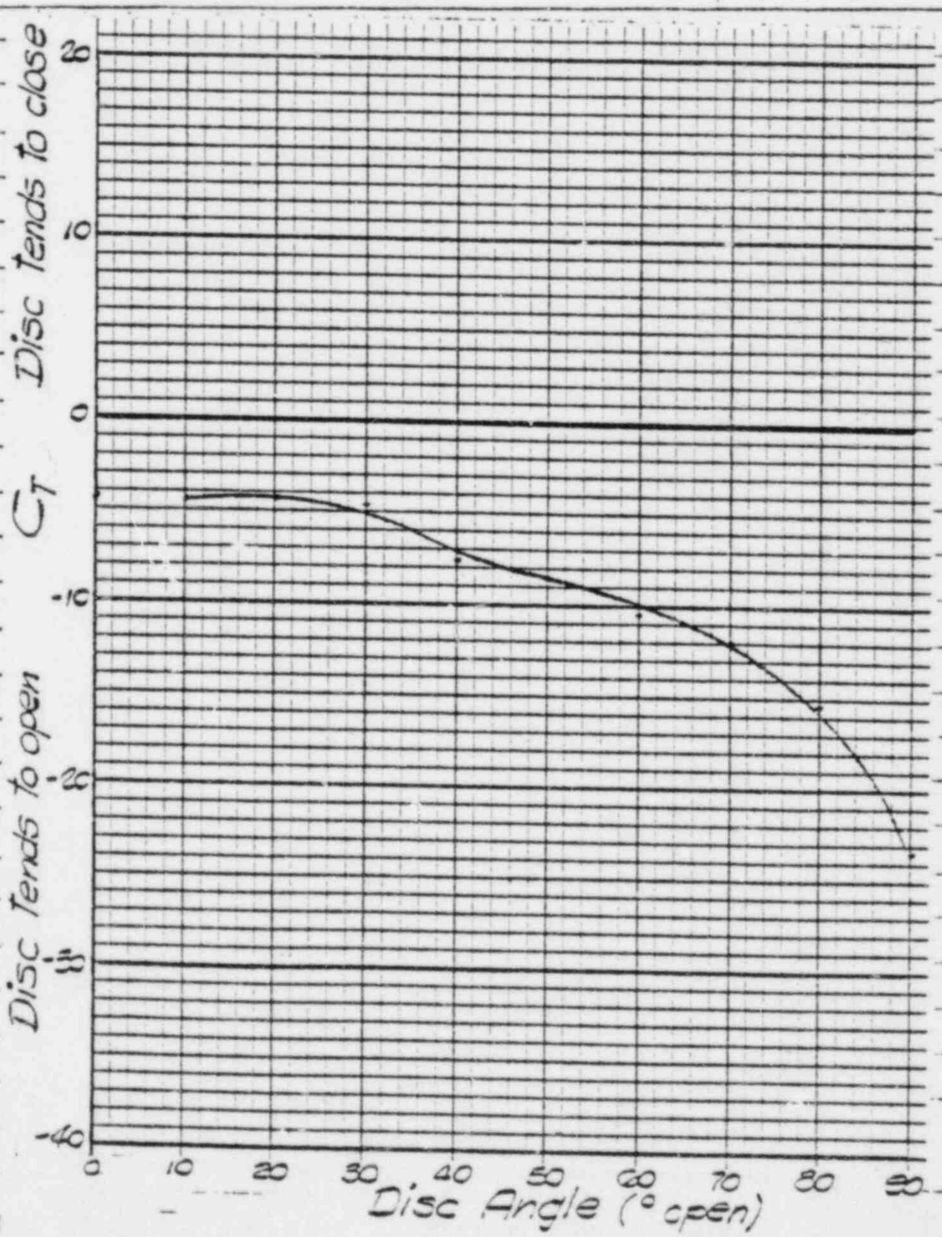
Value disc thickness to diameter ratio: .29

Initial upstream pressure: 30PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $Td = C_T \times D^3 \times \Delta P$

where Td is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 21 20 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 10 | 5.5 | 4.5 | -16.5 | -29.3 | 7.8 |
| 80 | 10.5 | 5 | 5.5 | -13.8 | -20.1 | 8.4 |
| 70 | 14 | 4 | 10 | -13.8 | -11.0 | 10.5 |
| 60 | 15 | 3 | 12 | -13.8 | -9.2 | 11.8 |
| 50 | 16.5 | 2 | 14.5 | -11.8 | -6.5 | 13.8 |
| 40 | 18 | 1.5 | 16.5 | -9.8 | -4.5 | 15.2 |
| 30 | 19 | 1 | 18 | -6.3 | -2.8 | 16.5 |
| 20 | 20 | .5 | 19.5 | -3.9 | -1.6 | 17.2 |
| 10 | 20 | 0 | 20 | -9.8 | -3.9 | 17.9 |
| 0 | 20 | 0 | 20 | -11.8 | -4.7 | 17.9 |

Test 21 30 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 17.5 | 7 | 10.5 | -30.7 | -23.4 | 13.2 |
| 80 | 20 | 7 | 13 | -24.8 | -15.3 | 13.8 |
| 70 | 22.5 | 6 | 16.5 | -24.8 | -12.0 | 16.5 |
| 60 | 25 | 5 | 20 | -25.9 | -10.4 | 18.5 |
| 50 | 28.5 | 4 | 24.5 | -25.9 | -8.5 | 19.9 |
| 40 | 29 | 3 | 26 | -24.8 | -7.6 | 21.2 |
| 30 | 30 | 2 | 28 | -16.5 | -4.7 | 21.9 |
| 20 | 31 | 1 | 30 | -15.7 | -4.2 | 22.6 |
| 10 | 31 | 1 | 30 | -16.5 | -4.4 | 22.6 |
| 0- | 31 | 1 | 30 | -16.5 | -4.4 | 22.6 |

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| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 5 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER — LITHO IN U.S.A.—A-C — CALCULATED BY NHG

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS — FORM 6715-1

Test No. 21

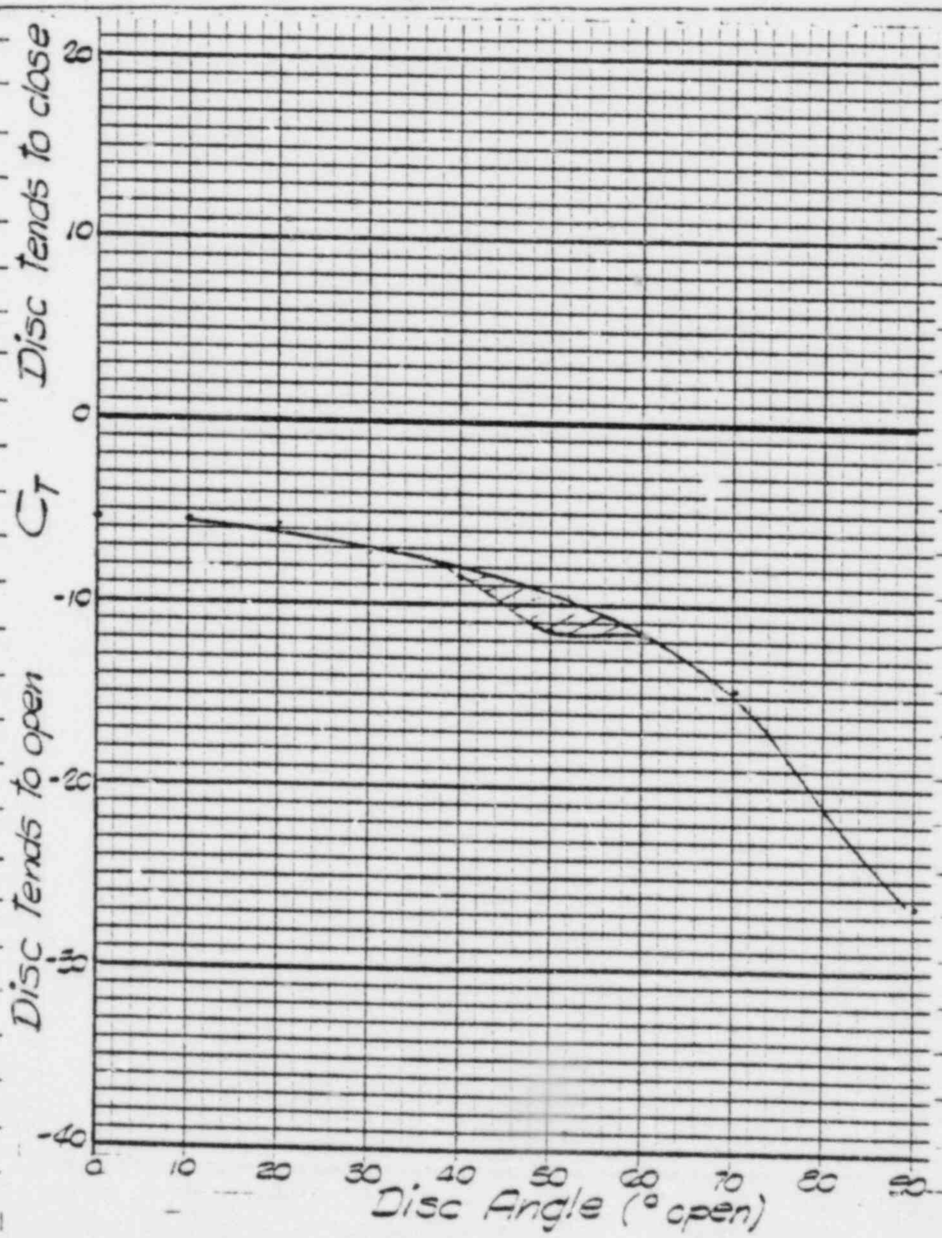
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 40 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



POOR ORIGINAL

CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 6 OF 7

SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.-A-C | CALCULATED BY WHG

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 21

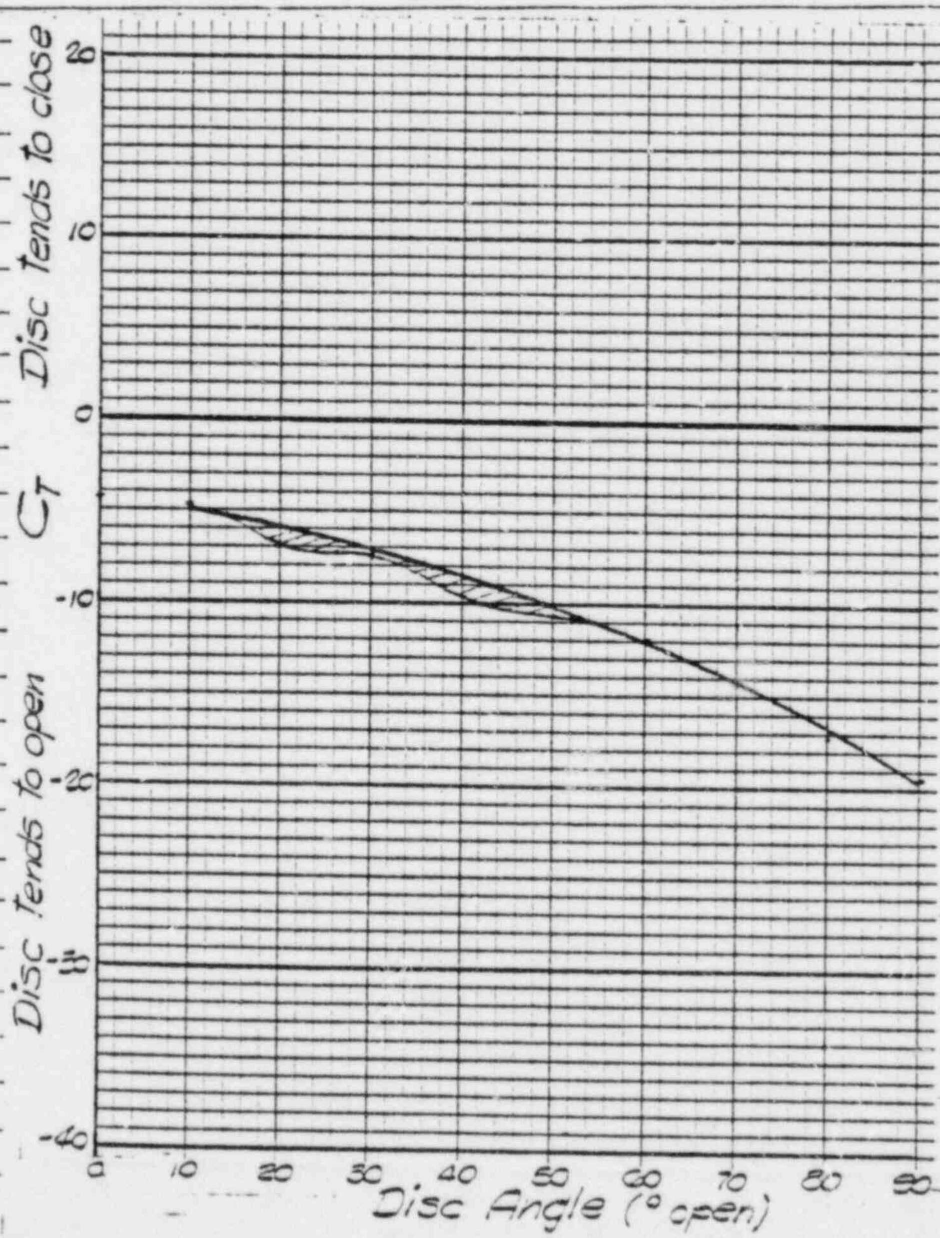
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 50PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 21 40 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25 | 12.5 | 12.5 | -41.3 | -26.4 | 20.6 |
| 80 | 25 | 12.5 | 12.5 | 33.0 | -21.1 | 21.9 |
| 70 | 30 | 12 | 18 | -33.0 | -14.7 | 23.9 |
| 60 | 30.5 | 8 | 22.5 | -33.0 | -11.7 | 25.3 |
| 50 | 35 | 6 | 29 | -41.3 | -11.4 | 28.0 |
| 40 | 35 | 4 | 31 | -33.0 | -8.5 | 29.3 |
| 30 | 35.5 | 4 | 31.5 | 28.1 | -7.1 | 30.7 |
| 20 | 38 | 4 | 34 | -24.8 | -5.8 | 31.3 |
| 10 | 40 | 3 | 37 | -24.8 | -5.4 | 31.3 |
| 0 | 40 | 2 | 38 | -24.8 | -5.2 | 31.3 |

Test 21 50 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 34.0 | 16.5 | 17.5 | -42.9 | -19.6 | 32.0 |
| 80 | 33.0 | 16.0 | 17.0 | -36.3 | -17.1 | 33.3 |
| 70 | 37.5 | 15.0 | 22.5 | -39.6 | -14.1 | 36.0 |
| 60 | 40.0 | 12.5 | 27.5 | -41.3 | -12.0 | 38.1 |
| 50 | 43.0 | 9.0 | 34.0 | -46.2 | -10.9 | 38.7 |
| 40 | 46.0 | 6.5 | 39.5 | -47.9 | -9.7 | 40.1 |
| 30 | 47.0 | 5.0 | 42.0 | -39.6 | -7.5 | 40.7 |
| 20 | 47.5 | 3.5 | 44.0 | -33.0 | -6.0 | 41.4 |
| 10 | 49.0 | 2.5 | 46.5 | -28.1 | -4.8 | 42.1 |
| 0 | 49.0 | 1.5 | 47.5 | -24.8 | -4.2 | 42.1 |

POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 7 of 7 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model — PRELIM. — FINAL

DRAWING NUMBER — LITHO IN U.S.A. — CALCULATED BY WHG

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS — FORM 6715-1

Test No. 21

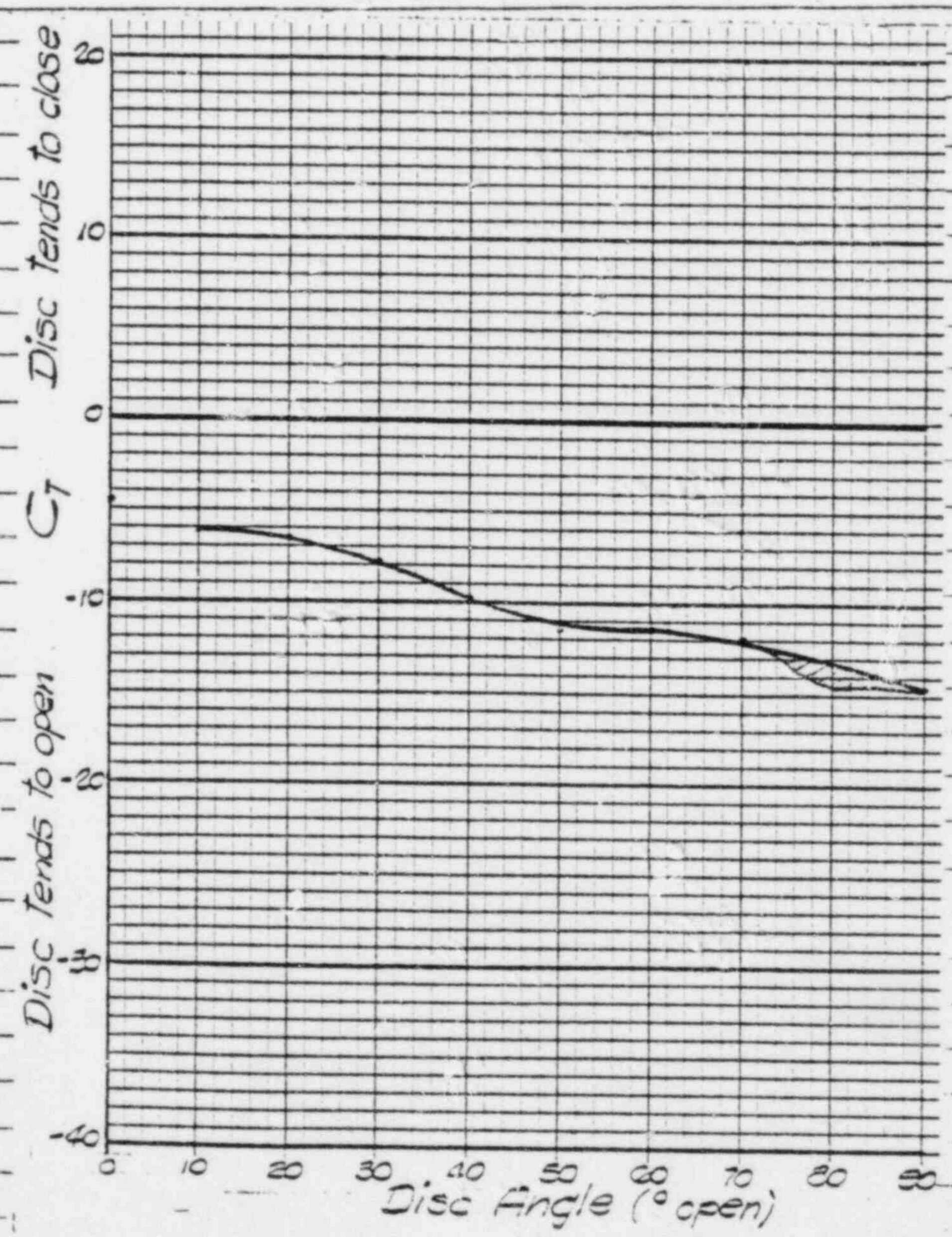
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 60 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 21 60 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 40 | 17.5 | 22.5 | -41.3 | -14.7 | 39.4 |
| 80 | 40 | 17.5 | 22.5 | -41.3 | -14.7 | 40.7 |
| 70 | 45 | 17.5 | 27.5 | -41.3 | -12.0 | 43.4 |
| 60 | 47.5 | 12.5 | 35 | -49.5 | -11.3 | 45.5 |
| 50 | 50 | 10 | 40 | -57.8 | -11.6 | 47.5 |
| 40 | 54 | 7.5 | 46.5 | -57.8 | -9.9 | 49.5 |
| 30 | 55 | 5 | 50 | -49.5 | -7.9 | 50.2 |
| 20 | 55 | 5 | 50 | -41.3 | -6.6 | 50.8 |
| 10 | 55 | 1 | 54 | -41.3 | -6.1 | 51.5 |
| 0 | 57 | 0 | 57 | -33.0 | -4.6 | 51.5 |

POOR ORIGINAL

| | | |
|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 1 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET — ALLIS-CHALMERS — LITHO IN U.S.A. — A-C — FORM 6715-1 | CALCULATED BY WHG — Test No. 22 |

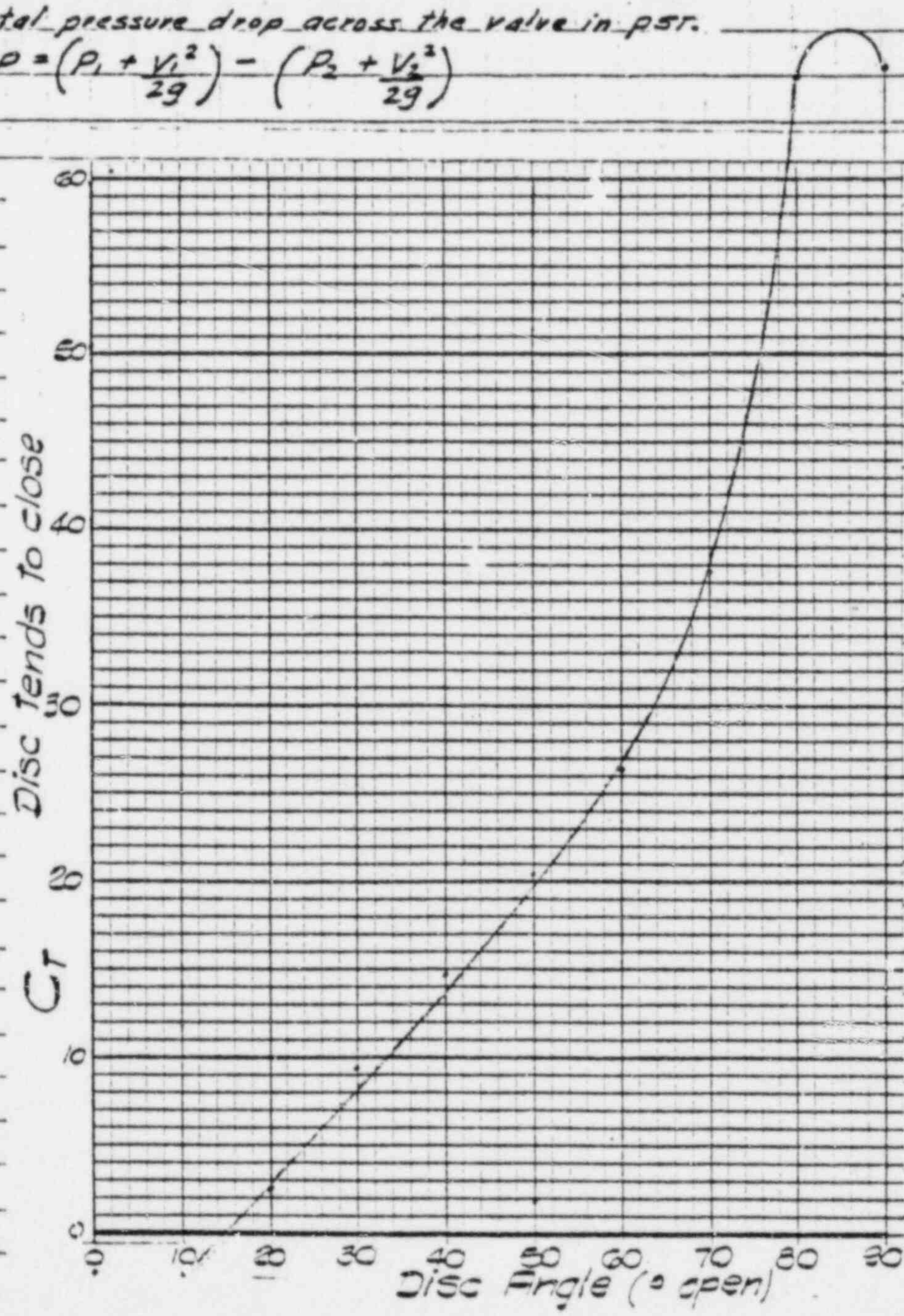
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 10PSIG Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 2 OF 7 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL | |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET (LITHO IN U.S.A. — A-C; ALLIS-CHALMERS; FORM 6715-1) | CALCULATED BY WHG | Test No. 22 |

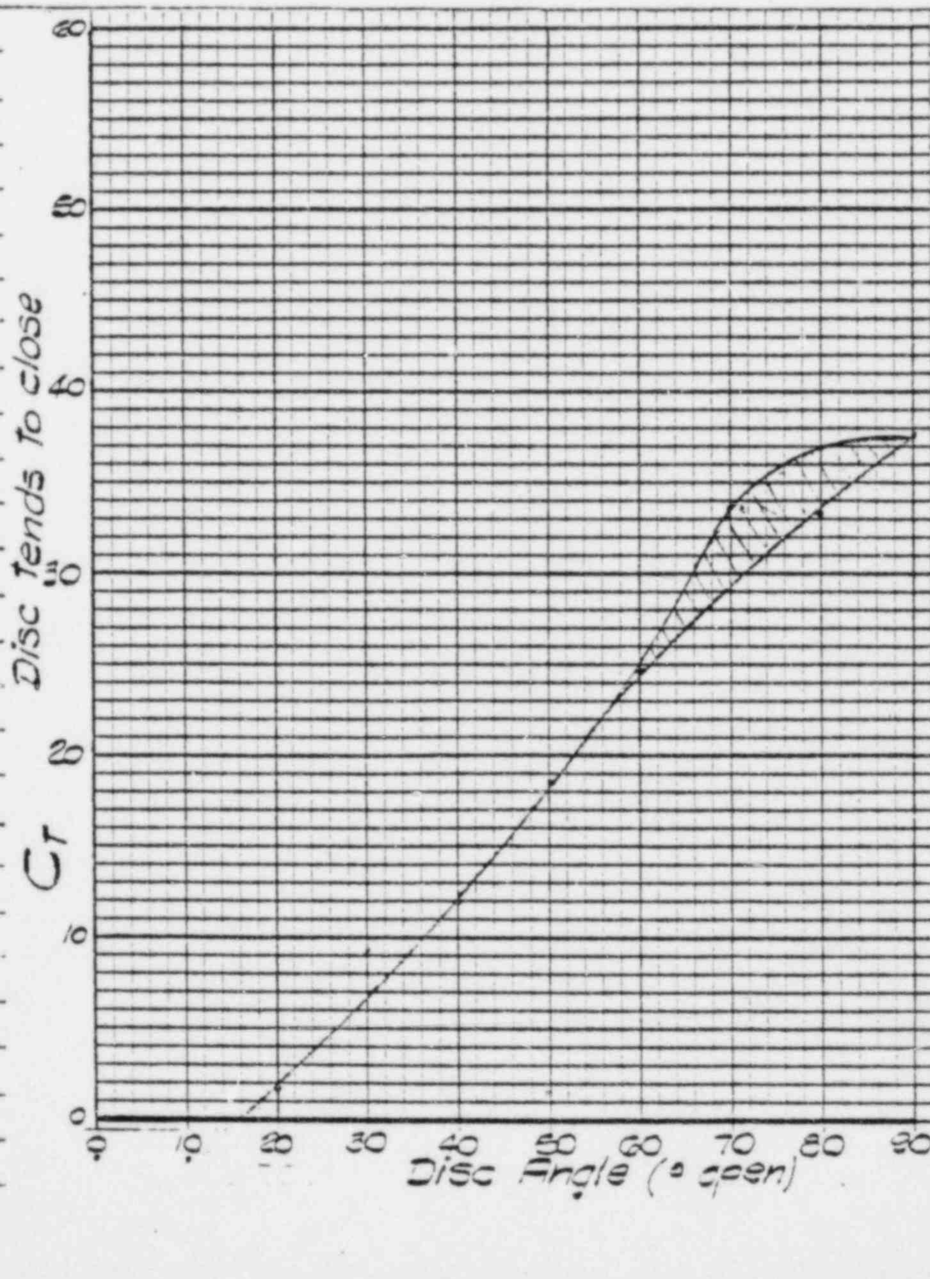
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 15 PSIG   Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 22 $P_{T_1}$ = 10 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4 | 3 | 1 | 8.3 | 66.4 | 5.1 |
| 80 | 5 | 3 | 2 | 16.5 | 66 | 6.4 |
| 70 | 5.5 | 2 | 3.5 | 16.5 | 37.7 | 8.4 |
| 60 | 7 | 2 | 5 | 16.5 | 26.4 | 10.5 |
| 50 | 8 | 1.5 | 6.5 | 16.5 | 20.3 | 11.8 |
| 40 | 9 | 1 | 8 | 14.9 | 14.9 | 11.8 |
| 30 | 10 | .5 | 9.5 | 11.0 | 9.3 | 13.2 |
| 20 | 10 | .5 | 9.5 | 3.1 | 2.6 | 13.2 |
| 10 | 10 | .5 | 9.5 | -3.1 | -2.6 | 13.2 |
| 0 | 10 | 0 | 10 | -3.1 | -2.5 | 13.2 |

Test 22 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 6.5 | 3 | 3.5 | 16.5 | 37.7 | 5.1 |
| 80 | 9 | 3 | 6 | 24.8 | 33.1 | 6.4 |
| 70 | 9 | 2.5 | 6.5 | 27.5 | 33.8 | 8.4 |
| 60 | 10 | 2 | 8 | 24.8 | 24.8 | 10.5 |
| 50 | 11 | 1.5 | 9.5 | 22.0 | 18.5 | 11.8 |
| 40 | 12 | 1 | 11 | 16.5 | 12 | 11.8 |
| 30 | 13 | 1 | 12 | 13.8 | 9.2 | 12.5 |
| 30 | 13 | 0 | 13 | 3.1 | 1.9 | 12.5 |
| 10 | 13 | 0 | 13 | -3.1 | -1.9 | 12.5 |
| 0 | 13 | 0 | 13 | -3.1 | -1.9 | 12.5 |

POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 3 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | ENGINEERING CALCULATION SHEET | CALCULATED BY WHG |
|---|---|---|
| | LITHO IN U.S.A.—A-C · ALLIS-CHALMERS · FORM 6715-1 | Test No. 22 |

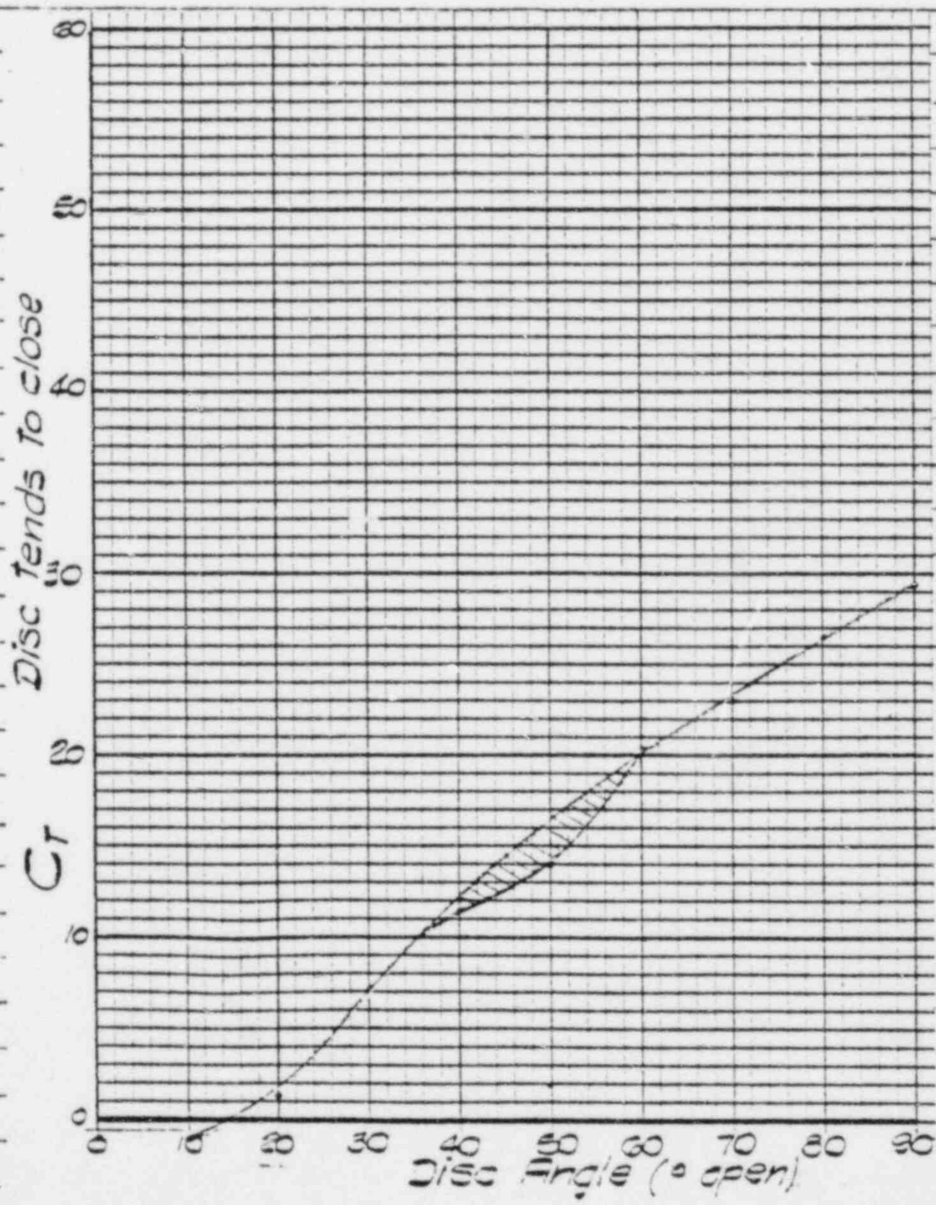
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 20 PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| | | |
|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 4 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET — ALLIS-CHALMERS — LITHO IN U.S.A.—A-C — FORM 6715-1 | CALCULATED BY WHG — Test No. 22 |

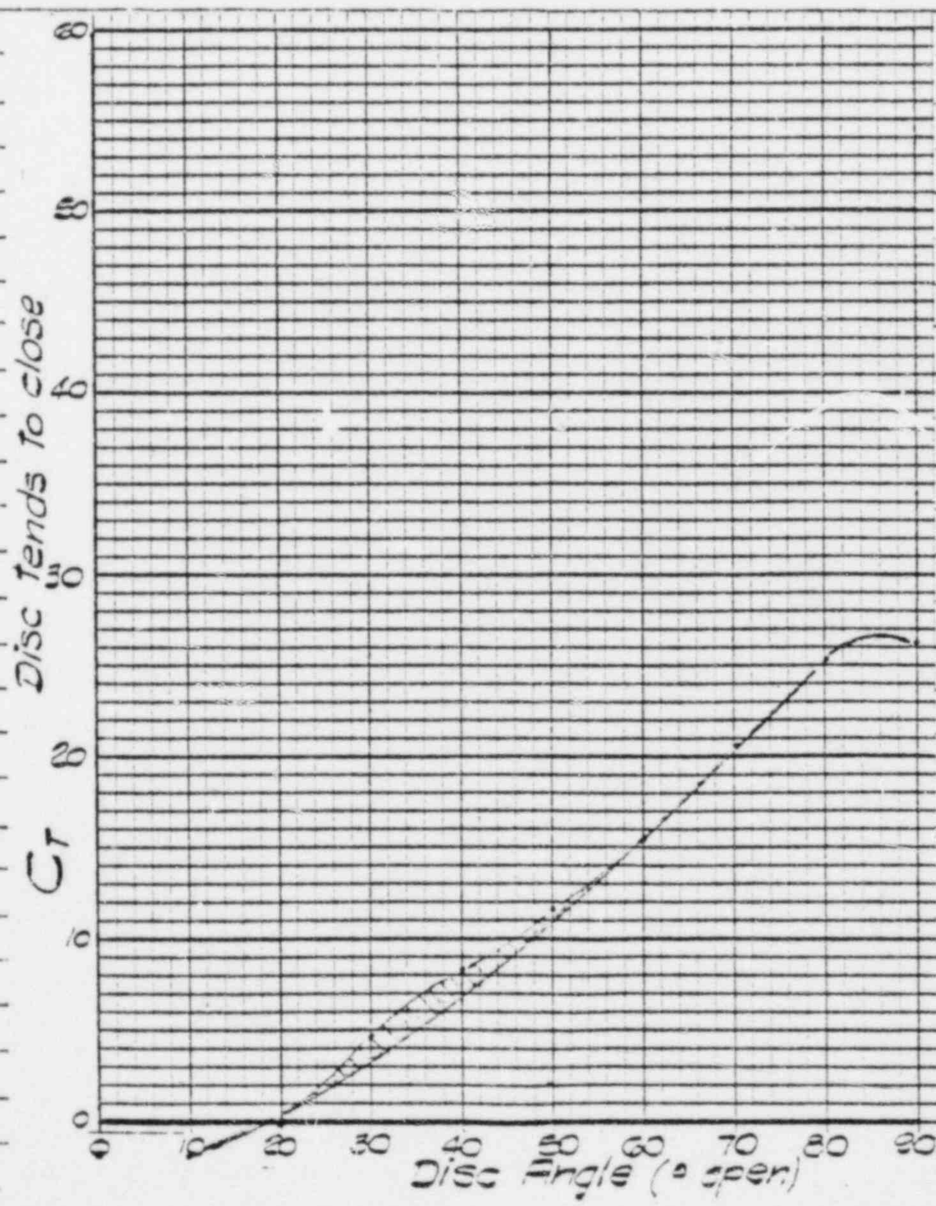
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 30PSIG   Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where Td is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and ΔP is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 22 20 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 10 | 4 | 6 | 22 | 29.3 | 6.4 |
| 80 | 13 | 3 | 10 | 33 | 26.4 | 8.4 |
| 70 | 14 | 2.5 | 11.5 | 33 | 23.0 | 10.5 |
| 60 | 15 | 2 | 13 | 33 | 20.3 | 11.8 |
| 50 | 18 | 2 | 16 | 28 | 14 | 13.8 |
| 40 | 19 | 1.5 | 17.5 | 24.8 | 11.3 | 15.2 |
| 30 | 19.5 | 1 | 18.5 | 16.5 | 7.1 | 15.2 |
| 20 | 20 | 0 | 20 | 3.1 | 1.2 | 15.2 |
| 10 | 20 | 0 | 20 | -3.1 | -1.2 | 15.8 |
| 0 | 20 | 0 | 20 | -3.1 | -1.2 | 15.8 |

Test 22 30 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 17 | 8 | 9 | 29.5 | 26.2 | 11.8 |
| 80 | 20 | 6 | 14 | 44.0 | 25.1 | 13.2 |
| 70 | 22 | 5 | 17 | 44.0 | 20.7 | 15.8 |
| 60 | 24 | 4 | 20 | 38.5 | 15.4 | 17.2 |
| 50 | 25.5 | 3 | 22.5 | 33.0 | 11.7 | 18.5 |
| 40 | 27 | 1.5 | 25.5 | 25.9 | 8.1 | 18.5 |
| 30 | 29 | 0 | 29 | 17.3 | 4.8 | 19.2 |
| 20 | 30 | 0 | 30 | 0 | 0 | 19.9 |
| 10 | 30 | 0 | 30 | -7.1 | -1.9 | 19.9 |
| 0 | 30 | 0 | 30 | -6.3 | -1.7 | 19.9 |

POOR ORIGINAL

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|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 5 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET (LITHO IN U.S.A.—A-C; ALLIS-CHALMERS; FORM 6715-1) | CALCULATED BY WHG; Test No. 22 |

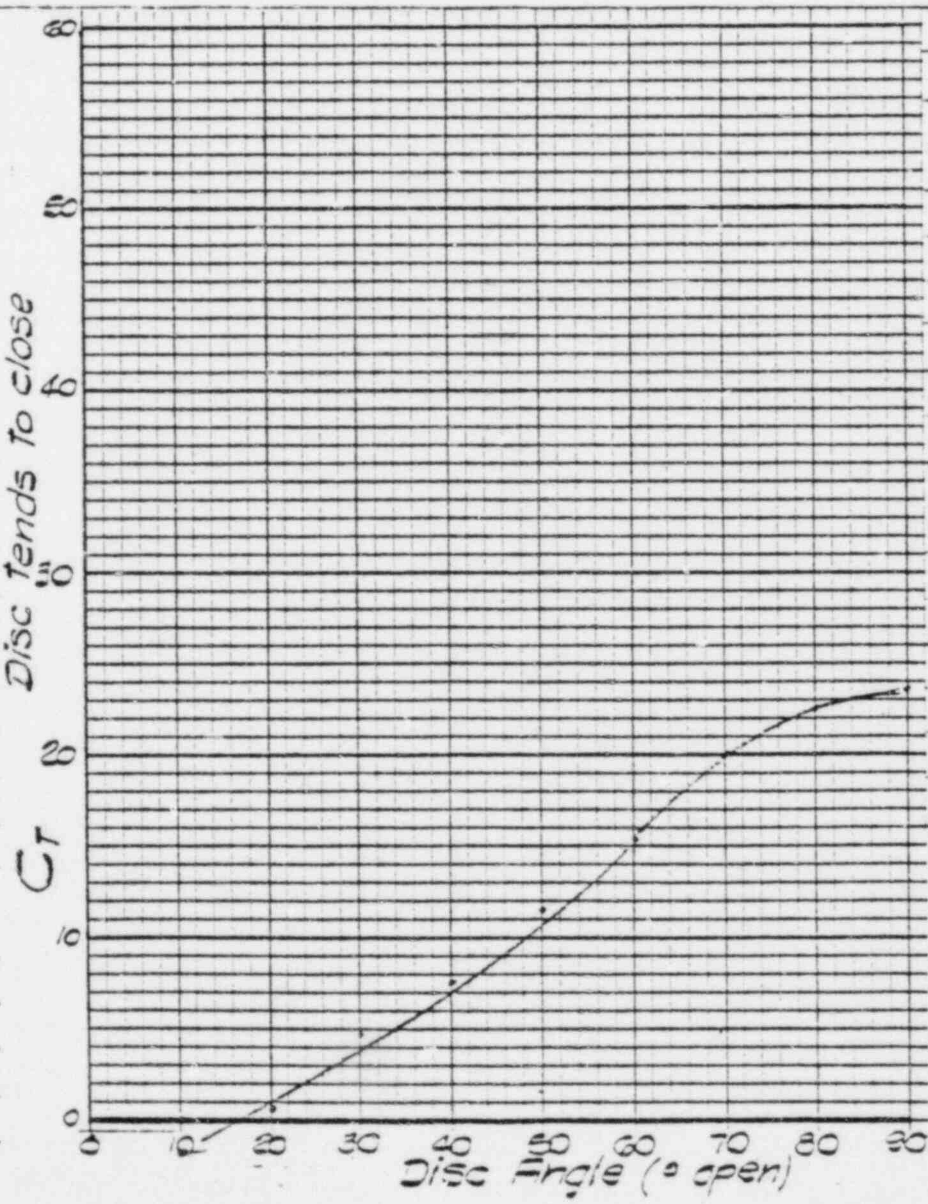
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 40PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Elow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 6 of 7 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. FINAL

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 4715-1

CALCULATED BY WHG

Test No. 22

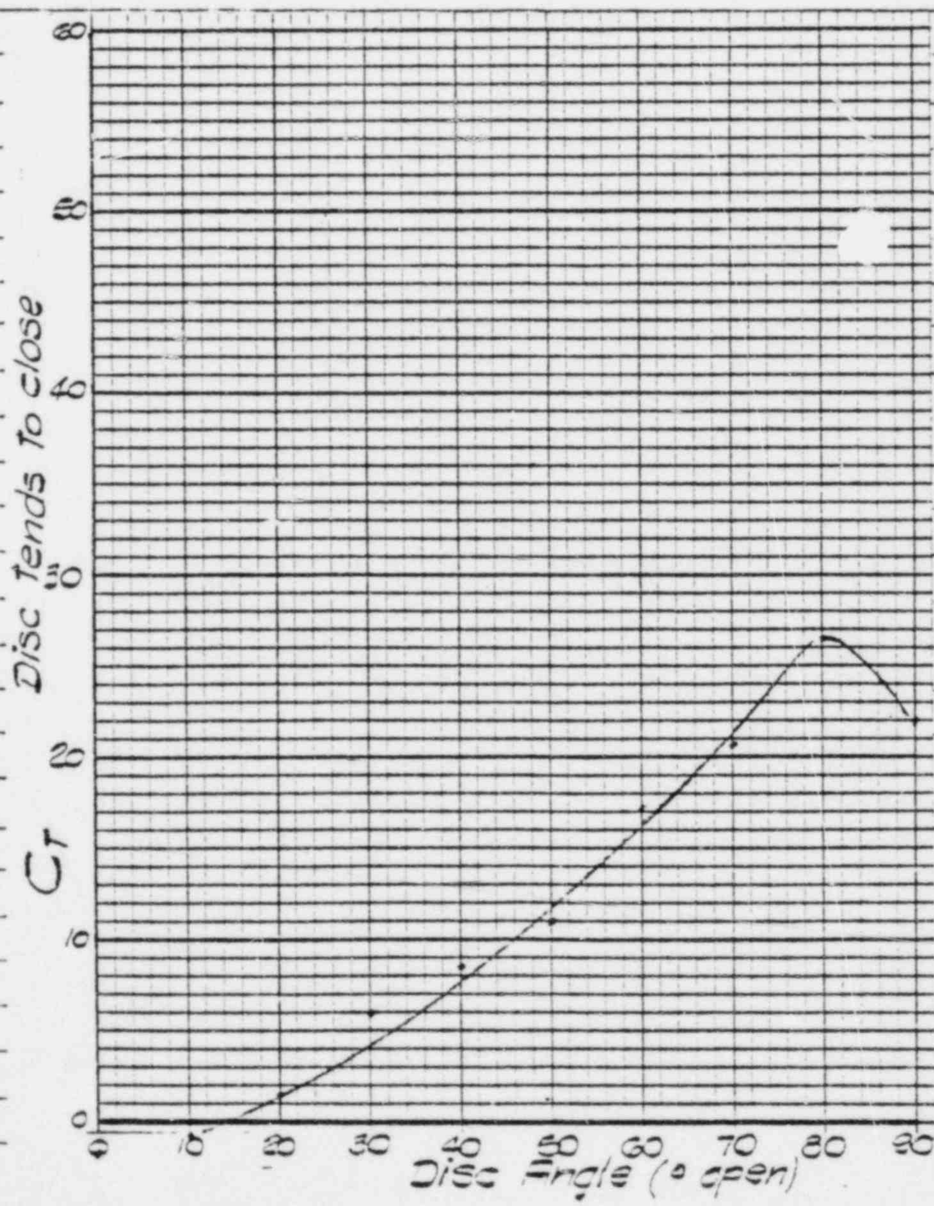
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 50PSIG Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 22 40 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25 | 12 | 13 | 38.5 | 23.7 | 19.9 |
| 80 | 29 | 9.5 | 19.5 | 55 | 22.6 | 21.9 |
| 70 | 30 | 8 | 22 | 55 | 20 | 23.9 |
| 60 | 33 | 7 | 26 | 49.5 | 15.2 | 25.3 |
| 50 | 35 | 5 | 30 | 44 | 11.7 | 27.3 |
| 40 | 37.5 | 3 | 34.5 | 33 | 7.7 | 28.6 |
| 30 | 38 | 2 | 36 | 22 | 4.9 | 29.3 |
| 20 | 38 | 1 | 37 | 3.9 | .8 | 30.0 |
| 10 | 39 | 0 | 39 | -11.0 | -2.3 | 30.0 |
| 0 | 40 | 0 | 40 | -5.5 | -1.1 | 30.0 |

Test 22 50 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 34 | 16 | 18 | 49.5 | 22 | 32.0 |
| 80 | 35 | 15 | 20 | 66.0 | 26.4 | 33.3 |
| 70 | 38.5 | 13 | 25.5 | 66.0 | 20.7 | 35.4 |
| 60 | 38.5 | 13 | 25.5 | 54.6 | 17.1 | 37.4 |
| 50 | 44 | 8 | 36 | 49.5 | 11 | 38.7 |
| 40 | 45 | 5 | 40 | 41.3 | 8.3 | 39.4 |
| 30 | 47 | 3 | 44 | 33.0 | 6 | 39.4 |
| 20 | 47.5 | 2 | 45.5 | 8.3 | 1.5 | 40.1 |
| 10 | 48 | 1 | 47 | -5.5 | -.9 | 40.1 |
| 0 | 49 | 1 | 48 | -8.3 | -1.4 | 40.1 |

POOR ORIGINAL

| | | |
|---|---|---|
| CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 7 OF 7 |
| SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY WHG |
| ENGINEERING CALCULATION SHEET | ALLIS-CHALMERS FORM 6715-1 | Test No. 22 |

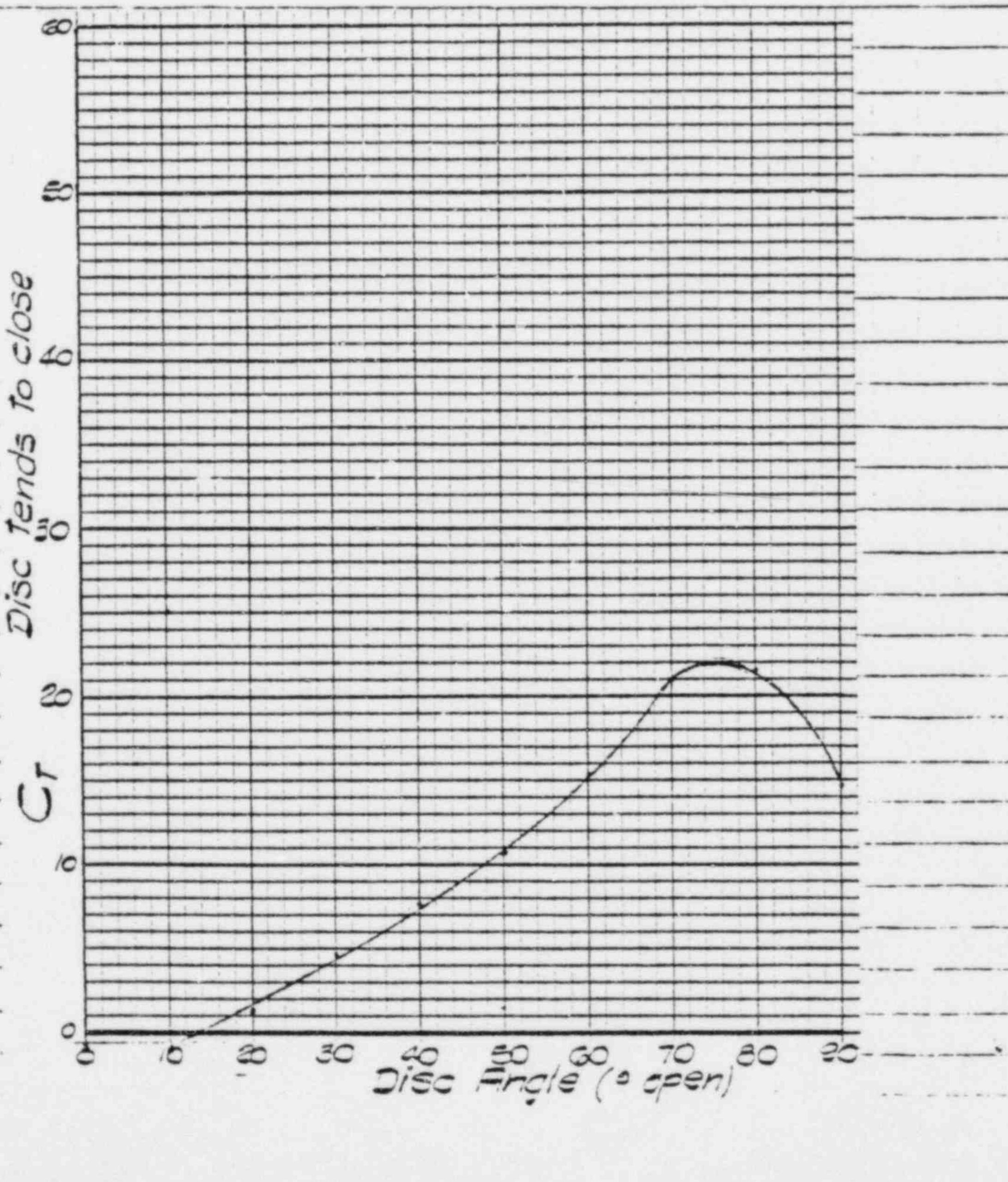
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 60 PSIG    Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 22 60 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 40.5 | 17 | 23.5 | 57.8 | 19.7 | 37.4 |
| 80 | 40 | 16 | 24 | 66.0 | 22 | 38.7 |
| 70 | 43.5 | 15.5 | 28 | 66.0 | 18.9 | 41.4 |
| 60 | 45 | 32.5 | 32.5 | 66.0 | 16.2 | 43.4 |
| 50 | 52.5 | 10 | 42.5 | 57.8 | 10.9 | 45.5 |
| 40 | 56 | 7 | 49 | 47.2 | 7.7 | 46.1 |
| 30 | 57.5 | 3.5 | 54 | 33.0 | 4.9 | 46.8 |
| 20 | 59 | 3 | 56 | 7.9 | 1.1 | 46.8 |
| 10 | 59.5 | 2 | 57.5 | -6.3 | -.9 | 46.8 |
| 0 | 59.5 | 2 | 57.5 | -9.8 | -1.4 | 46.8 |

POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 1 OF 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY |
|---|---|---|
| | ENGINEERING CALCULATION SHEET | WHG |
| | ALLIS-CHALMERS FORM 6715-1 | Test No. 23 |

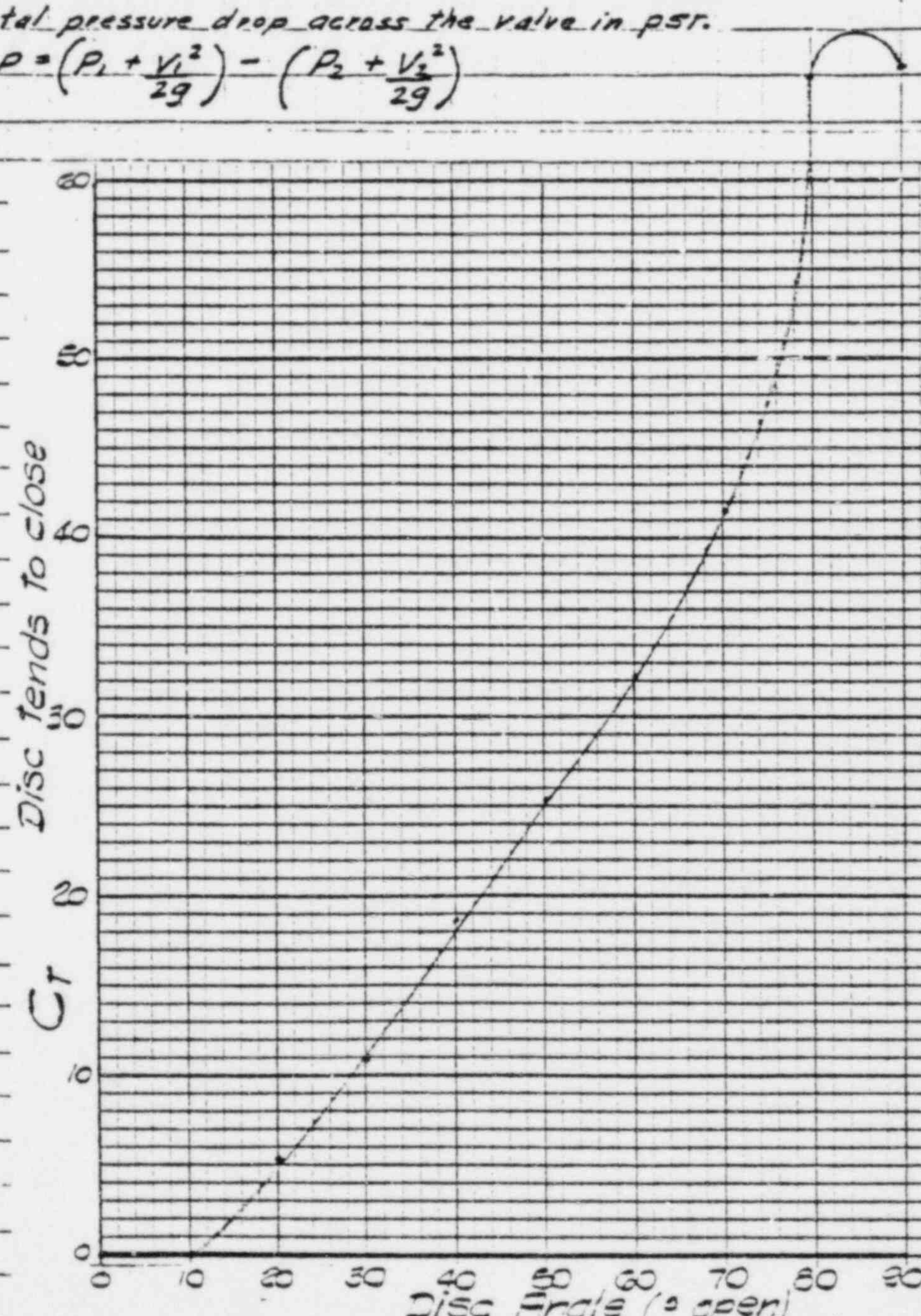
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 10 PSIG  Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 2 of 7 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS | FORM 6715-1

Test No. 23

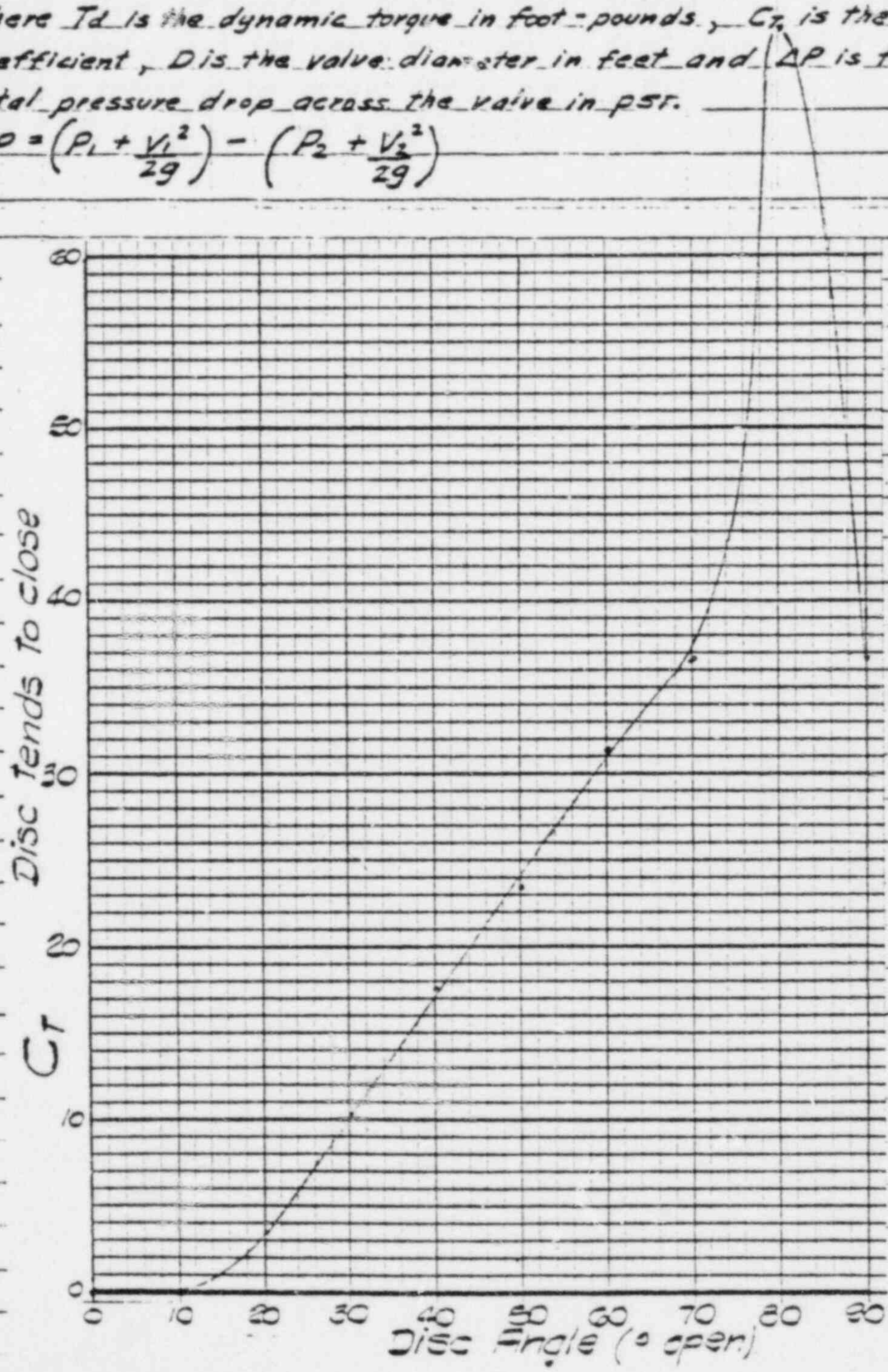
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 15 PSIG    Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 23 $P_{T_1}$ = 10 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4 | 3 | 1 | 8.3 | 66.4 | 5.1 |
| 80 | 5 | 3 | 2 | 16.5 | 66.0 | 5.1 |
| 70 | 5.5 | 2 | 3.5 | 18.1 | 41.4 | 8.4 |
| 60 | 6 | 1.5 | 4.5 | 18.1 | 32.2 | 10.5 |
| 50 | 7 | 1.5 | 5.5 | 17.3 | 25.2 | 11.1 |
| 40 | 8 | 1 | 7 | 16.5 | 18.9 | 11.8 |
| 30 | 9 | 1 | 8 | 11.0 | 11.0 | 11.8 |
| 20 | 9 | .5 | 8.5 | 5.5 | 5.2 | 11.8 |
| 10 | 10 | .5 | 9.5 | 0 | 0 | 11.8 |
| 0 | 10 | .5 | 9.5 | 0 | 0 | 11.8 |

Test 23 $P_{T_1}$ = 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 6 | 3 | 3 | 13.8 | 36.8 | 5.1 |
| 80 | 7 | 1 | 3 | 27.5 | 73.3 | 5.1 |
| 70 | 9 | 3 | 6 | 27.5 | 36.7 | 8.4 |
| 60 | 10 | 3 | 7 | 27.5 | 31.4 | 10.5 |
| 50 | 11 | 2.5 | 8.5 | 24.8 | 23.3 | 11.8 |
| 40 | 12 | 2 | 10 | 22.0 | 17.6 | 11.8 |
| 30 | 13 | 1.5 | 11.5 | 14.9 | 10.4 | 11.8 |
| 20 | 14 | 1 | 13 | 5.5 | 3.4 | 11.8 |
| 10 | 14 | 1 | 13 | 0 | 0 | 11.8 |
| 0 | 14 | 1 | 13 | 0 | 0 | 11.8 |

CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 3 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY WHG

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 23

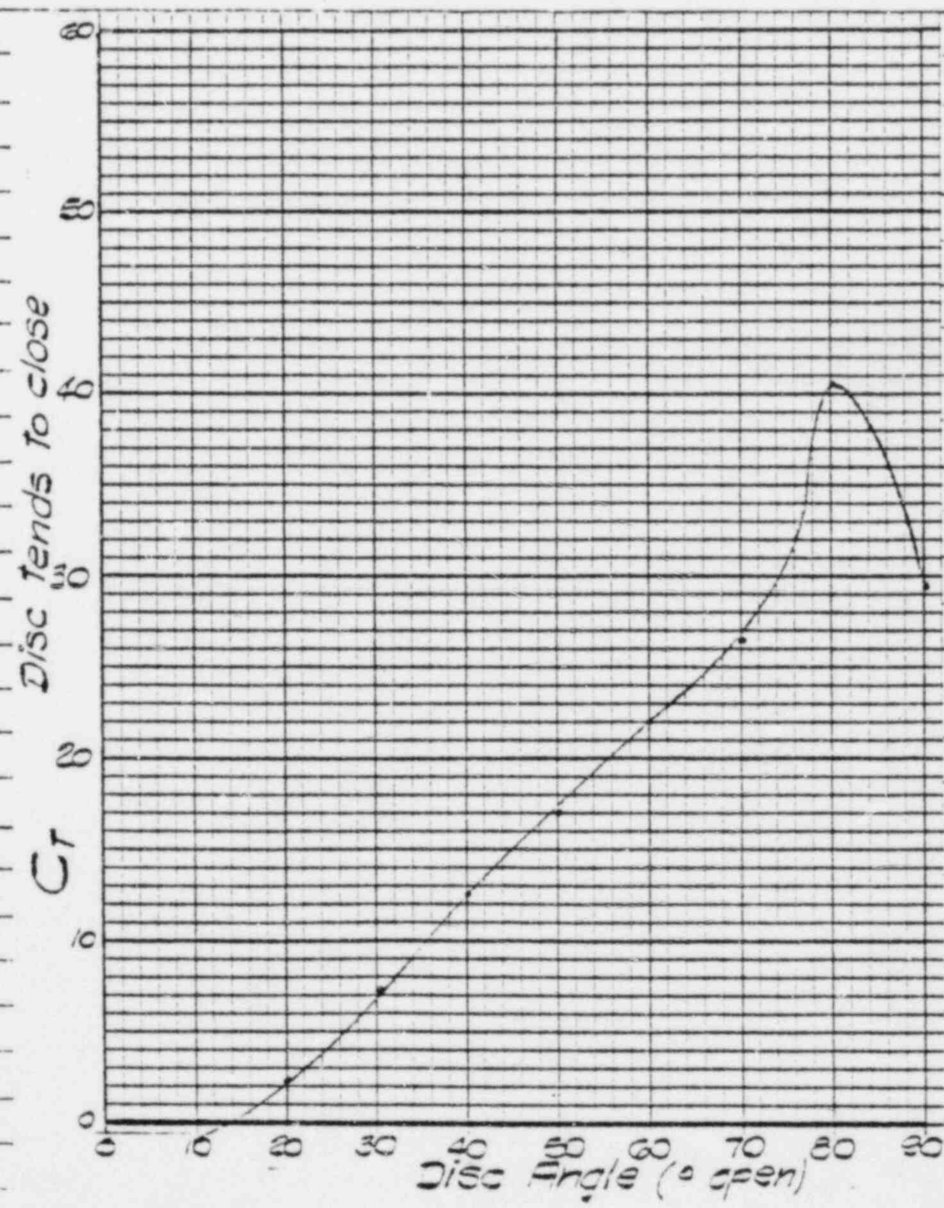
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 20PSIG   Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER — LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS — FORM 6715-1

CALCULATED BY WHG

Test No. 23

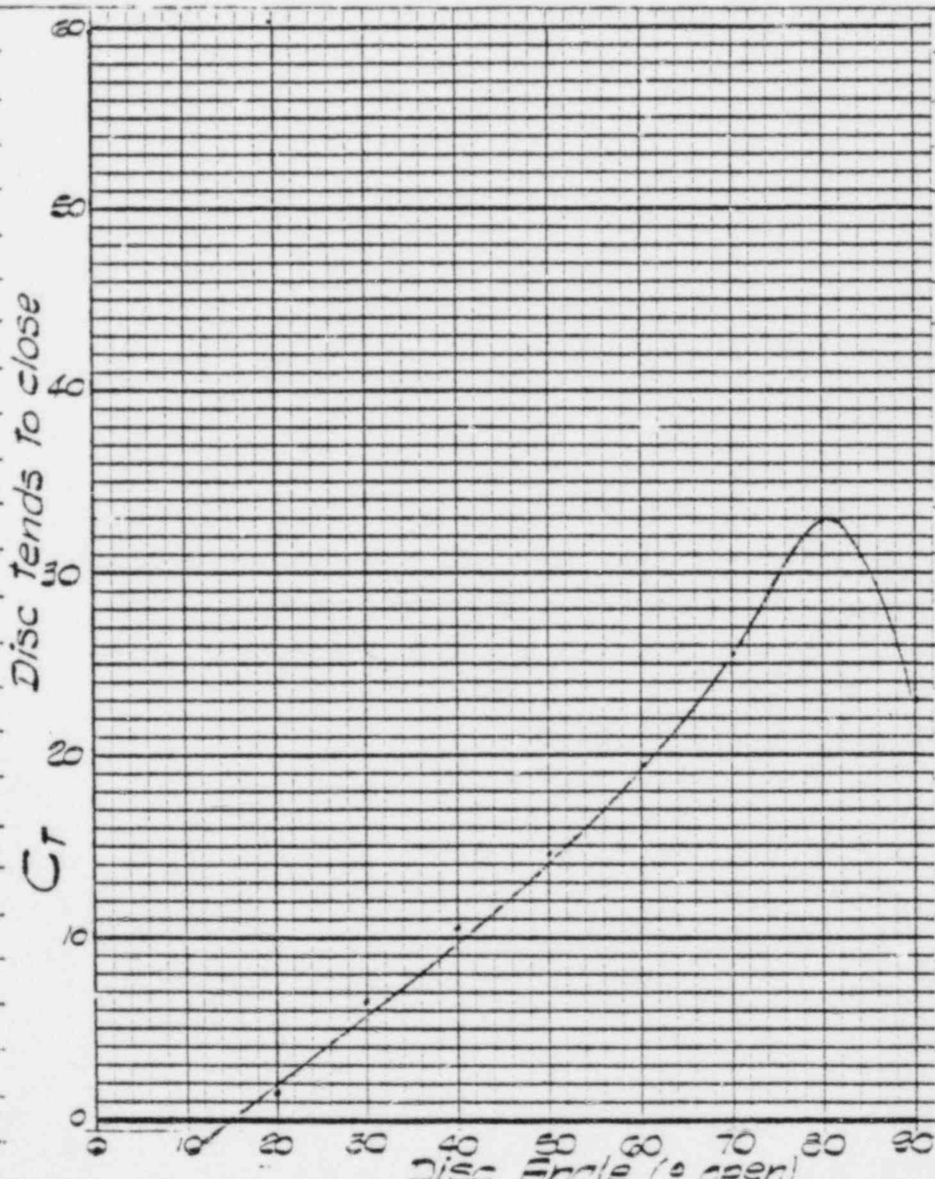
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 30PSIG  Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 23 $P_{T_1}$ = 20 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 10 | 4 | 6 | 22.0 | 29.3 | 5.1 |
| 80 | 12.5 | 6 | 6.5 | 33.0 | 40.6 | 7.8 |
| 70 | 14 | 3.5 | 10.5 | 34.6 | 26.4 | 9.8 |
| 60 | 15 | 3 | 12 | 33.0 | 22.0 | 11.8 |
| 50 | 17.5 | 2 | 15.5 | 33.0 | 17.0 | 13.2 |
| 40 | 18.5 | 1 | 17.5 | 27.5 | 12.6 | 13.8 |
| 30 | 19 | .5 | 18.5 | 16.5 | 7.1 | 15.2 |
| 20 | 20 | 0 | 20 | 5.5 | 2.2 | 15.2 |
| 10 | 20 | 0 | 20 | -2.8 | -1.1 | 15.2 |
| 0 | 20 | 0 | 20 | -2.8 | -1.1 | 15.2 |

Test 23 $P_{T_1}$ = 30 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 19 | 7.5 | 11.5 | 33.0 | 23.0 | 11.8 |
| 80 | 20 | 8 | 12 | 49.5 | 33.0 | 11.8 |
| 70 | 22 | 6.5 | 15.5 | 49.5 | 25.5 | 15.2 |
| 60 | 25.5 | 5 | 20.5 | 49.5 | 19.3 | 17.2 |
| 50 | 26 | 3.5 | 22.5 | 41.3 | 14.7 | 17.9 |
| 40 | 27.5 | 2.5 | 25.0 | 33.0 | 10.6 | 18.5 |
| 30 | 28 | 1.5 | 26.5 | 22.0 | 6.6 | 18.5 |
| 20 | 29 | 1 | 28 | 5.5 | 1.6 | 18.5 |
| 10 | 29 | 1 | 28 | -5.5 | -1.6 | 19.2 |
| 0 | 29 | 1 | 28 | -5.5 | -1.6 | 19.9 |

CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 5 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY WHG

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1 | Test No. 23

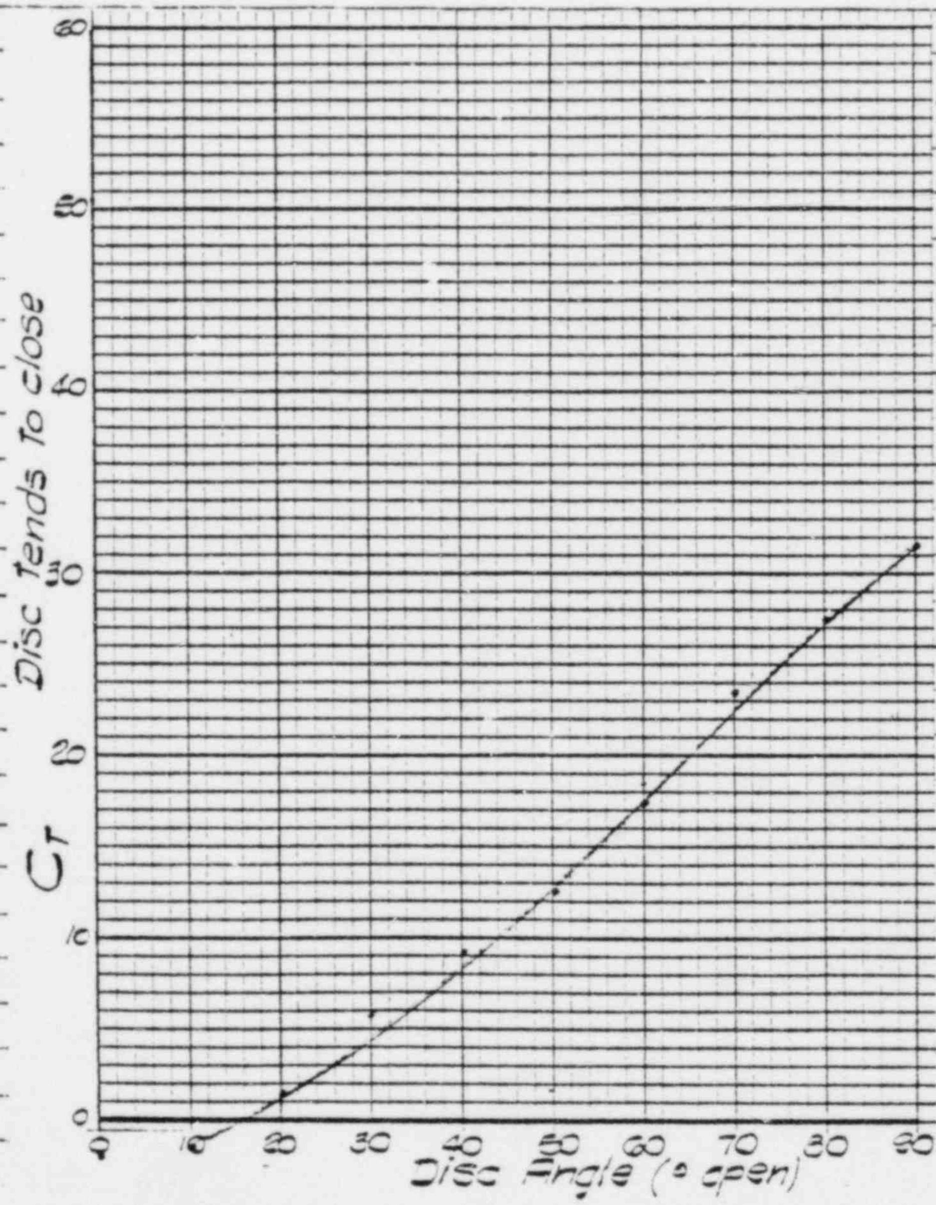
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 40 PSIG Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 6 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER — LITHO IN U.S.A. — A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS — FORM 6715-1

CALCULATED BY WHG

Test No. 23

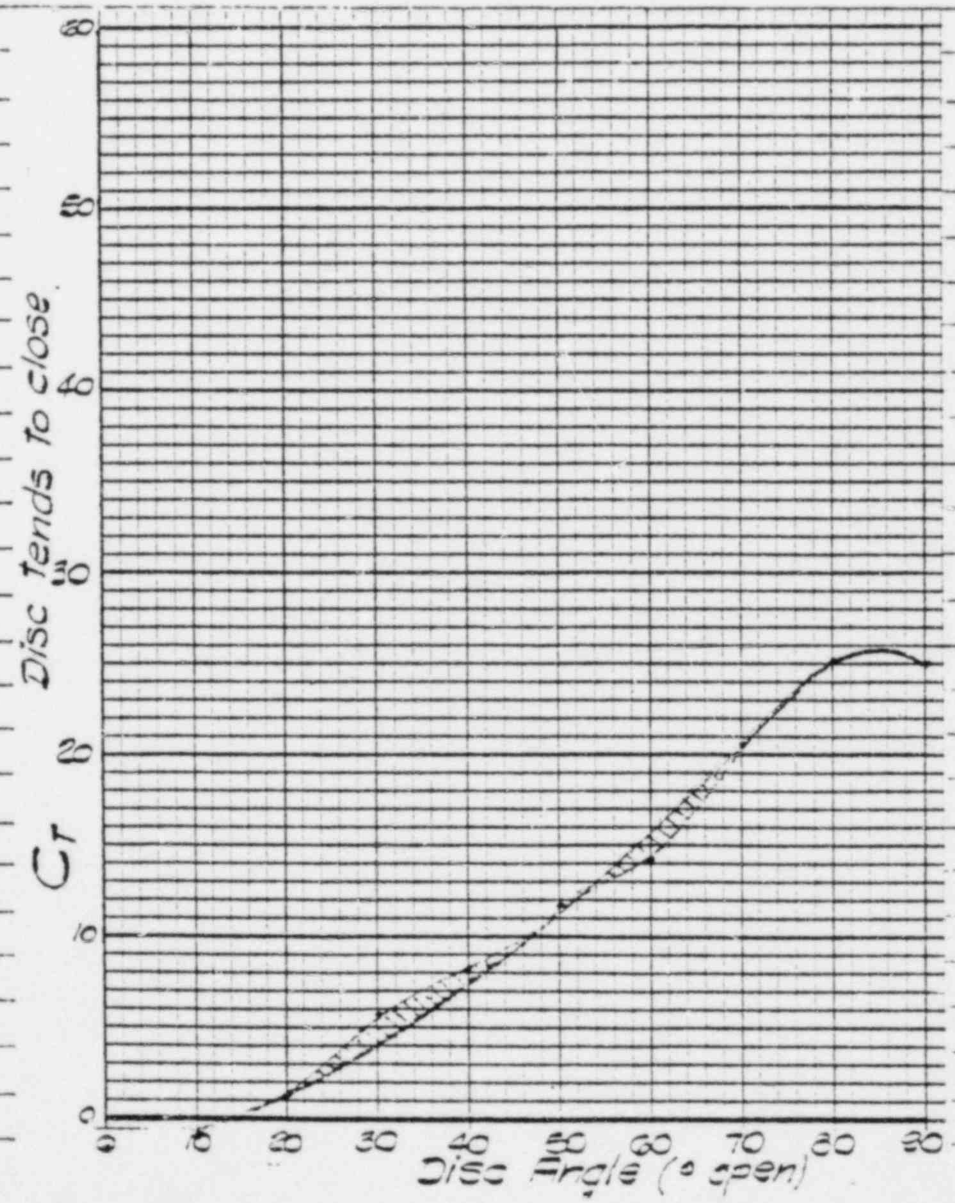
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 50PSIG   Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 23 $P_{T_1}$ = 40 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25 | 12.5 | 12.5 | 49.5 | 31.7 | 18.5 |
| 80 | 28 | 11 | 17 | 57.8 | 27.2 | 20.6 |
| 70 | 30 | 9.5 | 20.5 | 60.5 | 23.6 | 22.6 |
| 60 | 34 | 8.5 | 25.5 | 55.0 | 17.3 | 23.9 |
| 50 | 37 | 5.5 | 31.5 | 49.5 | 12.6 | 25.3 |
| 40 | 38 | 4 | 34 | 38.5 | 9.1 | 25.9 |
| 30 | 40 | 3 | 37 | 27.5 | 5.9 | 26.6 |
| 20 | 40 | 2 | 38 | 6.7 | 1.4 | 27.3 |
| 10 | 40 | 1 | 39 | -6.7 | -1.4 | 27.3 |
| 0 | 40 | 1 | 39 | -9.8 | -2.0 | 28.0 |

Test 23 $P_{T_1}$ = 50 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 34 | 15.5 | 18.5 | 57.8 | 25.0 | 29.3 |
| 80 | 35.5 | 14.5 | 21 | 66.0 | 25.1 | 32.0 |
| 70 | 39 | 13.5 | 25.5 | 66.0 | 20.7 | 33.3 |
| 60 | 44 | 10.5 | 33.5 | 59.0 | 14.1 | 35.4 |
| 50 | 45 | 8 | 37 | 55.0 | 11.9 | 36.0 |
| 40 | 46 | 5 | 41 | 41.3 | 8.1 | 36.7 |
| 30 | 48 | 3.5 | 44.5 | 33.0 | 5.9 | 37.4 |
| 20 | 48.5 | 2 | 46.5 | 7.1 | 1.2 | 38.1 |
| 10 | 49 | 2 | 47 | -5.5 | -.9 | 38.7 |
| 0 | 49 | 2 | 47 | -8.3 | -1.4 | 38.7 |

| CUSTOMER | DATE | SHEET |
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SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model — PRELIM. — FINAL

DRAWING NUMBER — LITHO IN U.S.A. — CALCULATED BY WHG

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS — FORM 6715-1

Test No. 23

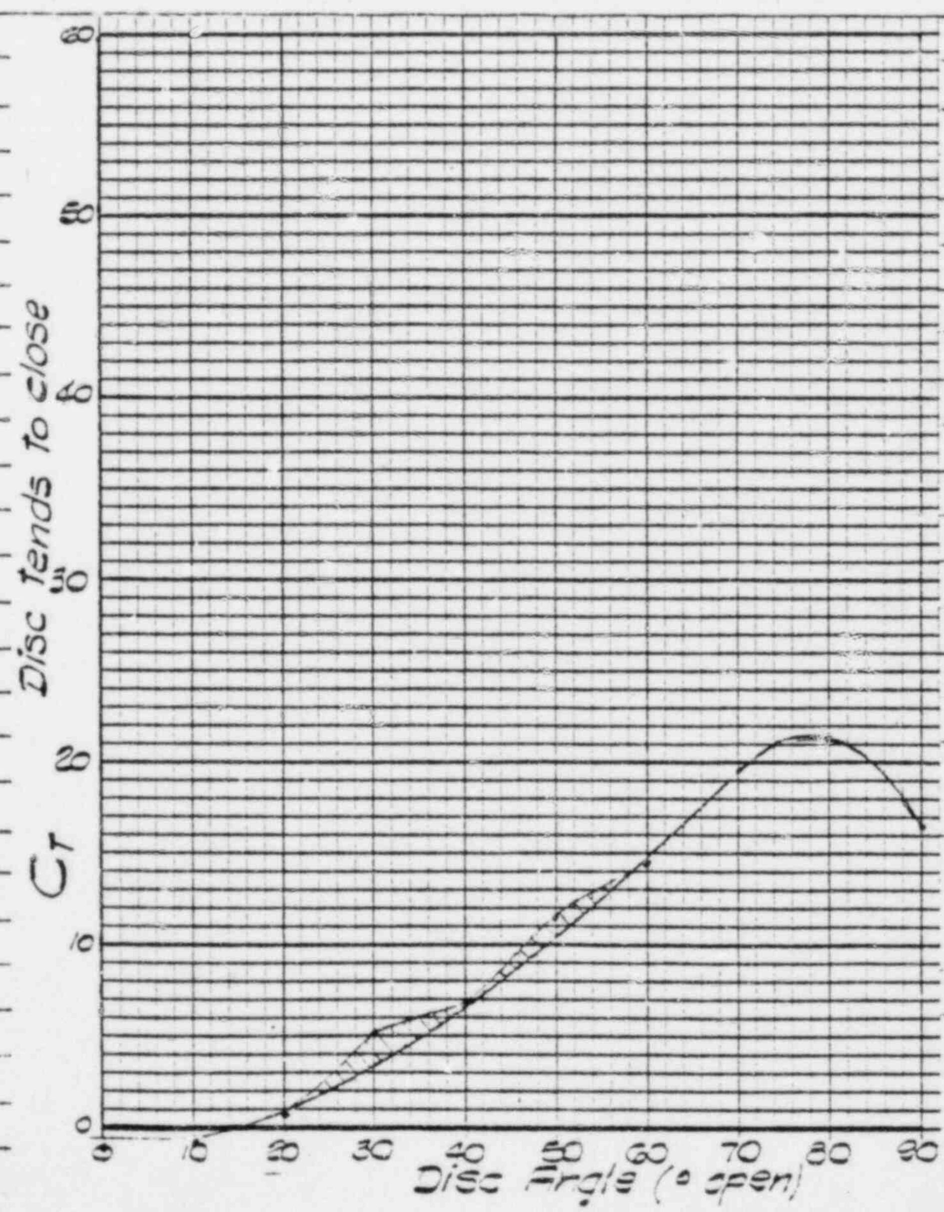
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 60 PSIG    Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 23 $P_{T_1} = 60$ PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 40 | 16 | 24 | 49.5 | 16.5 | 32.0 |
| 80 | 40 | 15 | 25 | 66.0 | 21.1 | 34.0 |
| 70 | 41 | 12 | 29 | 71.5 | 19.7 | 36.7 |
| 60 | 48 | 11 | 37 | 66.0 | 14.3 | 38.7 |
| 50 | 50 | 8 | 42 | 60.5 | 11.5 | 40.7 |
| 40 | 54 | 6 | 48 | 41.3 | 6.9 | 42.1 |
| 30 | 55 | 3 | 52 | 33.0 | 5.1 | 43.4 |
| 20 | 55 | 2 | 53 | 5.5 | .8 | 44.1 |
| 10 | 56 | 1 | 55 | -5.5 | -.8 | 44.1 |
| 0 | 56 | 1 | 55 | -8.3 | -1.2 | 44.1 |

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|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 1 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET (ALLIS-CHALMERS, LITHO IN U.S.A. - A-C, FORM 6715-1) | CALCULATED BY WHG; Test No. 24 |

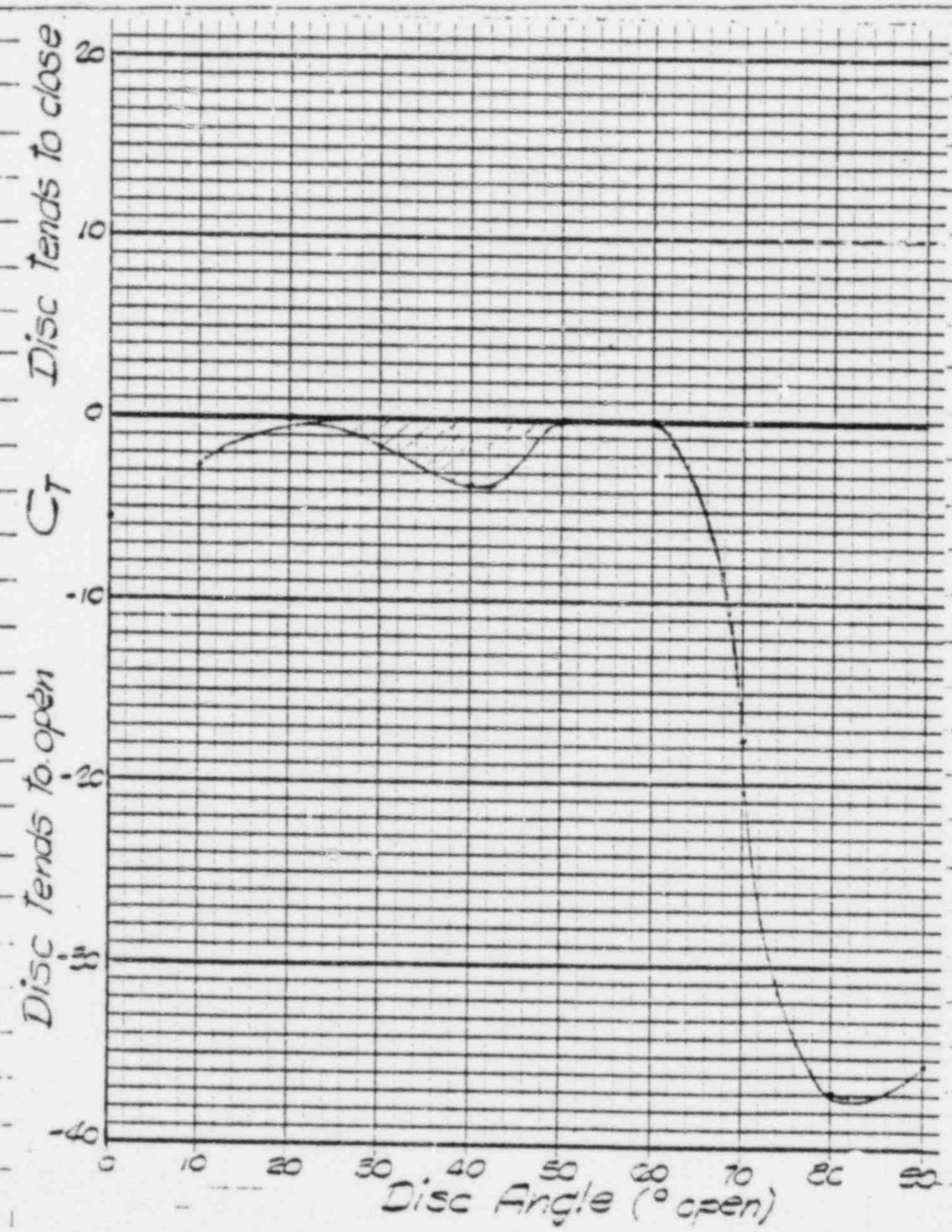
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 10PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 2 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER — LITHO IN U.S.A.—A-C — CALCULATED BY WHG

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS — FORM 6715-1

Test No. 24

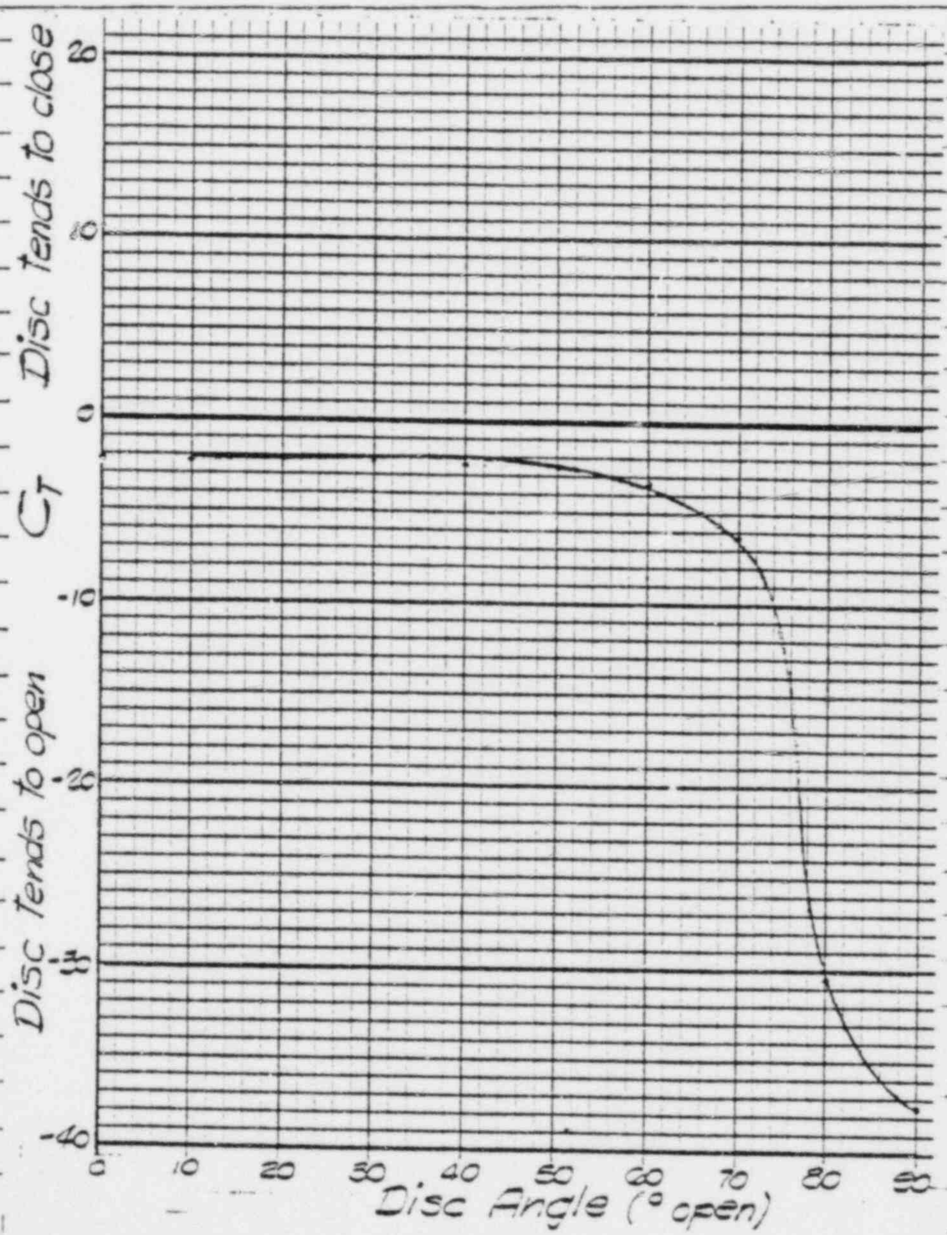
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 15 PSIG    Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 24 $P_{T_1}$ = 10 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4 | 2.5 | 1.5 | -6.6 | -35.2 | 6.4 |
| 80 | 5 | 2.5 | 2.5 | -11.6 | -37.0 | 6.4 |
| 70 | 5 | 2.0 | 3.0 | -6.6 | -17.6 | 8.4 |
| 60 | 6 | 2.0 | 4.0 | 0 | 0 | 10.5 |
| 50 | 7.5 | 1.5 | 6.0 | 0 | 0 | 11.8 |
| 40 | 8 | 1.0 | 7.0 | -3.3 | -3.8 | 11.8 |
| 30 | 9 | 1.0 | 8.0 | -1.7 | -1.7 | 13.2 |
| 20 | 10 | 0.5 | 9.5 | 0 | 0 | 13.2 |
| 10 | 10 | 0.5 | 9.5 | -3.3 | -2.8 | 13.2 |
| 0 | 10 | 0.5 | 9.5 | -6.6 | -5.6 | 13.2 |

Test 24 $P_{T_1}$ = 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 6 | 2.5 | 3.5 | -16.5 | -37.7 | 5.8 |
| 80 | 6 | 2.5 | 3.5 | -13.3 | -3.04 | 7.1 |
| 70 | 9 | 2.5 | 3.5 | -5.0 | -6.2 | 9.1 |
| 60 | 10 | 2.0 | 8.0 | -3.3 | -3.3 | 11.8 |
| 50 | 11 | 1.0 | 10.0 | -3.3 | -2.6 | 12.5 |
| 40 | 12 | 1.0 | 11.0 | -3.3 | -2.4 | 13.2 |
| 30 | 12.5 | 0 | 12.5 | -3.3 | -2.1 | 13.2 |
| 20 | 12.5 | 0 | 12.5 | -3.3 | -2.1 | 13.2 |
| 10 | 12.5 | 0 | 12.5 | -3.3 | -2.1 | 13.2 |
| 0 | 12.5 | 0 | 12.5 | -3.3 | -2.1 | 13.2 |

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| CUSTOMER | DATE | SHEET |
|---|---|---|
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| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

CALCULATED BY WHG

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 24

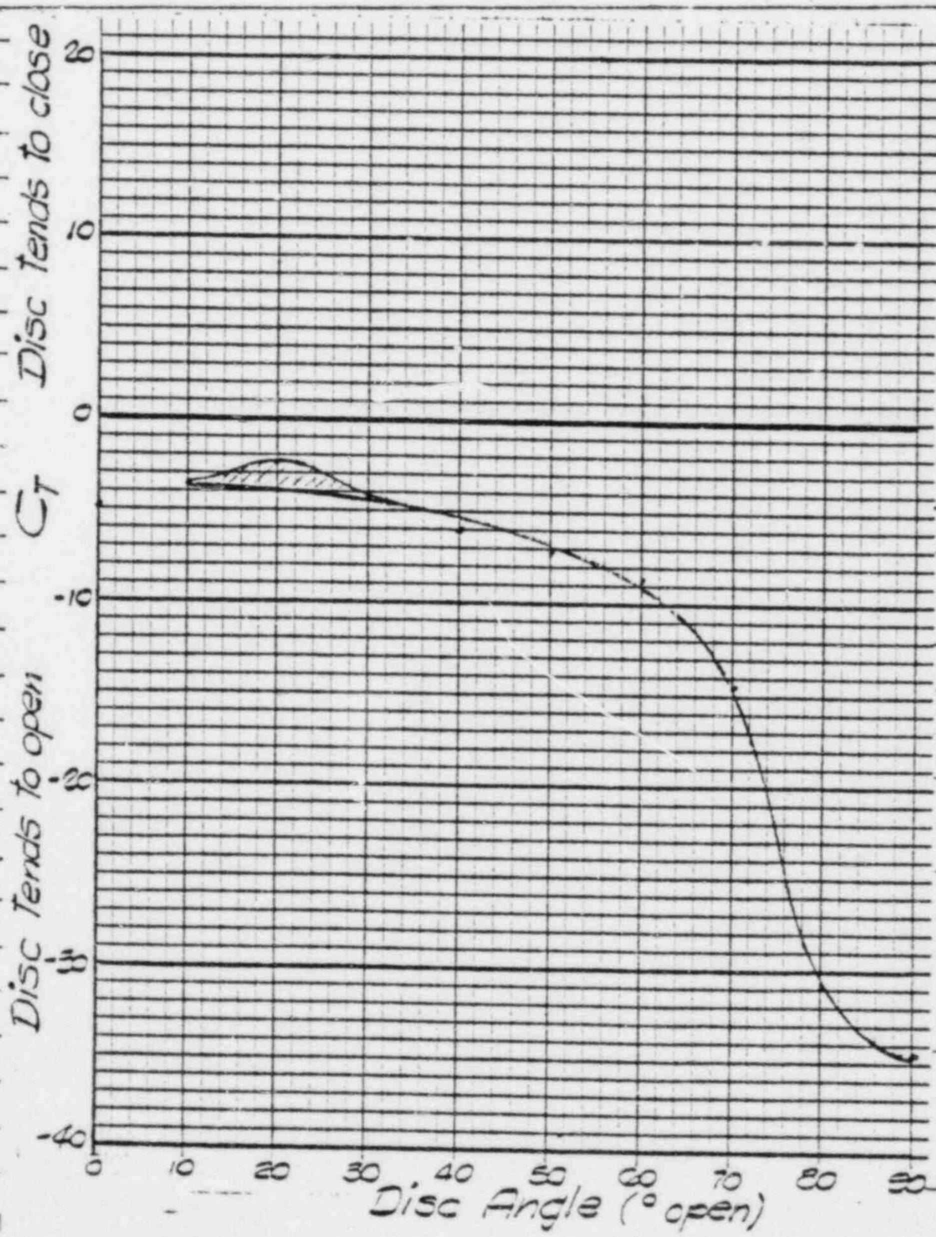
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 20PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY WHG

Test No. 24

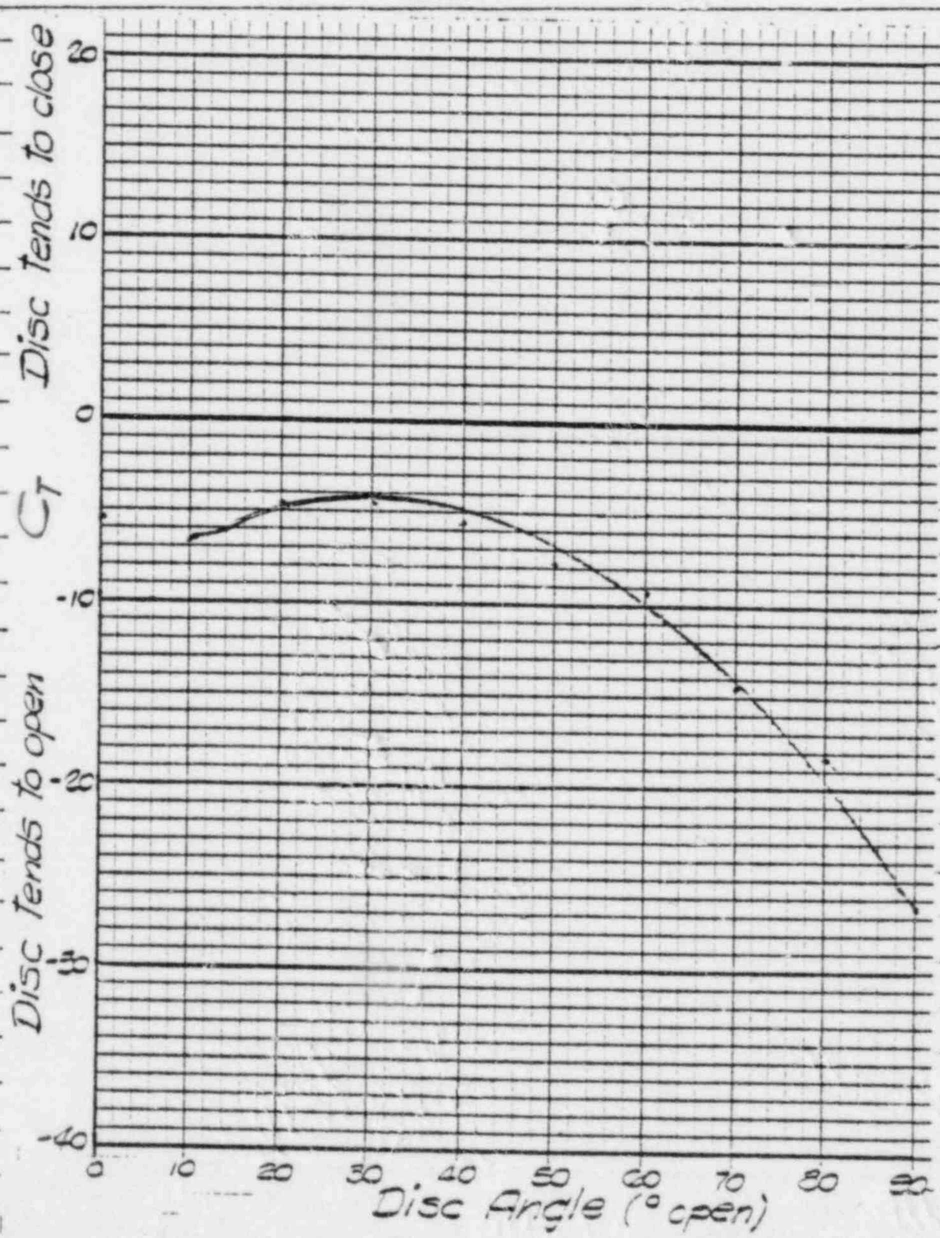
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 30 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in p.s.i.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 24 $P_{T_1}$ = 20 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 10.0 | 5.0 | 5.0 | -21.5 | -34.3 | 6.4 |
| 80 | 10.0 | 4.0 | 6.0 | -23.1 | -30.8 | 6.4 |
| 70 | 12.5 | 3.5 | 9.0 | -16.5 | -14.7 | 9.8 |
| 60 | 15.0 | 3.0 | 12.0 | -13.2 | -8.8 | 11.8 |
| 50 | 15.5 | 2.5 | 13.0 | -11.6 | -7.1 | 13.2 |
| 40 | 17.5 | 20.0 | 15.5 | -11.6 | -6.0 | 14.5 |
| 30 | 17.5 | 1.5 | 16.0 | -8.3 | -4.1 | 15.2 |
| 20 | 18.5 | 1.0 | 17.5 | -5.0 | -2.3 | 15.2 |
| 10 | 19.5 | 1.0 | 18.5 | -8.3 | -3.6 | 15.8 |
| 0 | 19.5 | 0.5 | 19.0 | -11.6 | -4.9 | 15.8 |

Test 24 $P_{T_1}$ = 30 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 17.5 | 7.5 | 10.0 | -33.0 | -26.5 | 12.5 |
| 80 | 20.0 | 5.5 | 14.5 | -33.0 | -18.2 | 15.2 |
| 70 | 21.0 | 4.5 | 16.5 | -29.7 | -14.4 | 17.2 |
| 60 | 25.0 | 3.5 | 21.5 | -24.6 | -9.2 | 18.5 |
| 50 | 27.5 | 2.5 | 25.0 | -24.6 | -7.9 | 19.9 |
| 40 | 30.0 | 2.0 | 28.0 | -19.8 | -5.7 | 20.6 |
| 30 | 30.0 | 1.0 | 29.0 | -16.5 | -4.6 | 21.9 |
| 20 | 30.0 | 1.0 | 29.0 | -16.5 | -4.6 | 21.9 |
| 10 | 30.0 | 1.0 | 29.0 | -24.8 | -6.8 | 21.9 |
| 0 | 30.0 | 1.0 | 29.0 | -19.8 | -5.5 | 21.9 |

| | | | |
|---|---|---|---|
| CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 5 OF 7 | |
| SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL | |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET (LITHO IN U.S.A.—A-C; ALLIS-CHALMERS; FORM 6715-1) | CALCULATED BY WHG | Test No. 24 |

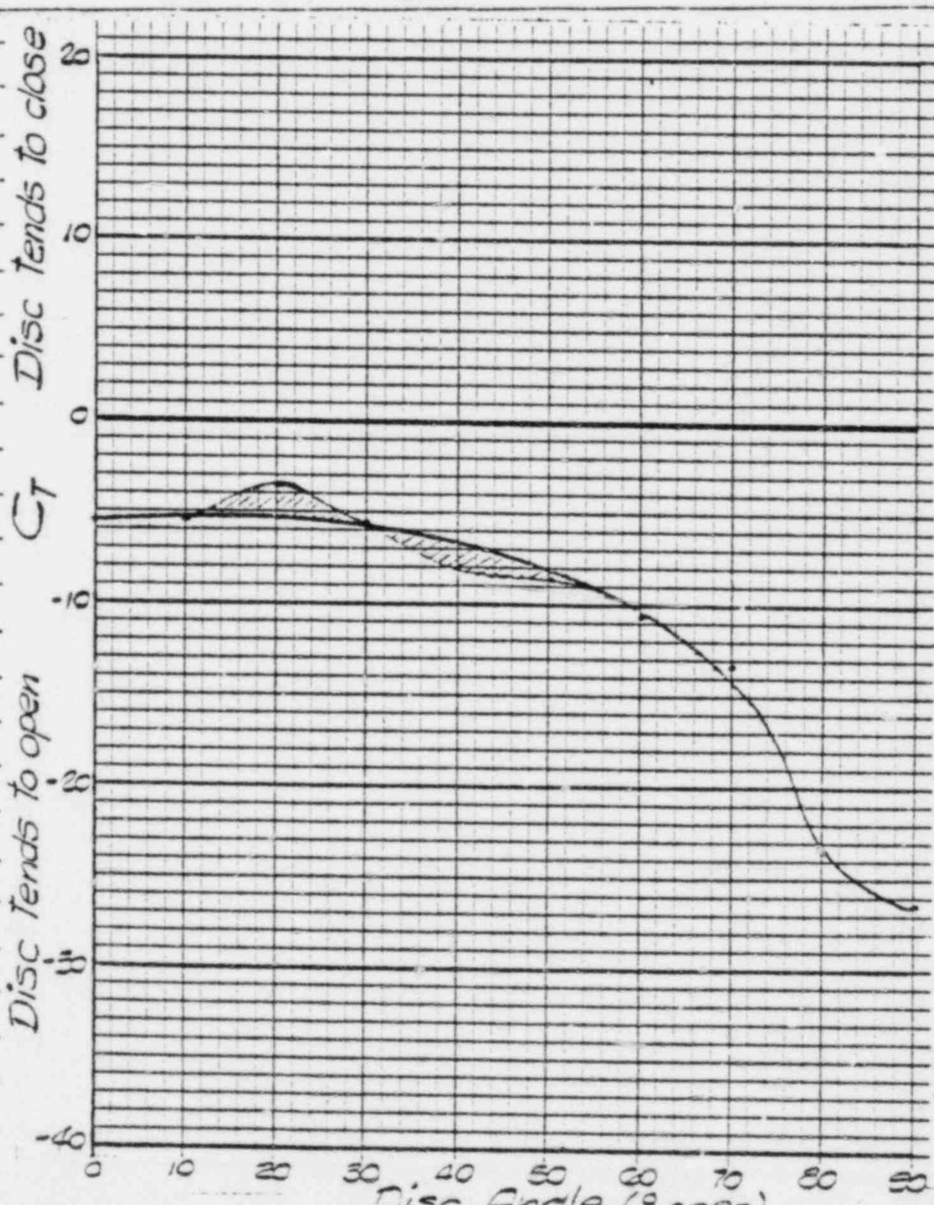
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 40PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER: Air Flow Tests NASA/Langley Research Center

DATE: Nov. & Dec. 1979

SHEET 6 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. | FINAL

DRAWING NUMBER

LITHO IN U.S.A.—A-C

CALCULATED BY WHG

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 24

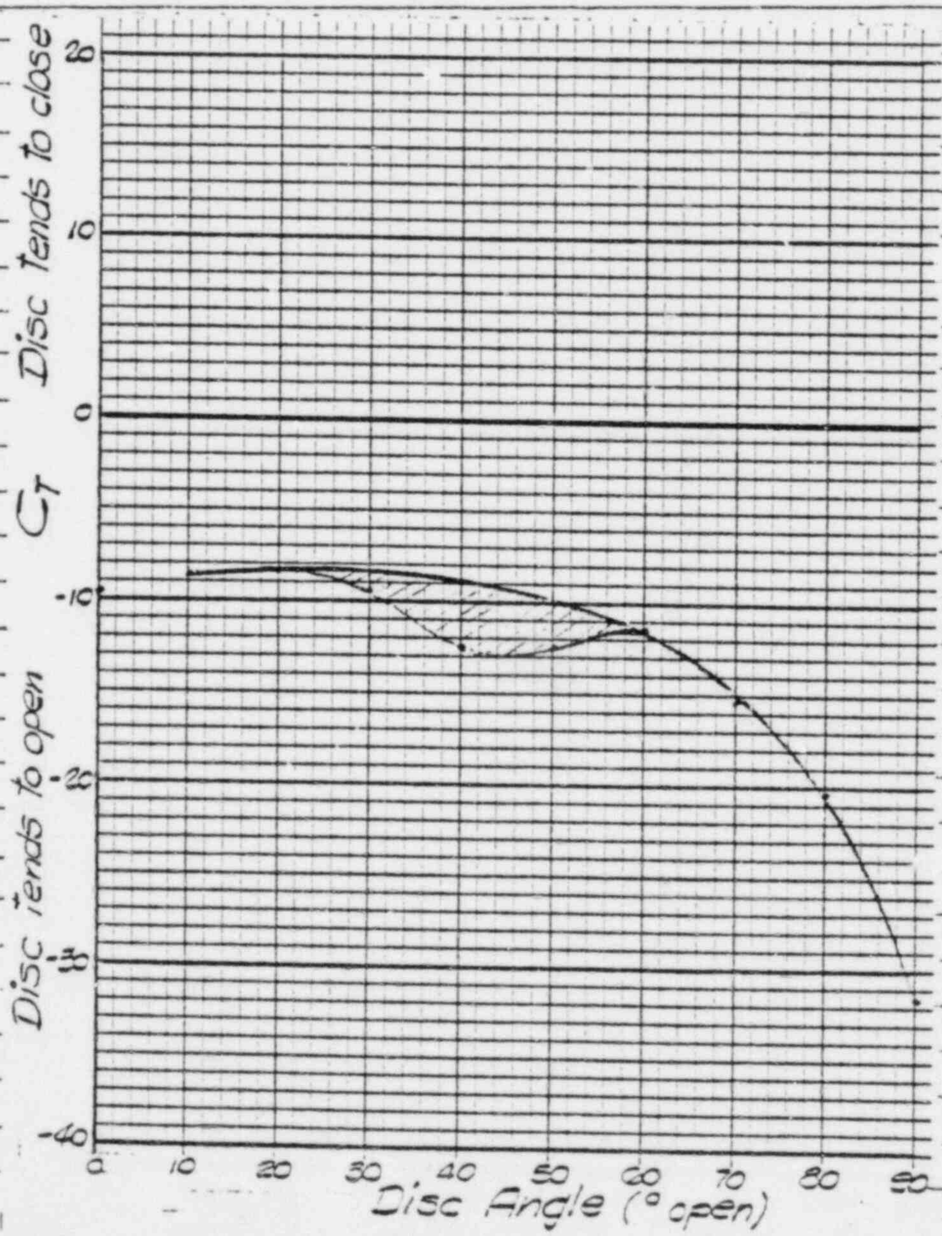
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 50 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 24 $P_{T_1}$ = 40 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25 | 12.5 | 12.5 | -41.3 | -26.4 | 21.2 |
| 80 | 25 | 11.0 | 14.0 | -41.3 | -23.6 | 21.9 |
| 70 | 30 | 10.0 | 20.0 | -33.0 | -13.2 | 23.9 |
| 60 | 32 | 7.5 | 24.5 | -33.0 | -10.8 | 26.6 |
| 50 | 35.0 | 5.0 | 30.0 | -33.0 | -8.8 | 28.6 |
| 40 | 36.0 | 3.0 | 33.0 | -33.0 | -8.0 | 30.0 |
| 30 | 37.0 | 3.0 | 34.0 | -24.8 | -5.8 | 30.7 |
| 20 | 38.0 | 3.0 | 35.0 | -16.56 | -3.8 | 31.3 |
| 10 | 39.0 | 3.0 | 36.0 | -24.8 | -5.5 | 32.0 |
| 0 | 39.0 | 3.0 | 36.0 | -24.8 | -5.5 | 32.0 |

Test 24 $P_{T_1}$ = 50 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 30.0 | 17.5 | 12.5 | -49.5 | -31.7 | 33.3 |
| 80 | 34.0 | 15.0 | 19.0 | -47.9 | -20.2 | 34.7 |
| 70 | 35.0 | 12.5 | 22.5 | -42.9 | -15.3 | 36.0 |
| 60 | 40.0 | 12.5 | 27.5 | -39.6 | -11.5 | 37.4 |
| 50 | 43.5 | 16.0 | 27.5 | -42.9 | -12.5 | 40.1 |
| 40 | 45.0 | 17.5 | 27.5 | -42.9 | -12.5 | 41.4 |
| 30 | 47.0 | 19.0 | 28.0 | -33.0 | -9.3 | 42.1 |
| 20 | 47.5 | 20.0 | 27.5 | -28.0 | -8.2 | 42.1 |
| 10 | 48.5 | 21.5 | 27.0 | -29.7 | -8.8 | 42.1 |
| 0 | 48.5 | 21.5 | 27.0 | -33.0 | -9.8 | 42.1 |

| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 7 OF 7 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | | PRELIM. | FINAL |
| DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY WHG | |
| | ENGINEERING CALCULATION SHEET | Test No. 24 | |
| | ALLIS-CHALMERS FORM 6715-1 | | |

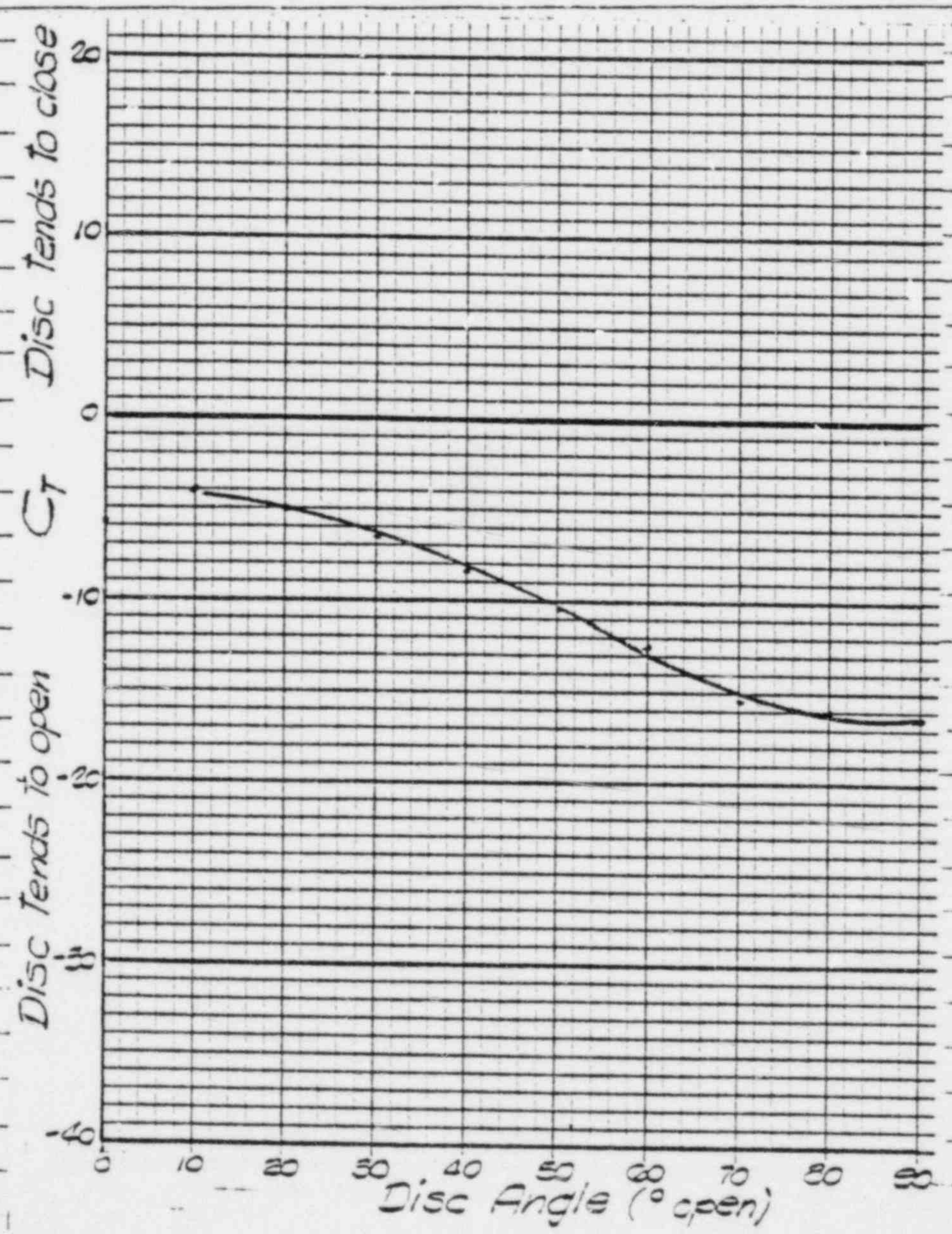
Valve disc thickness to diameter ratio: .29

Initial upstream pressure: 60PSIG Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 24 $P_{T_1} = 60$ PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 40.0 | 17.5 | 22.5 | -46.2 | -16.4 | 37.4 |
| 80 | 40.0 | 16.0 | 24.0 | -47.9 | -16.0 | 37.4 |
| 70 | 40.0 | 15.0 | 25.0 | -47.9 | -15.3 | 38.7 |
| 60 | 42.0 | 12.5 | 29.5 | -46.2 | -12.5 | 41.4 |
| 50 | 47.5 | 10.0 | 37.5 | -47.9 | -10.2 | 45.5 |
| 40 | 54.0 | 6.0 | 48.0 | -49.5 | -8.3 | 46.8 |
| 30 | 55.0 | 5.0 | 50.0 | -41.3 | -6.6 | 47.5 |
| 20 | 56.0 | 3.0 | 53.0 | -33.0 | -5.0 | 48.2 |
| 10 | 57.5 | 1.5 | 56.0 | -28.1 | -4.0 | 48.8 |
| 0 | 57.5 | 1.5 | 56.0 | -41.3 | -5.9 | 48.8 |

6/700155

| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 1 OF 7 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL | |
| DRAWING NUMBER | LITHO IN U.S.A.—A-C ENGINEERING CALCULATION SHEET ALLIS-CHALMERS FORM 6715-1 | CALCULATED BY R. Z. | Test No. 25 |

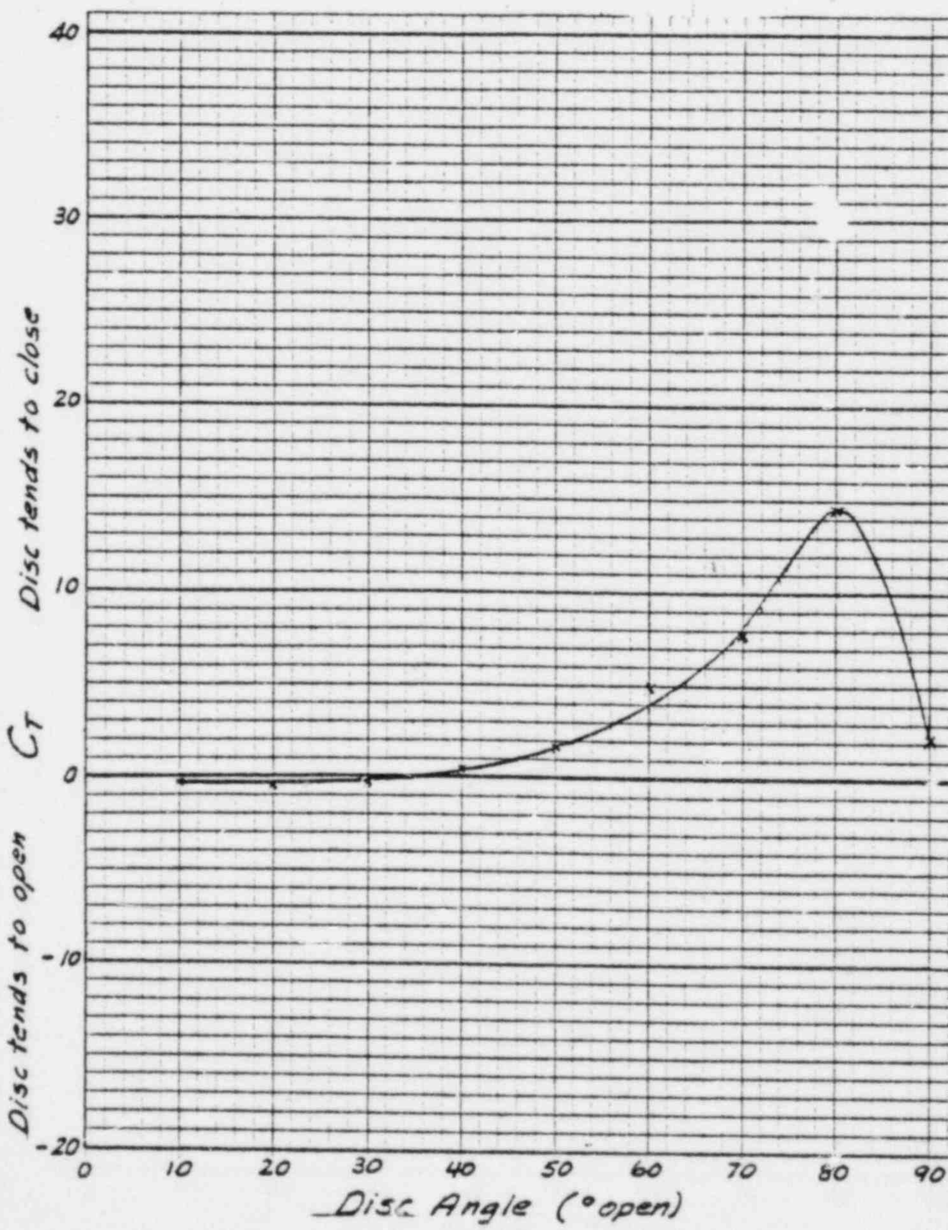
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 10 psig   Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 25 $P_{T_1}$ = 10 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 5 | 2.5 | 2.5 | .69 | 2.21 | 8.4 |
| 80 | 4 | 2.5 | 1.5 | 2.75 | 14.67 | 9.1 |
| 70 | 6 | 2.5 | 3.5 | 3.44 | 7.86 | 11.8 |
| 60 | 7 | 2.5 | 4.5 | 2.75 | 4.89 | 13.2 |
| 50 | 8 | 1.5 | 6.5 | 1.38 | 1.70 | 15.2 |
| 40 | 9 | 1.0 | 8.0 | -.34 | -.34 | 16.5 |
| 30 | 10 | 1.0 | 9.0 | -.34 | -.30 | 17.2 |
| 20 | 10 | 0 | 10.0 | -.59 | -.47 | 17.2 |
| 10 | 10 | 0 | 10.0 | -.25 | -.20 | 17.2 |
| 0 | 10 | 0 | 10.0 | -1.72 | -1.38 | 17.2 |

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| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | | CALCULATED BY |
|---|---|---|
| | LITHO IN U.S.A.—A-C<br>**ENGINEERING CALCULATION SHEET**<br>ALLIS-CHALMERS FORM 6715-1 | R. Z.<br>Test No. 25 |

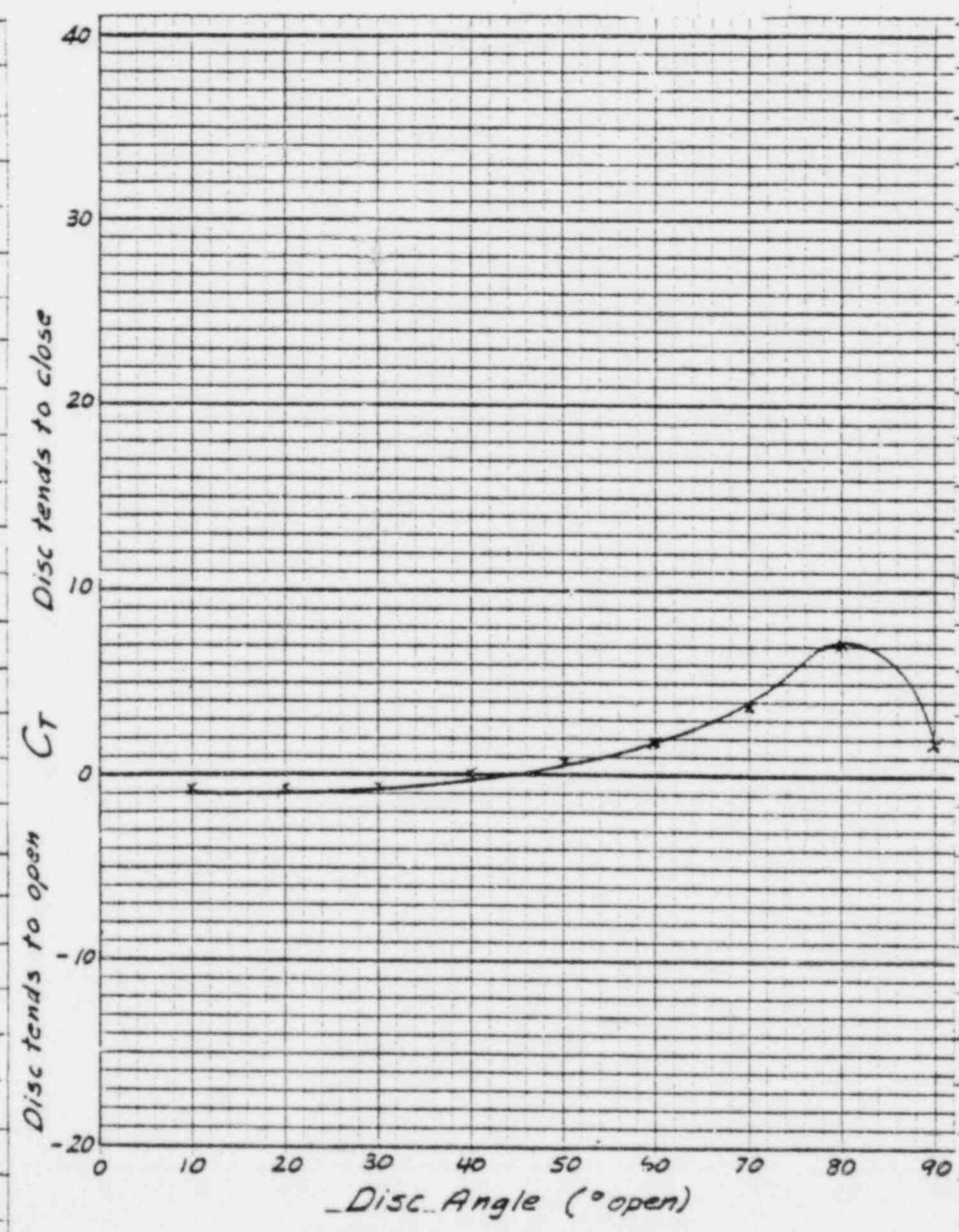
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 15 psig    Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 3 OF 7

SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY R. Z.

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 25

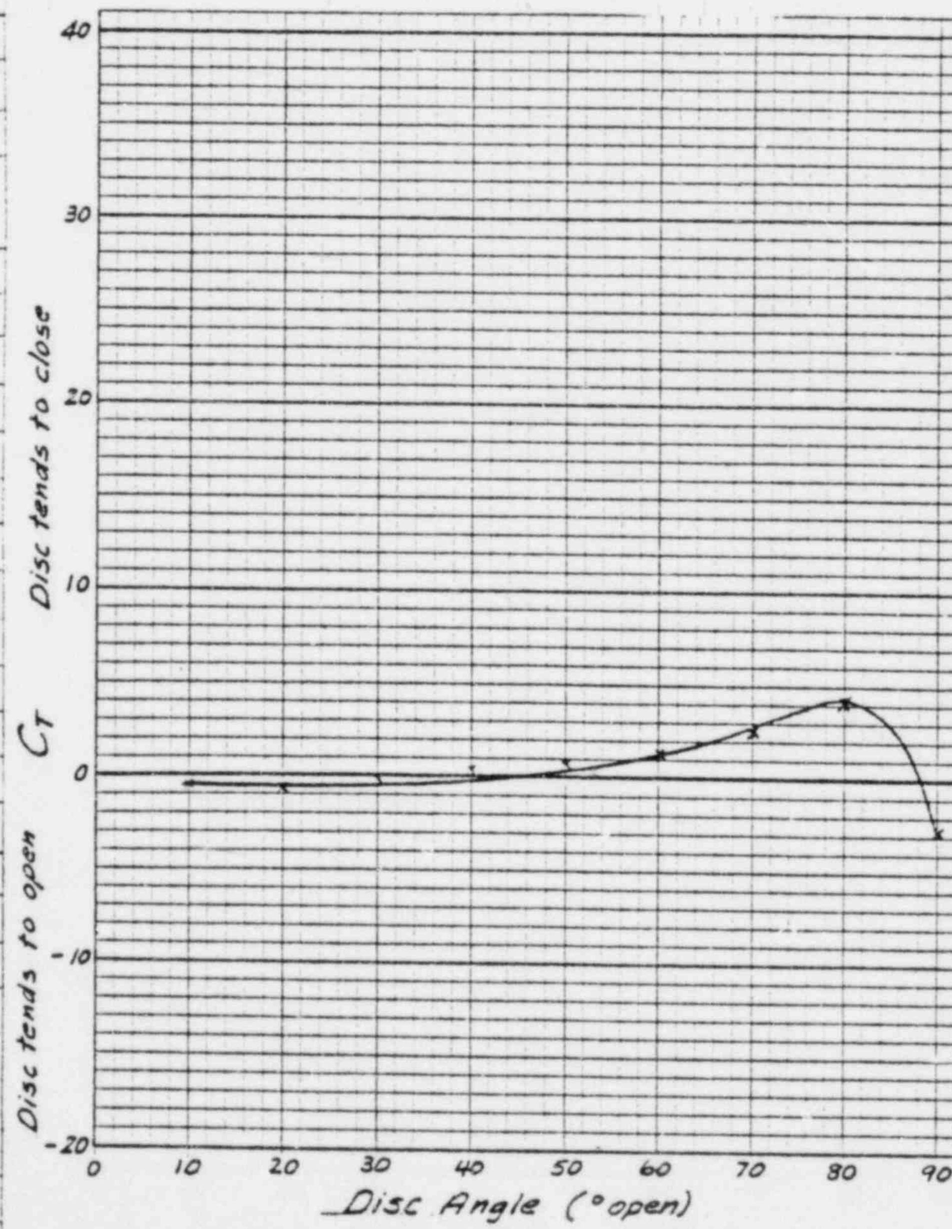
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 20 psig   Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 25 $P_T$ = 15 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 5.0 | 2.5 | 2.5 | .69 | 2.21 | 5.1 |
| 80 | 6.0 | 2.5 | 3.5 | 3.09 | 7.06 | 8.4 |
| 70 | 9.0 | 2.0 | 7.0 | 3.44 | 3.93 | 11.1 |
| 60 | 10.0 | 1.5 | 8.5 | 2.06 | 1.94 | 12.5 |
| 50 | 11.0 | 1.0 | 10.0 | 1.03 | .8 | 13.8 |
| 40 | 11.5 | 0.5 | 11.0 | 0 | 0 | 15.8 |
| 30 | 12.0 | 0 | 12.0 | -1.03 | -.69 | 16.5 |
| 20 | 12.0 | 0 | 12.0 | -1.38 | -.92 | 16.5 |
| 10 | 12.0 | 0 | 12.0 | -1.38 | -.92 | 16.5 |
| 0 | 12.0 | 0 | 12.0 | -2.06 | -1.37 | 16.5 |

Test 25 $P_T$ = 20 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 7.0 | 4.0 | 3.0 | -1.03 | -2.75 | 5.1 |
| 80 | 10.0 | 4.0 | 6.0 | 3.09 | 4.12 | 7.1 |
| 70 | 14.0 | 3.0 | 11.0 | 3.44 | 2.50 | 11.8 |
| 60 | 16.0 | 2.5 | 13.5 | 2.06 | 1.22 | 15.2 |
| 50 | 17.5 | 2.0 | 15.5 | 1.47 | .76 | 18.5 |
| 40 | 18.0 | 1.0 | 17.0 | .34 | .16 | 18.5 |
| 30 | 19.0 | 0.5 | 18.5 | -.34 | -.15 | 18.5 |
| 20 | 20.0 | 0 | 20.0 | -2.06 | -.82 | 18.5 |
| 10 | 20.0 | 0 | 20.0 | -1.03 | -.41 | 18.5 |
| 0 | 20.0 | 0 | 20.0 | -2.36 | -.94 | 18.5 |

| | | |
|---|---|---|
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| DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY R. Z. |

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

Test No. 25

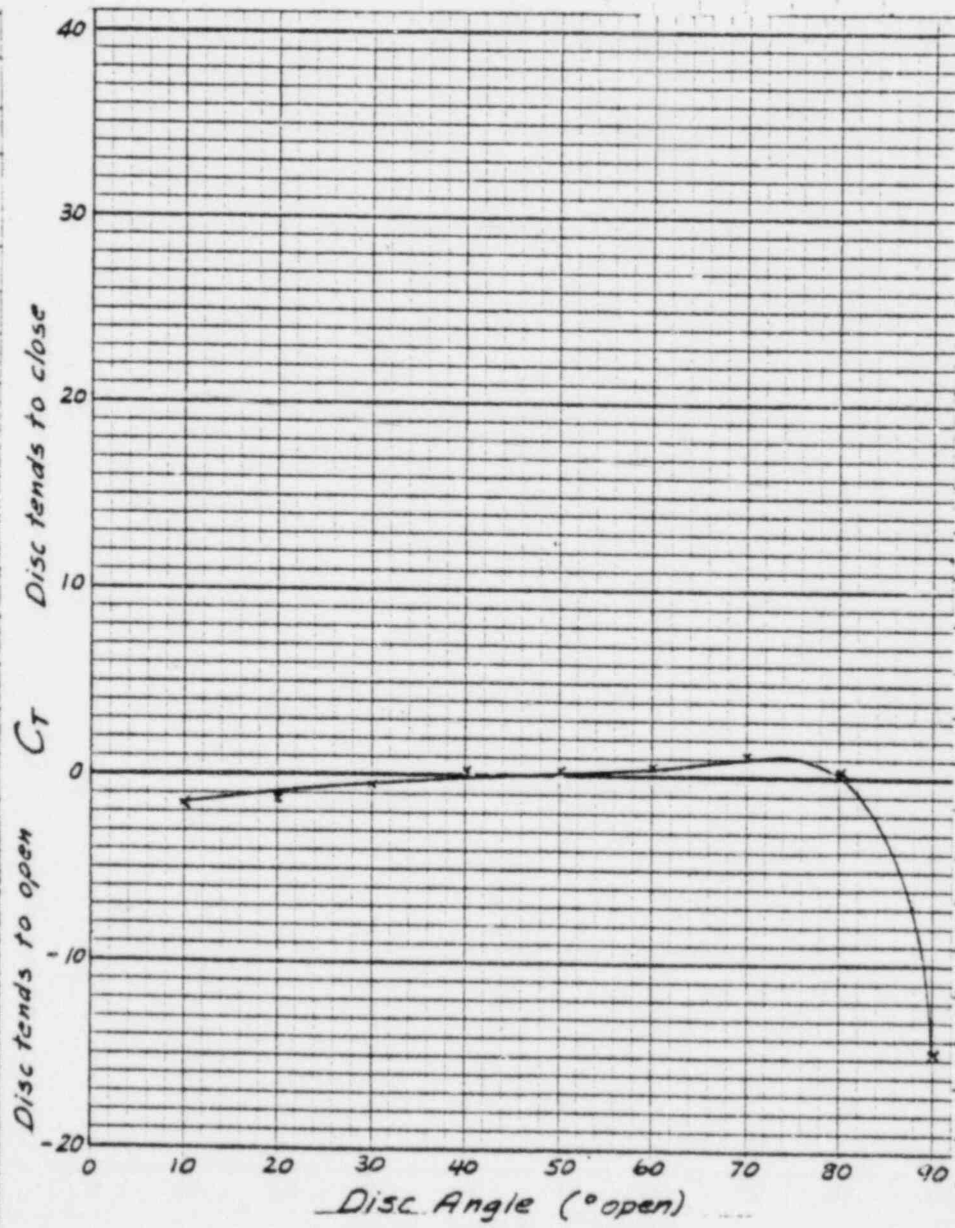
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 30 PSIG    Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.-A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R.Z.

Test No. 25

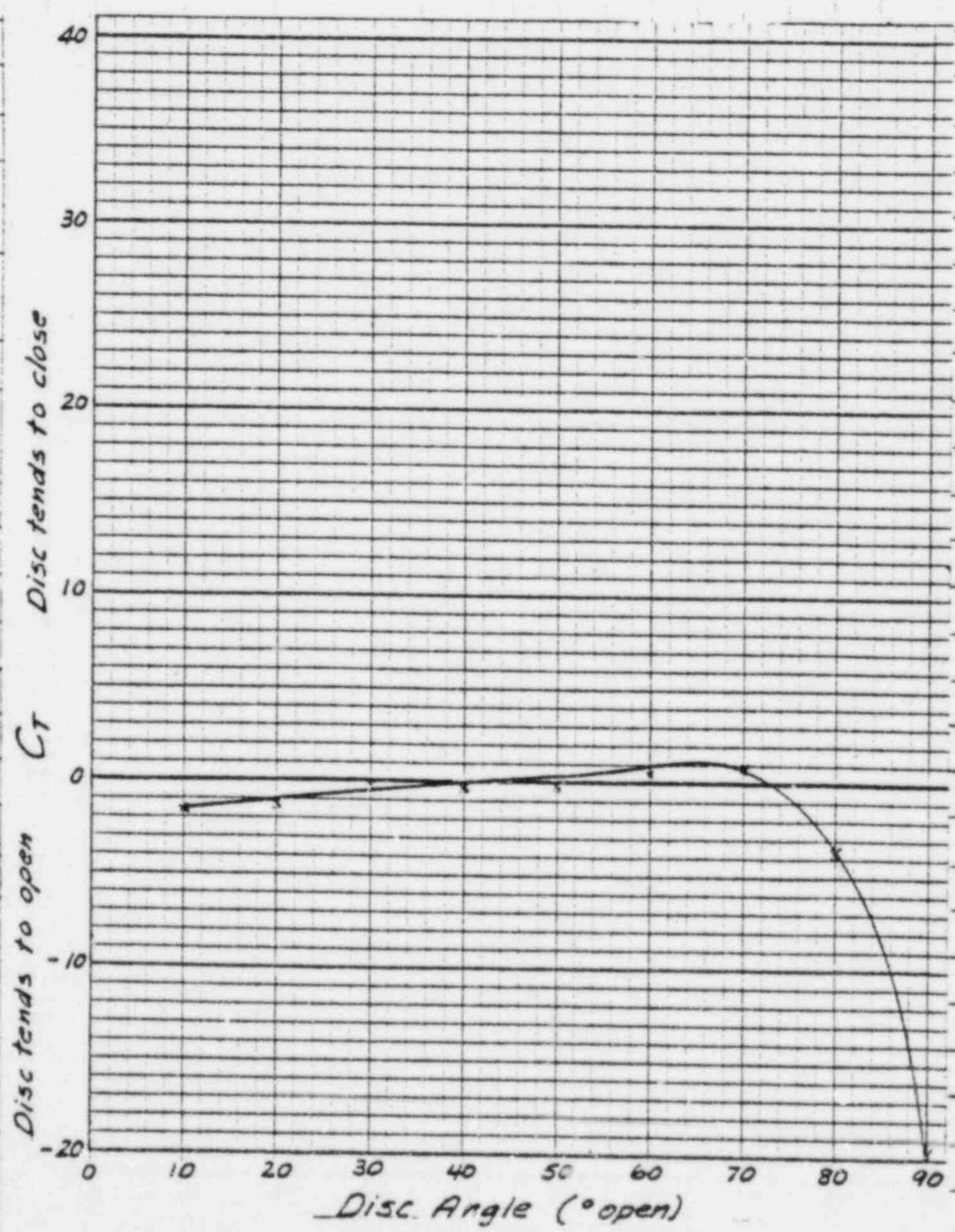
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 40 psig    Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 25 $P_{T_1}$ = 30 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 12.5 | 7.5 | 5.0 | -9.28 | -14.8 | 9.8 |
| 80 | 14.0 | 6.5 | 7.5 | .25 | .27 | 10.5 |
| 70 | 22.0 | 5.5 | 16.5 | 2.41 | 1.17 | 17.2 |
| 60 | 25.0 | 4.5 | 20.5 | 1.38 | .54 | 20.6 |
| 50 | 26.5 | 2.5 | 24.0 | .69 | .23 | 23.3 |
| 40 | 29.0 | 1.5 | 27.5 | .69 | .20 | 24.6 |
| 30 | 29.0 | 1.5 | 27.5 | -1.72 | -.50 | 25.3 |
| 20 | 29.0 | 1.5 | 27.5 | -4.13 | -1.20 | 25.3 |
| 10 | 29.0 | 1.5 | 27.5 | -5.16 | -1.50 | 25.3 |
| 0 | 29.0 | 1.5 | 27.5 | -2.06 | -.60 | 25.3 |

Test 25 $P_{T_1}$ = 40 PSIG

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 18 | 12 | 6 | -14.8 | -19.8 | 17.9 |
| 80 | 19 | 11 | 8 | -3.7 | -3.7 | 18.5 |
| 70 | 28 | 10 | 18 | 2.1 | .91 | 21.9 |
| 60 | 33 | 7 | 26 | 1.03 | .32 | 30.0 |
| 50 | 36 | 4 | 32 | -.4 | -.1 | 32.0 |
| 40 | 38 | 2.5 | 35.5 | -1.03 | -.23 | 33.3 |
| 30 | 39 | 2 | 37 | -1.2 | -.27 | 34.0 |
| 20 | 39 | 1 | 38 | -6 | -1.26 | 34.0 |
| 10 | 39 | 1 | 38 | -8.25 | -1.73 | 34.0 |

CUSTOMER: Air Flow Tests NASA/Langley Research Center

DATE: Nov. & Dec. 1979 — SHEET 6 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. | FINAL

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# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS — FORM 6715-1

CALCULATED BY: R. Z.

Test No. 25

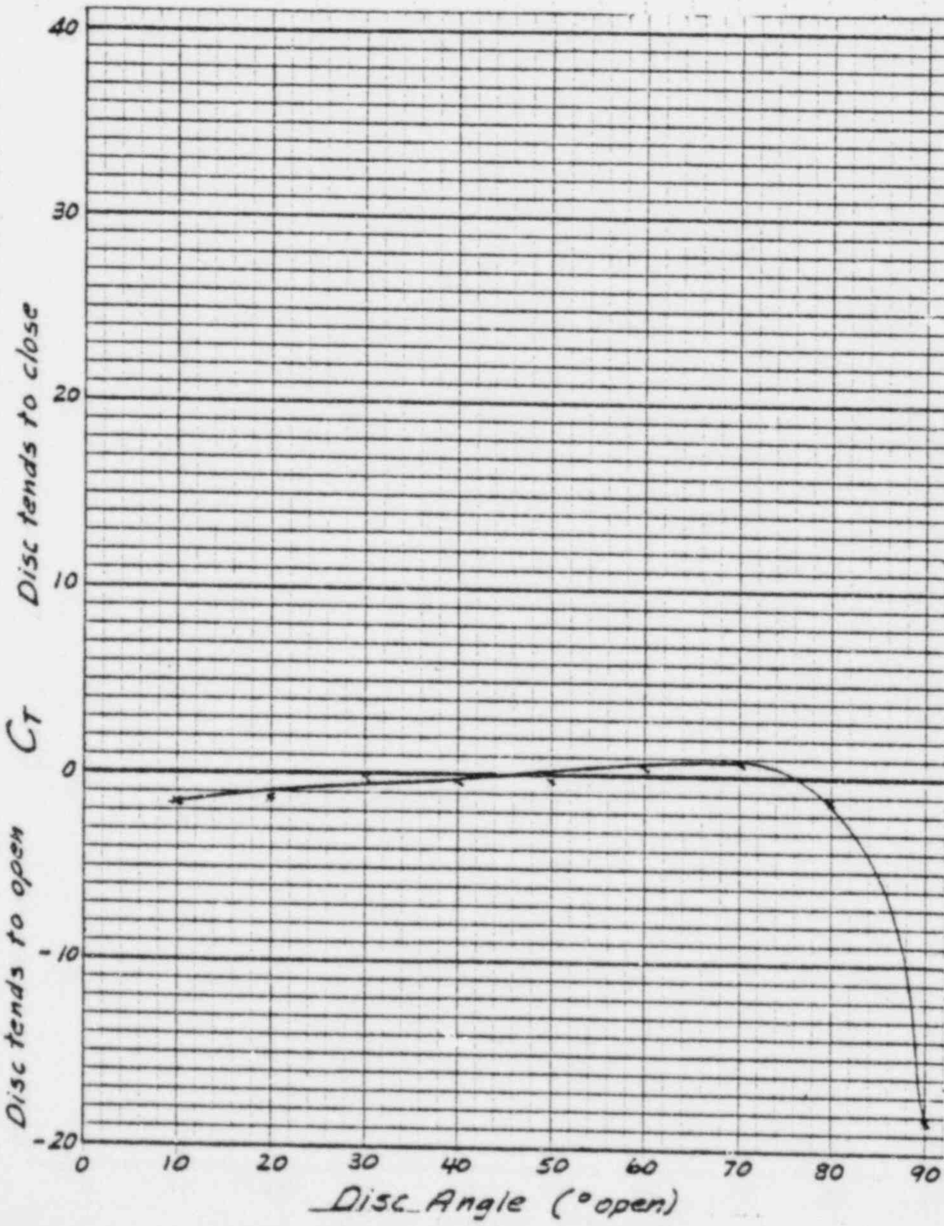
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 50 psig    Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

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**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. Z.

Test No. 25

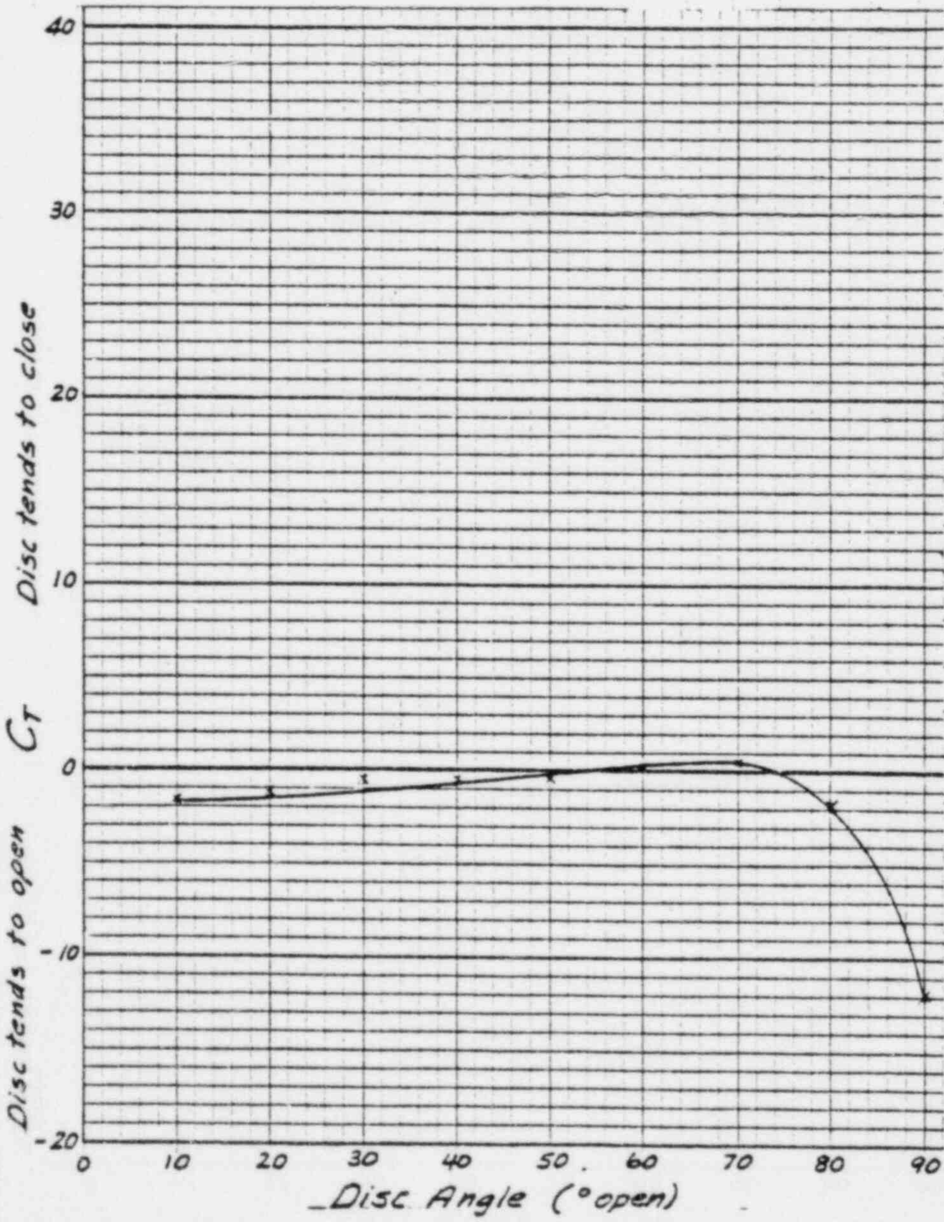
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 60 psig  Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

Test 25 $P_{T_1}$ = 60 PSIG

| Disc Angle | $P_{T_5}$ | $P_{T_6}$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 18 | 12 | 6 | -14.8 | -19.8 | 17.9 |
| 90 | 19 | 11 | 8 | -3.7 | -3.7 | 18.5 |
| 70 | 28 | 10 | 18 | 2.1 | [illegible] | 21.9 |
| 60 | 33 | 7 | 26 | 1.03 | .32 | 30.0 |
| 50 | 36 | 4 | 32 | -.4 | -.1 | 32.0 |
| 40 | 38 | 2.5 | 35.5 | -1.03 | -.23 | 33.3 |
| 30 | 39 | 2 | 37 | -1.2 | -.27 | 34.0 |
| 20 | 39 | 1 | 38 | -6 | -1.26 | 34.0 |
| 10 | 39 | 1 | 38 | -8.25 | -1.73 | 34.0 |

Test 25 $P_{T_1}$ = 50 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 24 | 16.5 | 7.5 | -17.19 | -18.34 | 30.7 |
| 80 | 26 | 14.5 | 11.5 | -3.09 | -2.15 | 32.0 |
| 70 | 37 | 13.5 | 23.5 | 2.06 | .70 | 38.7 |
| 60 | 42 | 10.0 | 32.0 | 1.03 | .26 | 42.1 |
| 50 | 44 | 6.5 | 37.5 | -1.03 | -.22 | 45.5 |
| 40 | 47 | 3.5 | 43.5 | -2.06 | -.38 | 45.5 |
| 30 | 48 | 2.0 | 46.0 | -1.03 | -.18 | 45.5 |
| 20 | 48 | 1.0 | 47.0 | -8.25 | -1.40 | 45.5 |
| 10 | 48 | 1.0 | 47.0 | -9.63 | -1.64 | 45.5 |
| 0 | 48 | 1.0 | 47.0 | -6.88 | -1.17 | 45.5 |

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LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. G.

Test No. 26

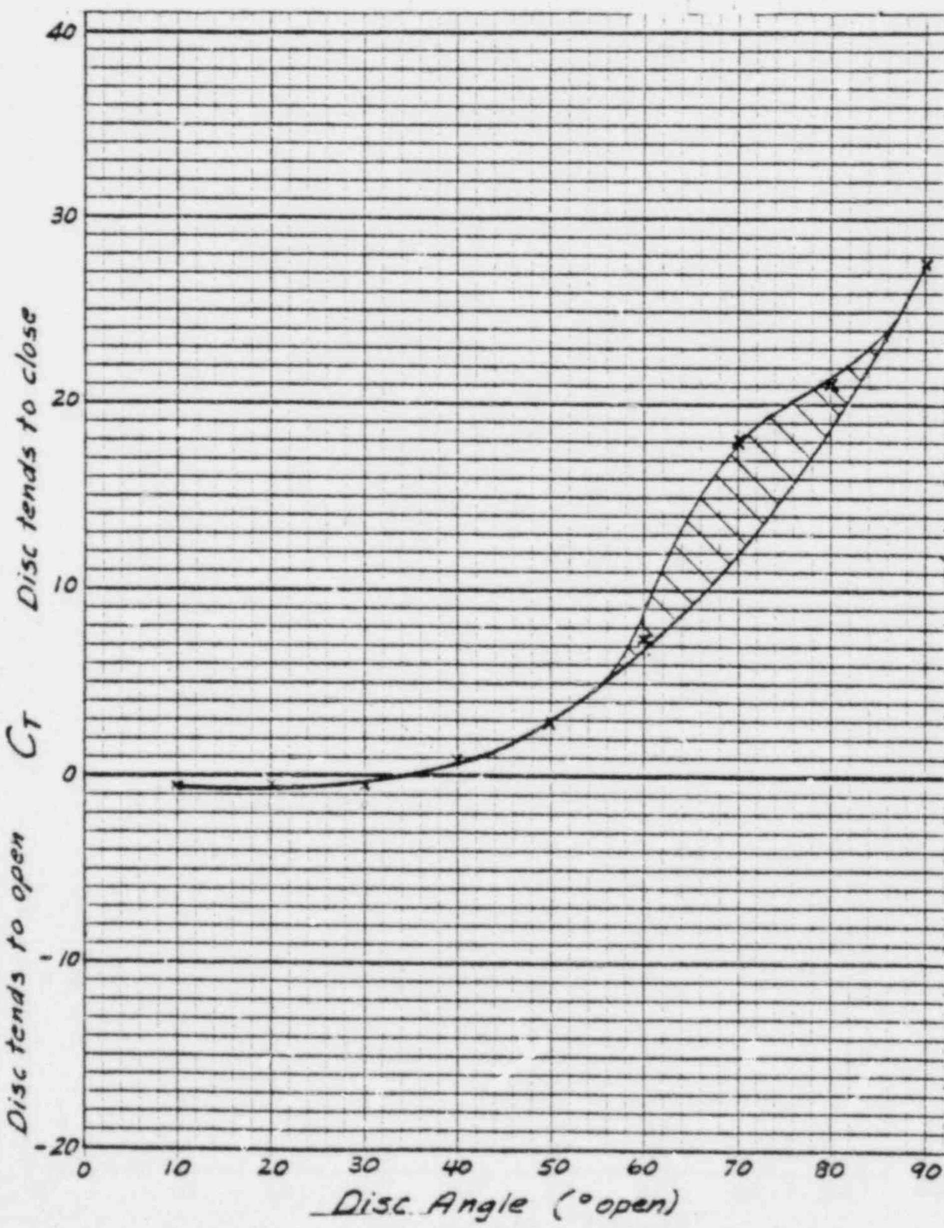
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 10 psig   Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



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SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY R. J.

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 26

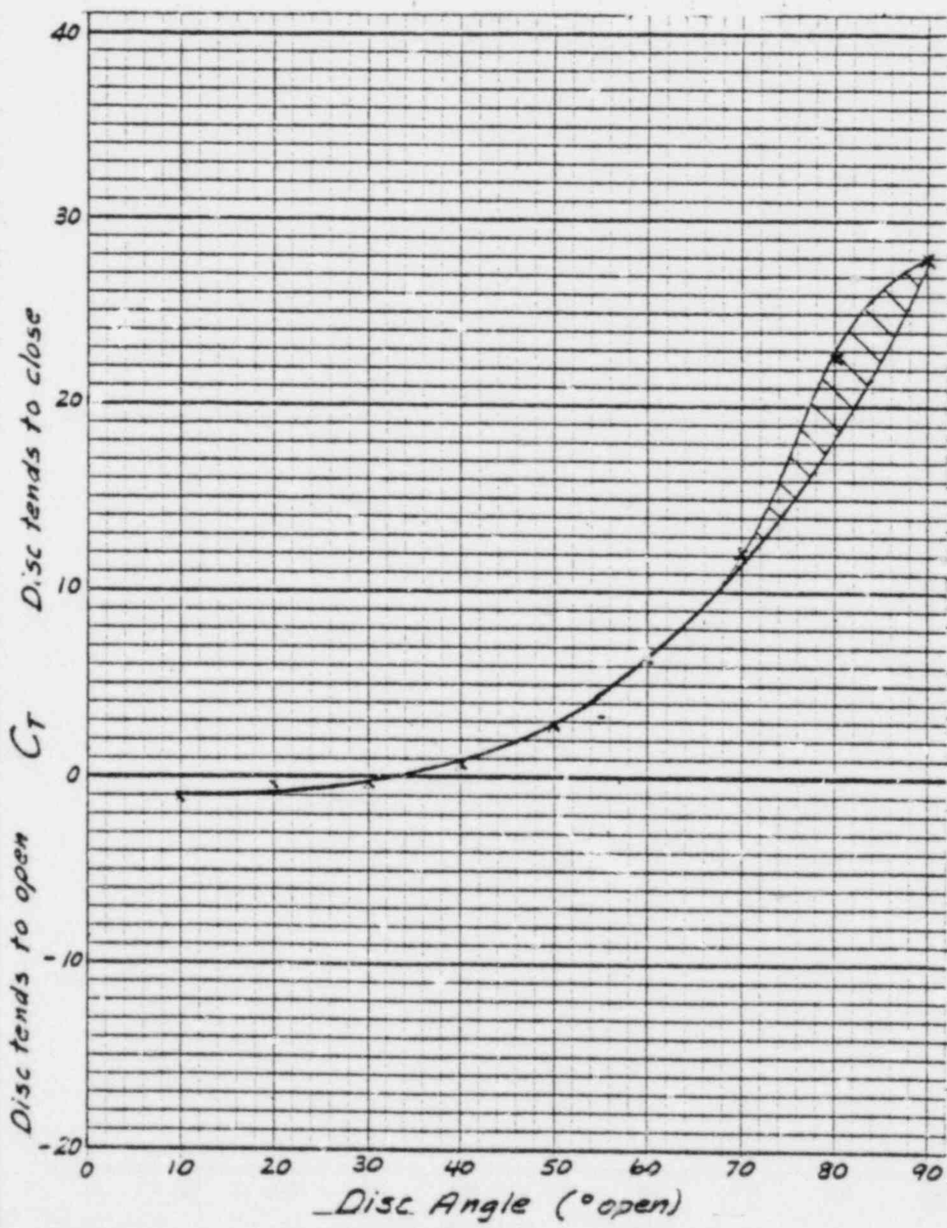
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 15 psig    Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 26 $P_{T_1}$ = 10 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4.0 | 2.5 | 1.5 | 5.2 | 27.7 | 9.1 |
| 80 | 4.5 | 2.0 | 2.5 | 6.6 | 21.1 | 10.5 |
| 70 | 5.0 | 2.0 | 3.0 | 6.8 | 18.1 | 11.8 |
| 60 | 7.0 | 1.5 | 5.5 | 5.0 | 7.3 | 13.8 |
| 50 | 8.5 | 1.0 | 7.5 | 2.7 | 2.9 | 15.8 |
| 40 | 9.0 | 0.5 | 8.5 | 1.0 | 0.9 | 17.2 |
| 30 | 10.0 | 0 | 10.0 | -0.6 | -0.5 | 17.9 |
| 20 | 10.0 | 0 | 10.0 | -0.6 | -0.5 | 17.9 |
| 10 | 10.0 | 0 | 10.0 | -0.8 | -0.6 | 17.9 |
| 0 | 10.0 | 0 | 10.0 | -2.1 | -1.7 | 17.9 |

Test 26 $P_{T_1}$ = 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 5.0 | 3.0 | 2.0 | 7.0 | 28.0 | 6.4 |
| 80 | 5.5 | 2.5 | 3.0 | 8.5 | 22.7 | 7.8 |
| 70 | 8.0 | 2.5 | 5.5 | 8.3 | 12.1 | 11.8 |
| 60 | 9.5 | 2.0 | 7.5 | 6.0 | 6.4 | 13.8 |
| 50 | 11.0 | 1.5 | 9.5 | 3.5 | 2.9 | 15.8 |
| 40 | 12.0 | 1.0 | 11.0 | 1.0 | 0.7 | 16.5 |
| 30 | 12.0 | 1.0 | 11.0 | -0.6 | -0.4 | 17.2 |
| 20 | 12.0 | 0.5 | 11.5 | -0.6 | -0.4 | 17.2 |
| 10 | 12.5 | 0.5 | 12.0 | -1.7 | -1.1 | 17.2 |
| 0 | 12.5 | 0.5 | 12.0 | -3.3 | -2.2 | 17.2 |

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LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. Z.

Test No. 26

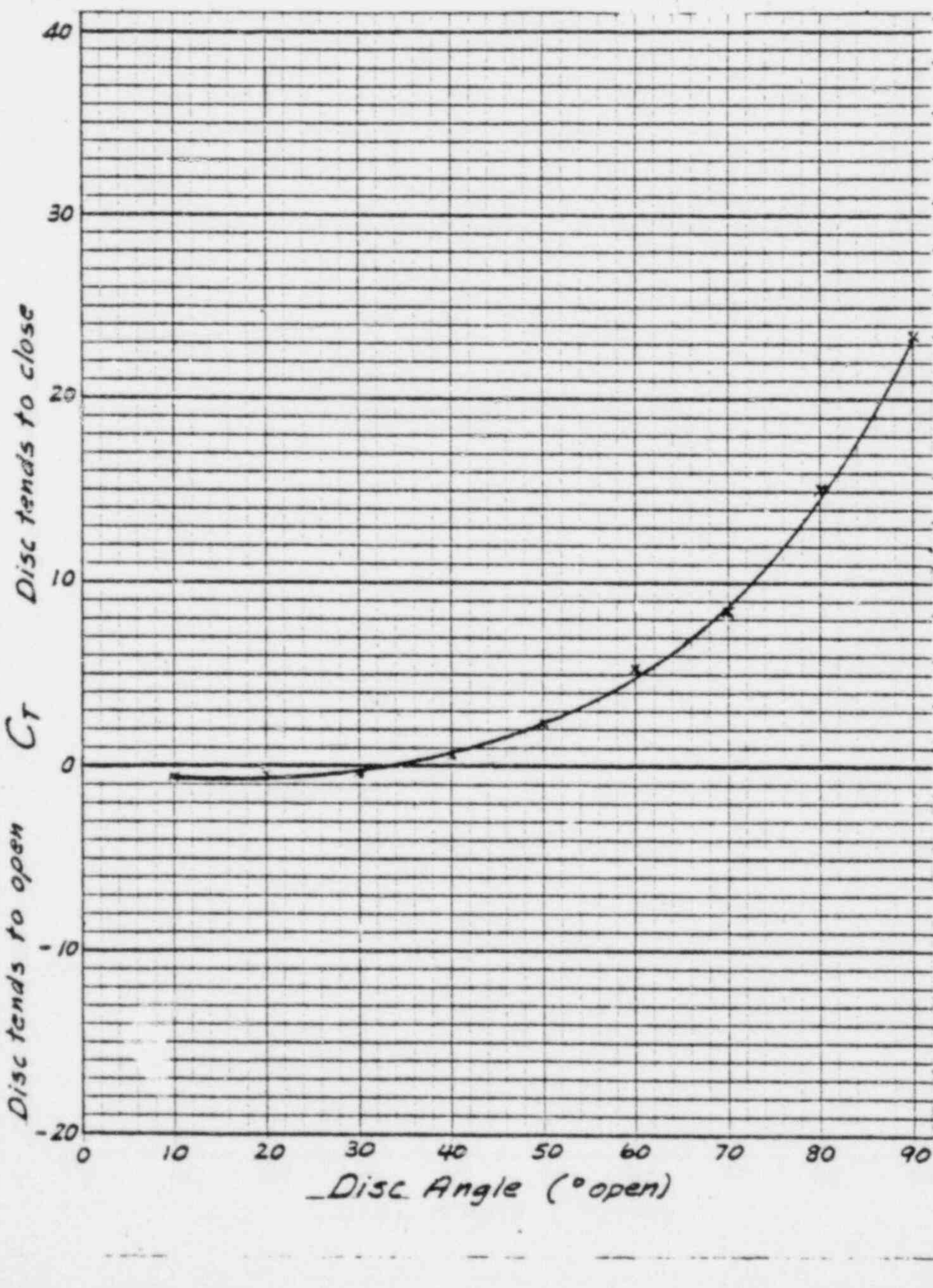
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 20 psig  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A. - A-C

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS — FORM 6715-1

CALCULATED BY R. Z.

Test No. 26

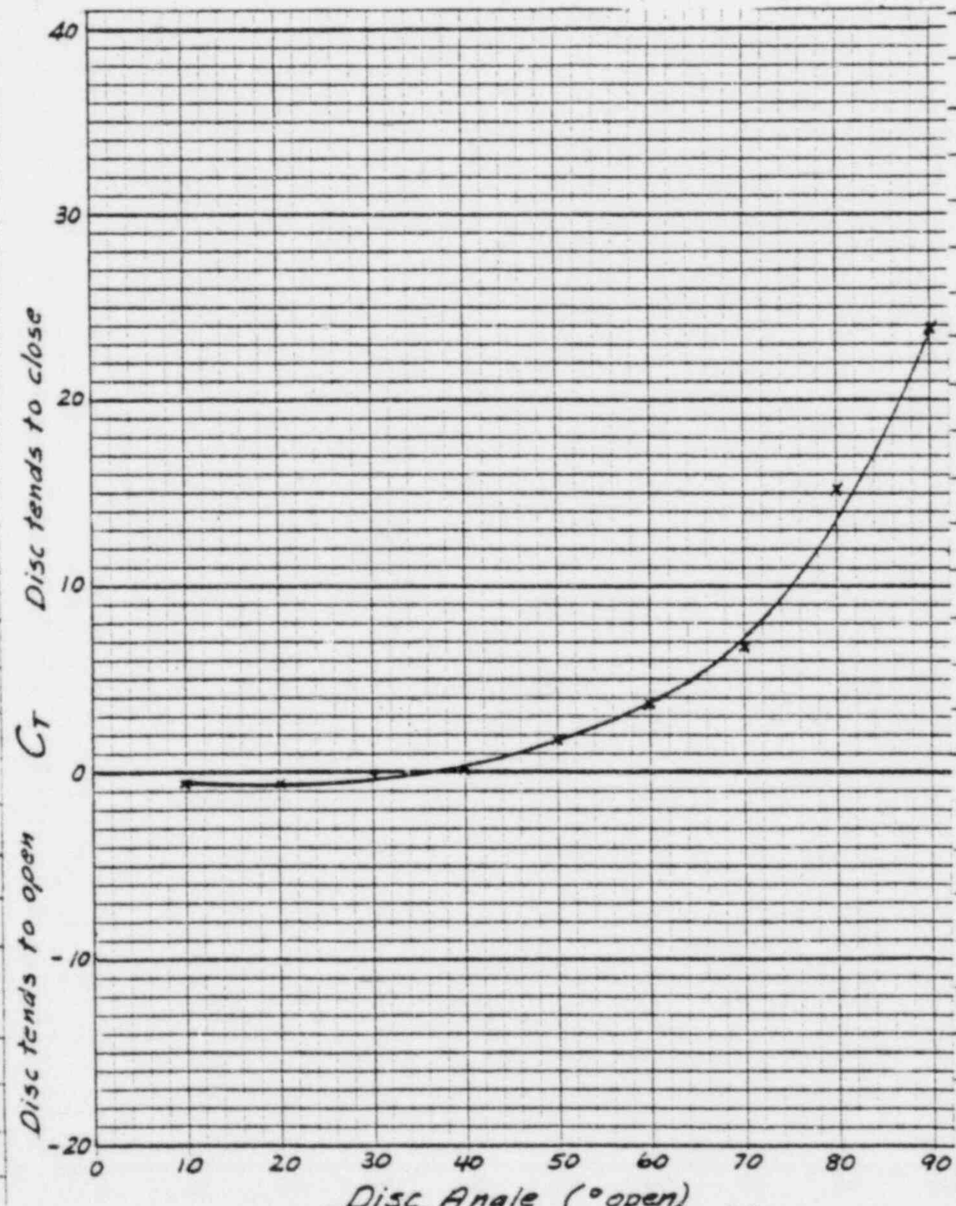
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 30 psig    Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 26 $P_{T_1}$ = 20 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 7.0 | 3.5 | 3.5 | 10.3 | 23.5 | 6.4 |
| 80 | 10.0 | 3.0 | 7.0 | 13.2 | 15.1 | 8.4 |
| 70 | 13.5 | 3.0 | 10.5 | 11.1 | 8.5 | 11.8 |
| 60 | 15.5 | 2.5 | 13.0 | 8.5 | 5.2 | 15.8 |
| 50 | 18.0 | 2.0 | 16.0 | 4.7 | 2.3 | 17.9 |
| 40 | 19.0 | 1.5 | 17.5 | 1.2 | 0.5 | 18.5 |
| 30 | 19.5 | 1.0 | 18.5 | -1.0 | -0.4 | 18.5 |
| 20 | 20.0 | 0.5 | 19.5 | -1.2 | -0.5 | 18.5 |
| 10 | 20.0 | 0.5 | 19.5 | -1.7 | -0.7 | 18.5 |
| 0 | 20.0 | 0.5 | 19.5 | -3.5 | -1.4 | 18.5 |

Test 26 $P_{T_1}$ = 30 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 12.5 | 7.5 | 5.0 | 14.9 | 23.8 | 11.8 |
| 80 | 16.0 | 7.5 | 8.5 | 16.1 | 15.2 | 13.8 |
| 70 | 22.0 | 7.0 | 15.0 | 12.8 | 6.8 | 18.5 |
| 60 | 25.0 | 3.5 | 21.5 | 9.9 | 3.7 | 22.6 |
| 50 | 27.5 | 3.0 | 24.5 | 5.6 | 1.8 | 23.9 |
| 40 | 29.5 | 2.5 | 27.0 | 0.1 | 0.03 | 25.3 |
| 30 | 29.5 | 2.0 | 27.5 | -0.2 | -0.06 | 25.3 |
| 20 | 29.5 | 2.0 | 27.5 | -2.5 | -0.7 | 25.3 |
| 10 | 29.5 | 2.0 | 27.5 | -2.1 | -0.6 | 25.3 |
| 0 | 29.5 | 2.0 | 27.5 | -6.4 | -1.9 | 25.3 |

| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 5 of 7 |

| SUBJECT | PRELIM. | FINAL |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.-A-C

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715.1

CALCULATED BY R. Z.

Test No. 26

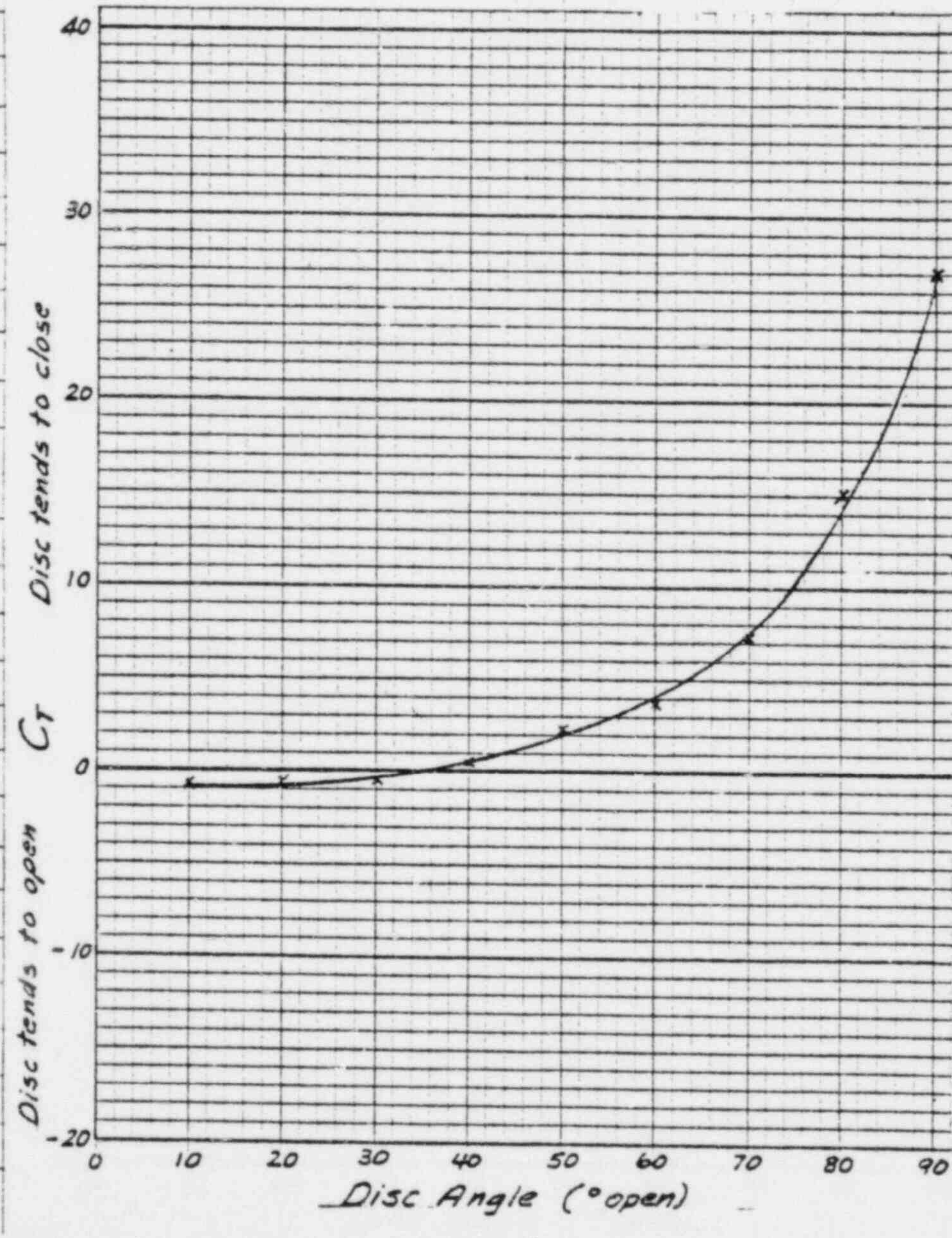
Valve disc thicknsss to diameter ratio: .12

Initial upstream pressure: 40 psig   Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY

Test No. 26

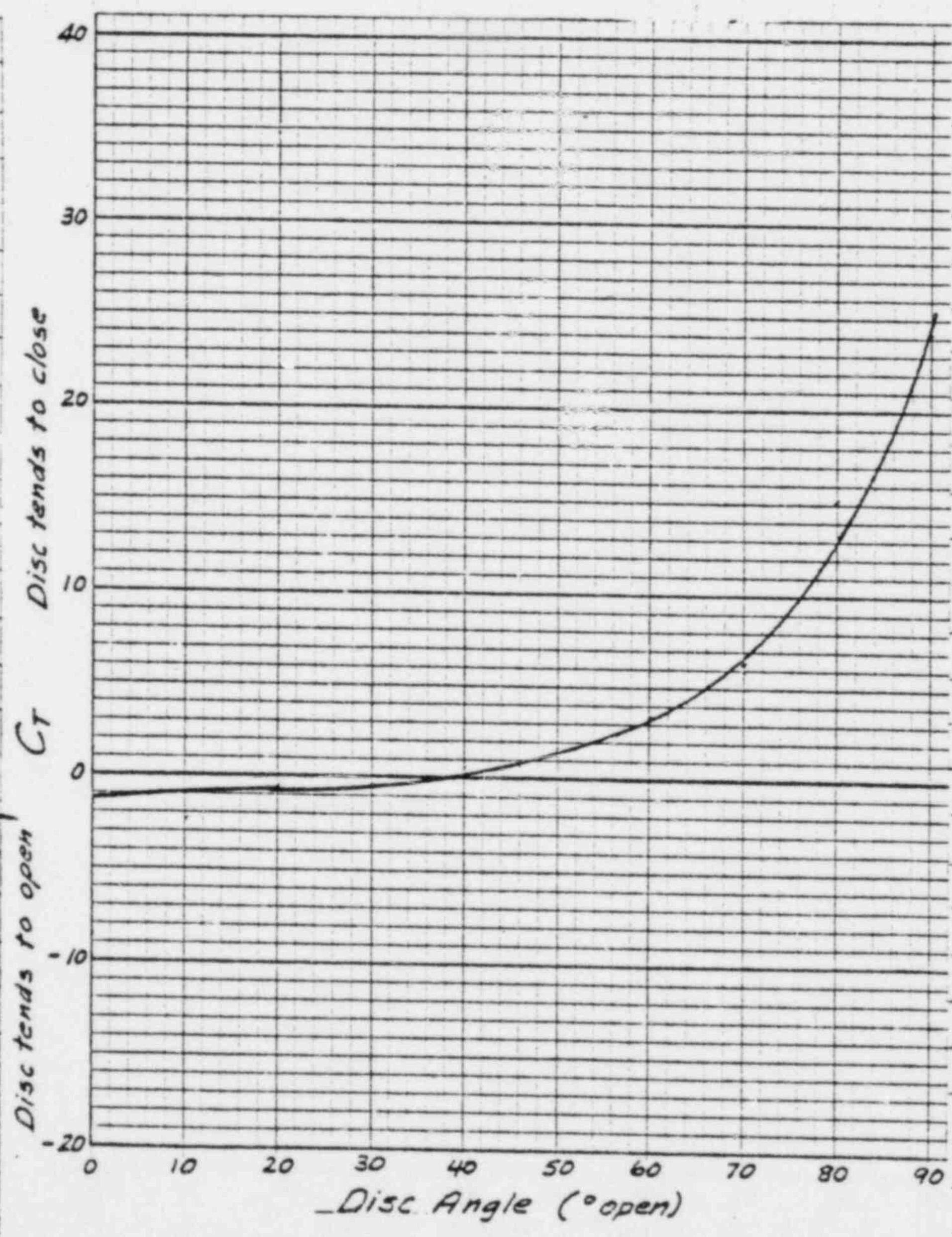
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 50 PSIG Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 26 $P_{T_1} = 40$ PSIG

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 18 | 12.5 | 5.5 | 18.57 | 27 | 19.9 |
| 80 | 22 | 11 | 11 | 20.63 | 15 | 21.9 |
| 70 | 28 | 10 | 18 | 16.51 | 7.34 | 25.9 |
| 60 | 32.5 | 7.5 | 25 | 11.86 | 3.79 | 32.0 |
| 50 | 35 | 5 | 30 | 8.35 | 2.23 | 33.3 |
| 40 | 37.5 | 2.5 | 35 | 2.46 | .56 | 34.0 |
| 30 | 38 | 2.0 | 36 | -2.46 | -.55 | 34.7 |
| 20 | 38 | 2.0 | 36 | -2.46 | -.55 | 34.7 |
| 10 | 39 | 1.0 | 38 | -4.13 | -.87 | 34.7 |
| 0 | 40 | 0 | 40 | -8.25 | -1.65 | 34.7 |

Test 26 $P_{T_1} = 50$ PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 24.0 | 16.5 | 7.5 | 22.7 | 24.2 | 32.0 |
| 80 | 27.5 | 15.0 | 12.5 | 23.7 | 15.2 | 33.3 |
| 70 | 37.0 | 13.5 | 23.5 | 18.6 | 6.3 | 38.7 |
| 60 | 42.0 | 10.0 | 32.0 | 13.2 | 3.3 | 44.1 |
| 50 | 44.5 | 6.0 | 38.5 | 8.3 | 1.7 | 45.5 |
| 40 | 46.5 | 3.0 | 43.5 | 2.5 | 0.5 | 46.8 |
| 30 | 47.0 | 2.5 | 44.5 | -2.5 | -0.4 | 46.8 |
| 20 | 47.0 | 2.0 | 45.0 | -2.7 | -0.5 | 46.8 |
| 10 | 48.0 | 2.0 | 46.0 | -5.6 | -1.0 | 46.8 |
| 0 | 48.0 | 0.5 | 47.5 | -10.3 | -1.7 | 46.8 |

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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

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LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY R. Z.

Test No. 26

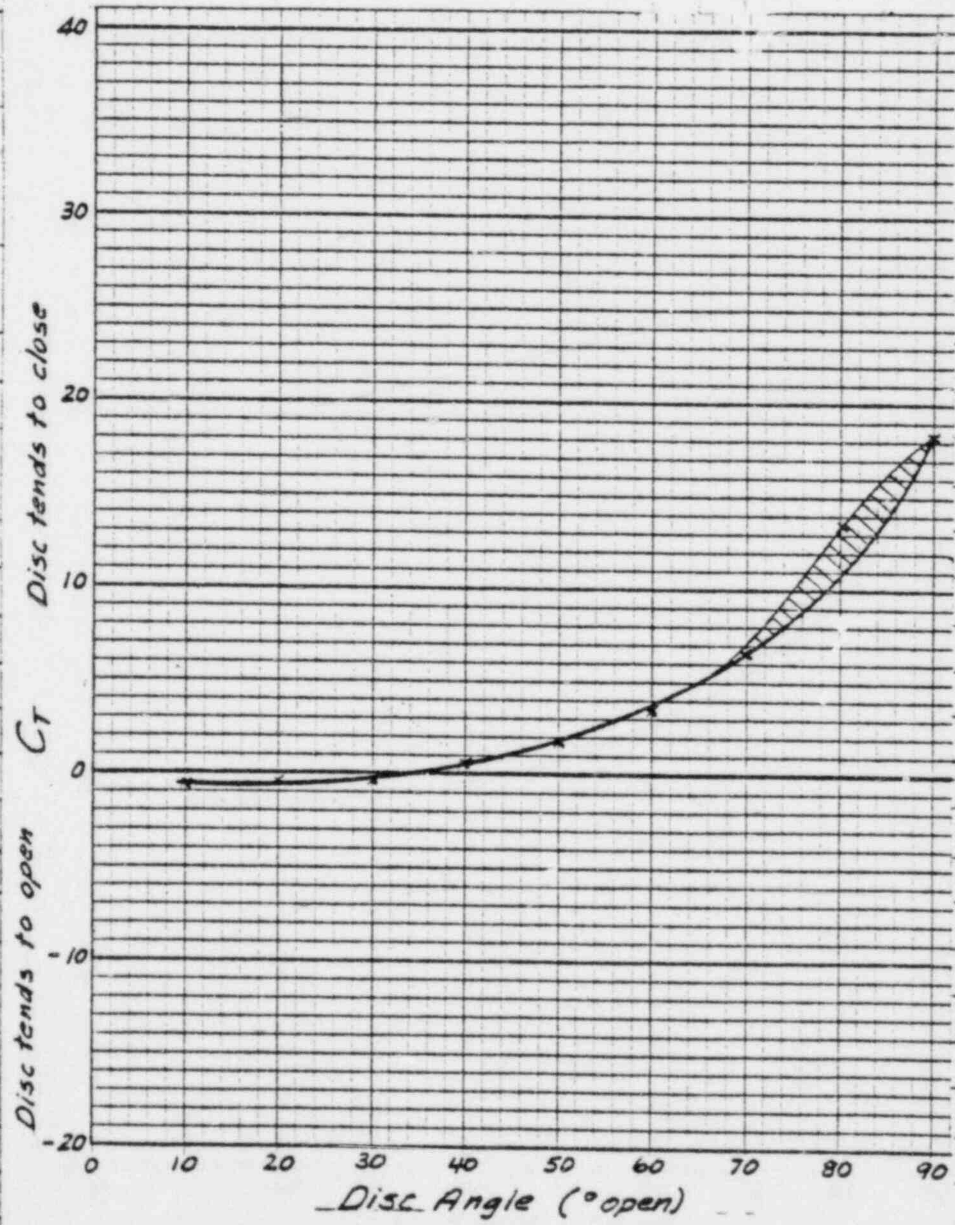
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 60 psig   Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 26

$P_{T_1} = 60$ PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 29.0 | 18.0 | 11.0 | 25.0 | 18.2 | 38.7 |
| 80 | 32.5 | 17.0 | 15.5 | 26.2 | 13.5 | 41.4 |
| 70 | 41.0 | 16.0 | 25.0 | 20.6 | 6.6 | 47.5 |
| 60 | 48.0 | 12.5 | 35.5 | 15.3 | 3.4 | 51.5 |
| 50 | 51.5 | 7.5 | 44.0 | 9.9 | 1.8 | 52.9 |
| 40 | 54.0 | 4.0 | 50.0 | 3.1 | 0.5 | 52.9 |
| 30 | 55.0 | 2.5 | 52.5 | -2.1 | -0.3 | 53.5 |
| 20 | 55.0 | 2.0 | 53.0 | -2.7 | -0.4 | 53.5 |
| 10 | 55.0 | 1.5 | 53.5 | -6.2 | -0.9 | 53.5 |
| 0 | 55.0 | 1.0 | 54.0 | -10.7 | -1.6 | 53.5 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 1 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 27 ✓

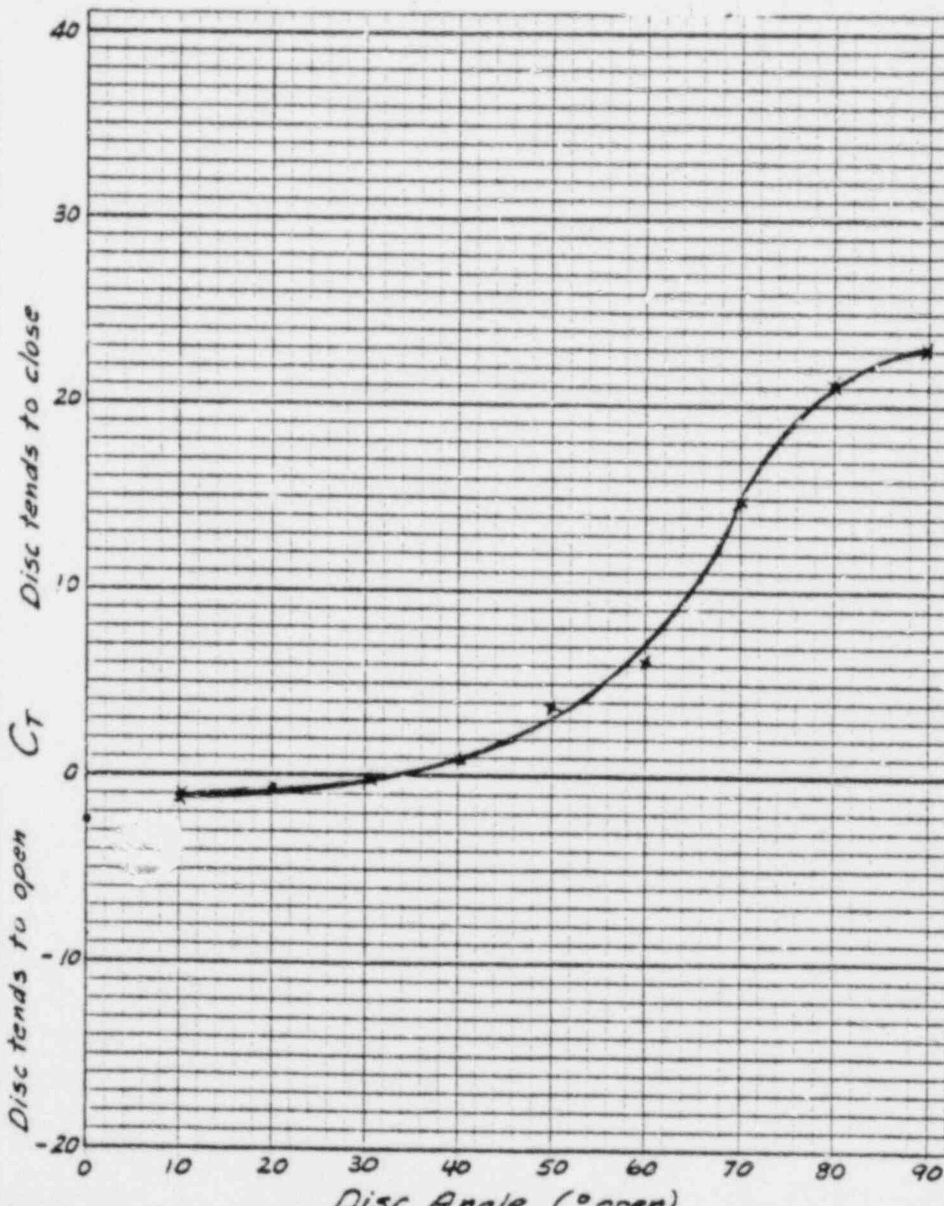
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 10 PSIG    Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 27 10 PSI

| | | | | | |
|---|---|---|---|---|---|
| 90 | 5.0 | 2.5 | 2.5 | 7.2 | 23.1 |
| 80 | 6.0 | 2.5 | 3.5 | 9.3 | 21.2 |
| 70 | 7.5 | 2.5 | 5.0 | 9.3 | 14.9 |
| 60 | 10.0 | 2.0 | 8.0 | 6.2 | 6.2 |
| 50 | 10.5 | 1.5 | 9.0 | 4.1 | 3.7 |
| 40 | 12.0 | 1.5 | 10.5 | 1.2 | 0.9 |
| 30 | 12.5 | 1.0 | 11.5 | -0.1 | -0.07 |
| 20 | 12.5 | 1.0 | 11.5 | -1.0 | -0.7 |
| 10 | 12.5 | 0.5 | 12.0 | -1.7 | -1.1 |
| 0 | 12.5 | 0.5 | 12.0 | 3.5 | -2.3 |

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| CUSTOMER | DATE | |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | SHEET 2 OF 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | | CALCULATED BY |
|---|---|---|
| | LITHO IN U.S.A.-A-C<br>ENGINEERING CALCULATION SHEET<br>ALLIS-CHALMERS FORM 6715-1 | CHH<br>Test No. 27 |

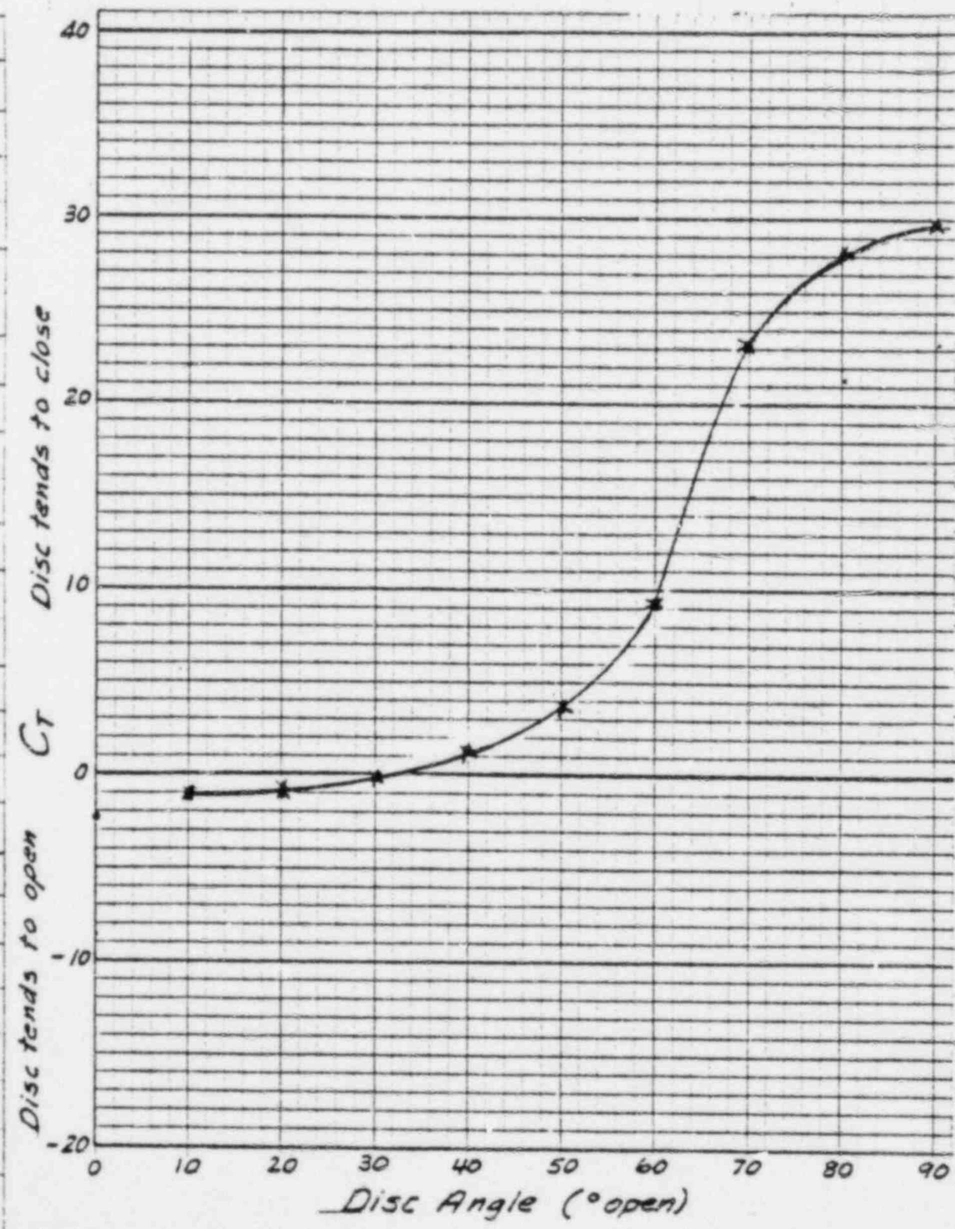
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 15 PSIG  Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests _ NASA/Langley Research Center | Nov. & Dec. 1979 | SHEET 3 OF 7 |
| SUBJECT | PRELIM. | FINAL |
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |
| DRAWING NUMBER | | CALCULATED BY BHH |

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

Test No. 27

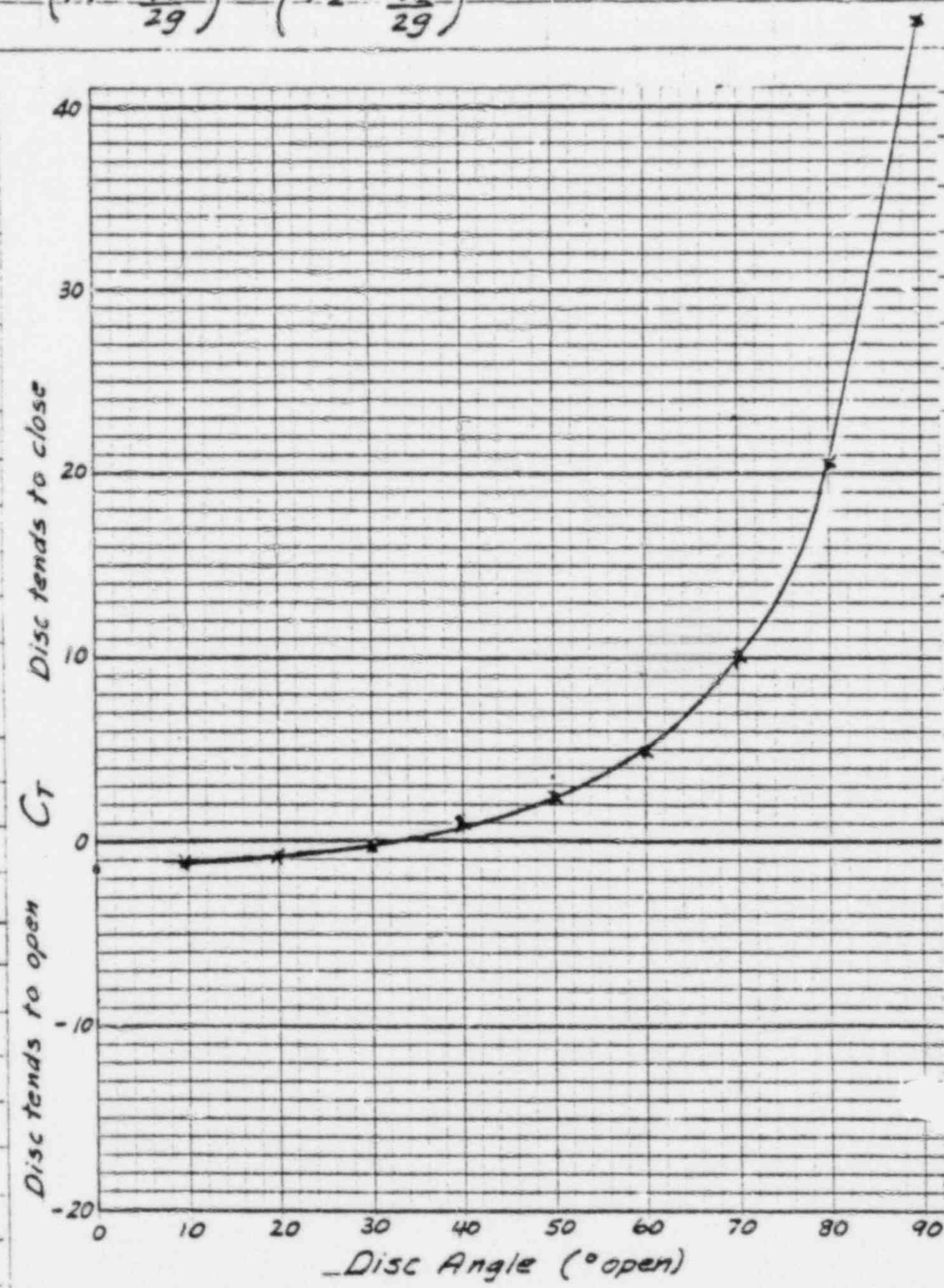
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 20 PSIG Valve orientation ref Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 27 15 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4.0 | 2.5 | 1.5 | 5.6 | 29.7 | not recorded |
| 80 | 4.5 | 2.5 | 2.0 | 7.0 | 28.0 | |
| 70 | 5.0 | 2.5 | 2.5 | 7.2 | 23.1 | |
| 60 | 6.5 | 2.0 | 4.5 | 5.2 | 9.2 | |
| 50 | 8.0 | 1.0 | 7.0 | 3.1 | 3.5 | |
| 40 | 8.0 | 1.0 | 7.0 | 1.2 | 1.4 | |
| 30 | 9.0 | 0.5 | 8.5 | -0.1 | -0.1 | |
| 20 | 10.0 | 0.5 | 9.5 | -1.0 | -0.9 | |
| 10 | 10.0 | 0.5 | 9.5 | -1.4 | -1.2 | |
| 0 | 10.0 | 0.5 | 9.5 | -2.7 | -2.3 | |

Test 27 20 PSI

| | | | | | |
|---|---|---|---|---|---|
| 90 | 7.0 | 5.0 | 2.0 | 11.3 | 45.2 |
| 80 | 10.0 | 4.5 | 5.5 | 14.0 | 20.4 |
| 70 | 12.5 | 3.0 | 9.5 | 12.0 | 10.1 |
| 60 | 16.0 | 2.5 | 13.5 | 8.3 | 4.9 |
| 50 | 17.5 | 2.5 | 15.0 | 4.7 | 2.5 |
| 40 | 19.0 | 1.0 | 18.0 | 2.06 | 0.9 |
| 30 | 19.5 | 1.0 | 18.5 | -0.4 | -0.2 |
| 20 | 20.0 | 0.5 | 19.5 | -1.9 | -0.8 |
| 10 | 20.0 | 0 | 20.0 | -2.9 | -1.2 |
| 0 | 20.0 | 0 | 20.0 | -3.7 | -1.5 |

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| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY BHH

Test No. 27

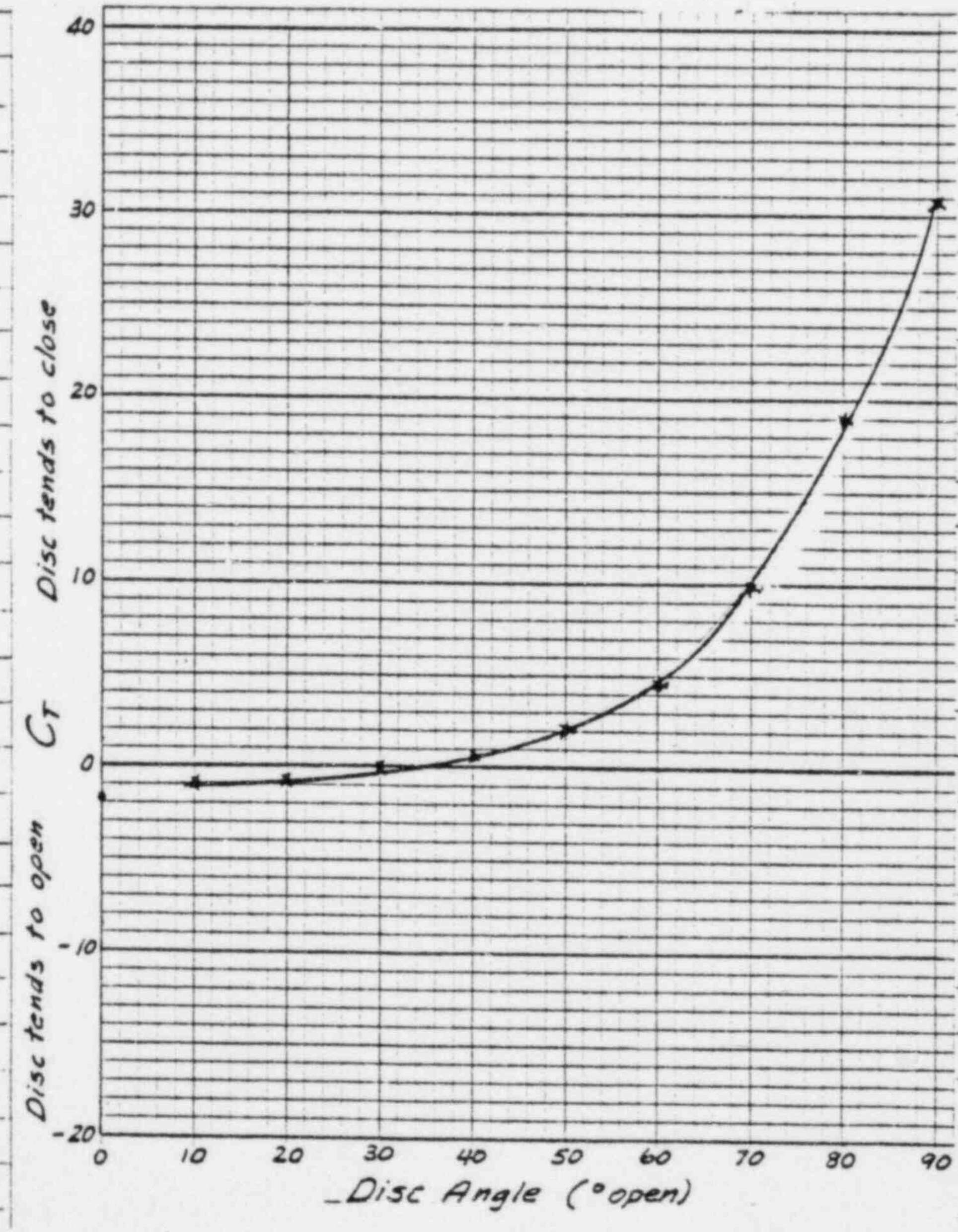
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 30 PSIG Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in PSI.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 5 OF 7

SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY BHH.

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 27

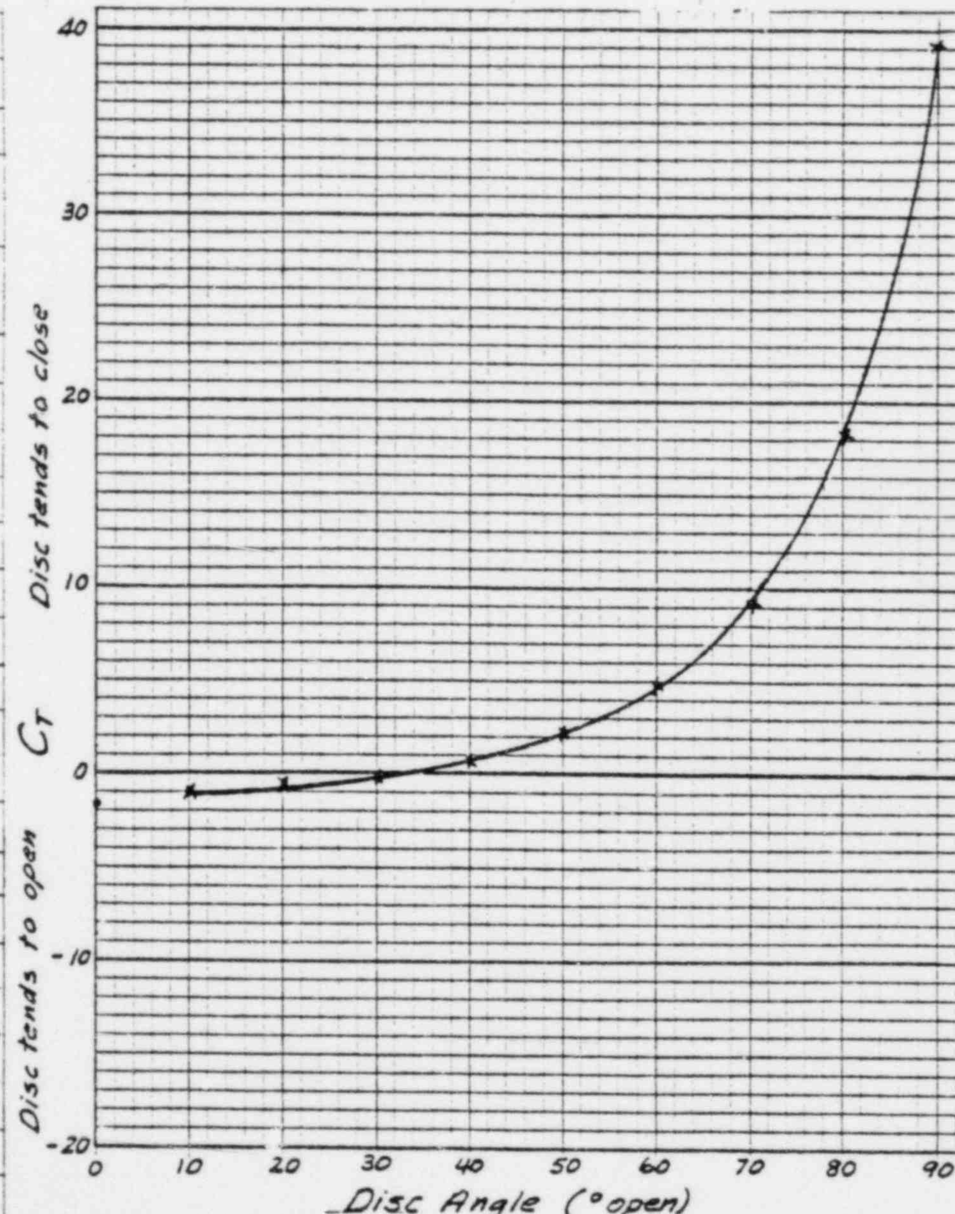
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 40 PSIG   Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \cdot D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

Test 27 30 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 12.0 | 8.0 | 4.0 | 15.5 | 30.9 | not recorded |
| 80 | 15.0 | 7.0 | 8.0 | 19.0 | 19.0 | |
| 70 | 19.0 | 6.0 | 13.0 | 16.1 | 9.9 | |
| 60 | 25.0 | 5.0 | 20.0 | 11.3 | 4.5 | |
| 50 | 26.5 | 2.5 | 24.0 | 6.1 | 2.1 | |
| 40 | 27.5 | 1.5 | 26.0 | 2.1 | 0.6 | |
| 30 | 28.0 | 0 | 28.0 | 0 | 0 | |
| 20 | 28.0 | 0 | 28.0 | -2.5 | -0.7 | |
| 10 | 28.0 | 0 | 28.0 | -2.9 | -0.8 | |
| 0 | 28.0 | 0 | 28.0 | -6.4 | -1.8 | |

Test 27 40 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 19.0 | 13.0 | 4.0 | 19.6 | 39.2 | 17.2 |
| 80 | 21.5 | 11.0 | 10.5 | 23.7 | 18.1 | 18.5 |
| 70 | 27.5 | 10.0 | 17.5 | 19.8 | 9.1 | 23.3 |
| 60 | 32.5 | 7.5 | 25.0 | 15.1 | 4.8 | 27.3 |
| 50 | 36.0 | 5.0 | 31.0 | 8.7 | 2.2 | 30.0 |
| 40 | 37.5 | 2.5 | 35.0 | 2.9 | 0.7 | 31.3 |
| 30 | 38.0 | 1.5 | 36.5 | -1.0 | -0.2 | 32.0 |
| 20 | 39.0 | 1.0 | 38.0 | -3.1 | -0.7 | 32.0 |
| 10 | 39.0 | 0.5 | 38.5 | -4.7 | -1.0 | 32.0 |
| 0 | 39.0 | 0 | 39.0 | -8.5 | -1.7 | 32.0 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 6 of 7 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY: B.H.H.

Test No. 27

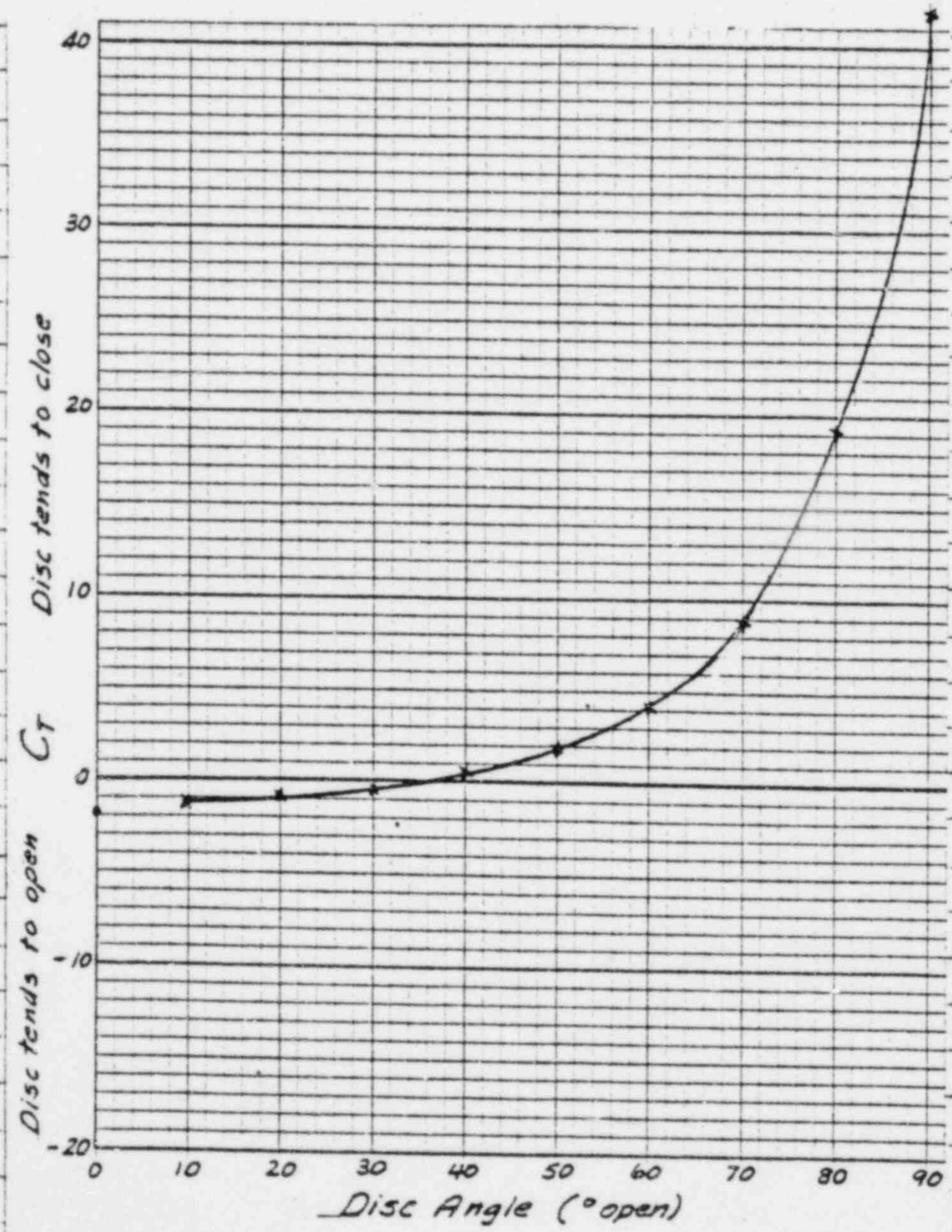
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 50PSIG  Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [signature]

Test No. 27

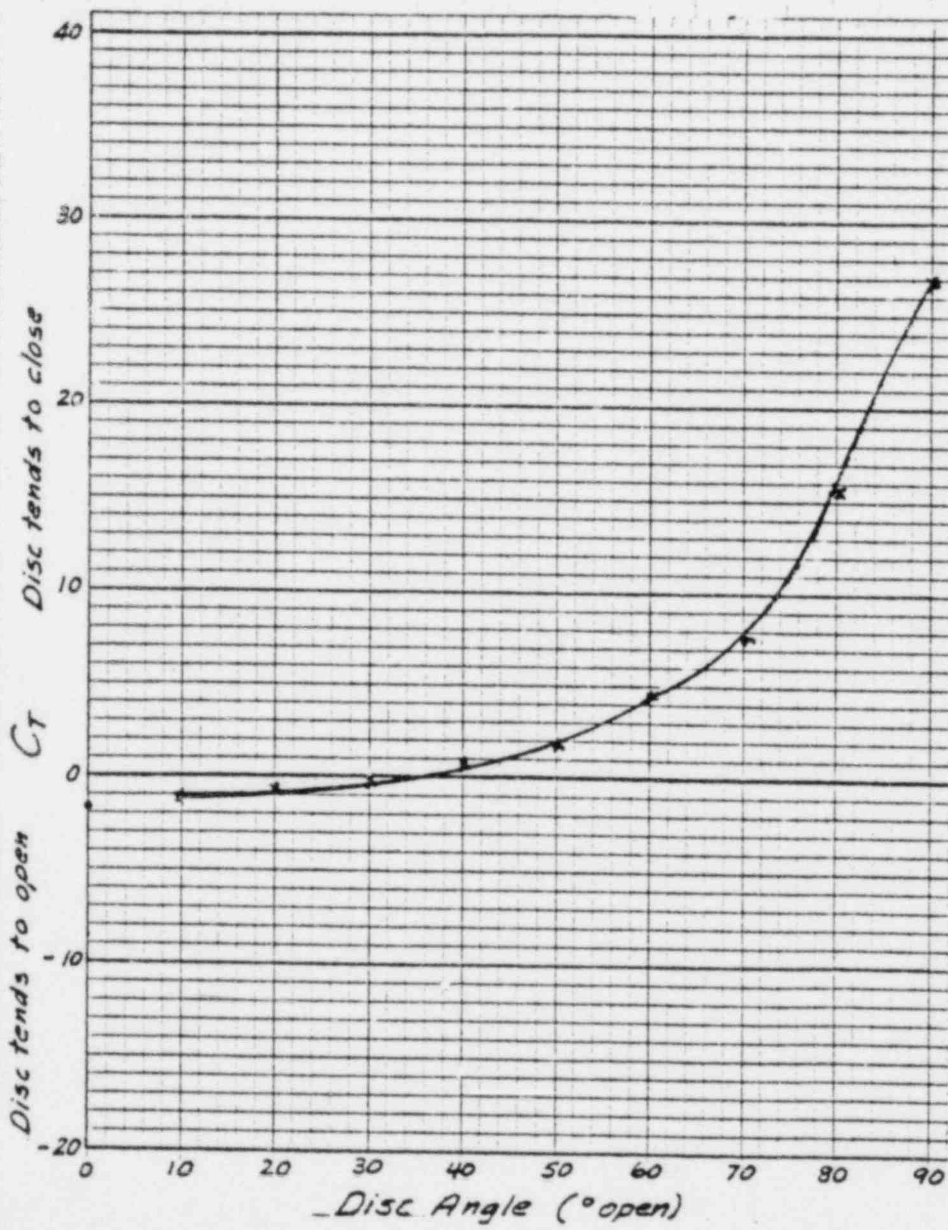
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 60 PSIG Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 27 50 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 30.0 | 25.5 | 4.5 | 23.7 | 42.2 | 26.6 |
| 80 | 33.0 | 21.5 | 11.5 | 27.6 | 19.2 | 28.0 |
| 70 | 40.0 | 19.0 | 21.0 | 23.1 | 8.8 | 34.0 |
| 60 | 47.5 | 15.0 | 32.5 | 16.5 | 4.1 | 38.1 |
| 50 | 50.0 | 11.0 | 39.0 | 9.3 | 1.9 | 39.4 |
| 40 | 52.5 | 8.5 | 44.0 | 3.1 | 0.6 | 40.1 |
| 30 | 53.0 | 8.0 | 45.0 | -2.1 | -0.4 | 40.1 |
| 20 | 53.0 | 7.5 | 45.5 | -4.5 | -0.8 | 40.1 |
| 10 | 54.0 | 7.5 | 46.5 | -6.2 | -1.1 | 40.1 |
| 0 | 54.0 | 7.5 | 46.5 | -10.3 | -1.8 | 40.1 |

Test 27 60 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 30.0 | 22.0 | 8.0 | 26.8 | 26.8 | 34.7 |
| 80 | 34.0 | 18.0 | 16.0 | 30.9 | 15.5 | 37.4 |
| 70 | 43.0 | 16.0 | 27.0 | 25.2 | 7.5 | 43.4 |
| 60 | 48.0 | 13.0 | 35.0 | 19.4 | 4.4 | 46.0 |
| 50 | 52.0 | 7.5 | 44.5 | 9.9 | 1.8 | 48.1 |
| 40 | 54.5 | 3.5 | 51.0 | 3.7 | 0.6 | 48.8 |
| 30 | 55.0 | 2.5 | 52.5 | -1.7 | -0.3 | 48.8 |
| 20 | 55.0 | 2.0 | 53.0 | -4.7 | -0.7 | 48.8 |
| 10 | 55.0 | 1.5 | 53.5 | -7.4 | -1.1 | 48.8 |
| 0 | 55.0 | 0 | 55.0 | -11.6 | -1.7 | 48.8 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
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| SUBJECT | PRELIM. | FINAL |
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| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 28

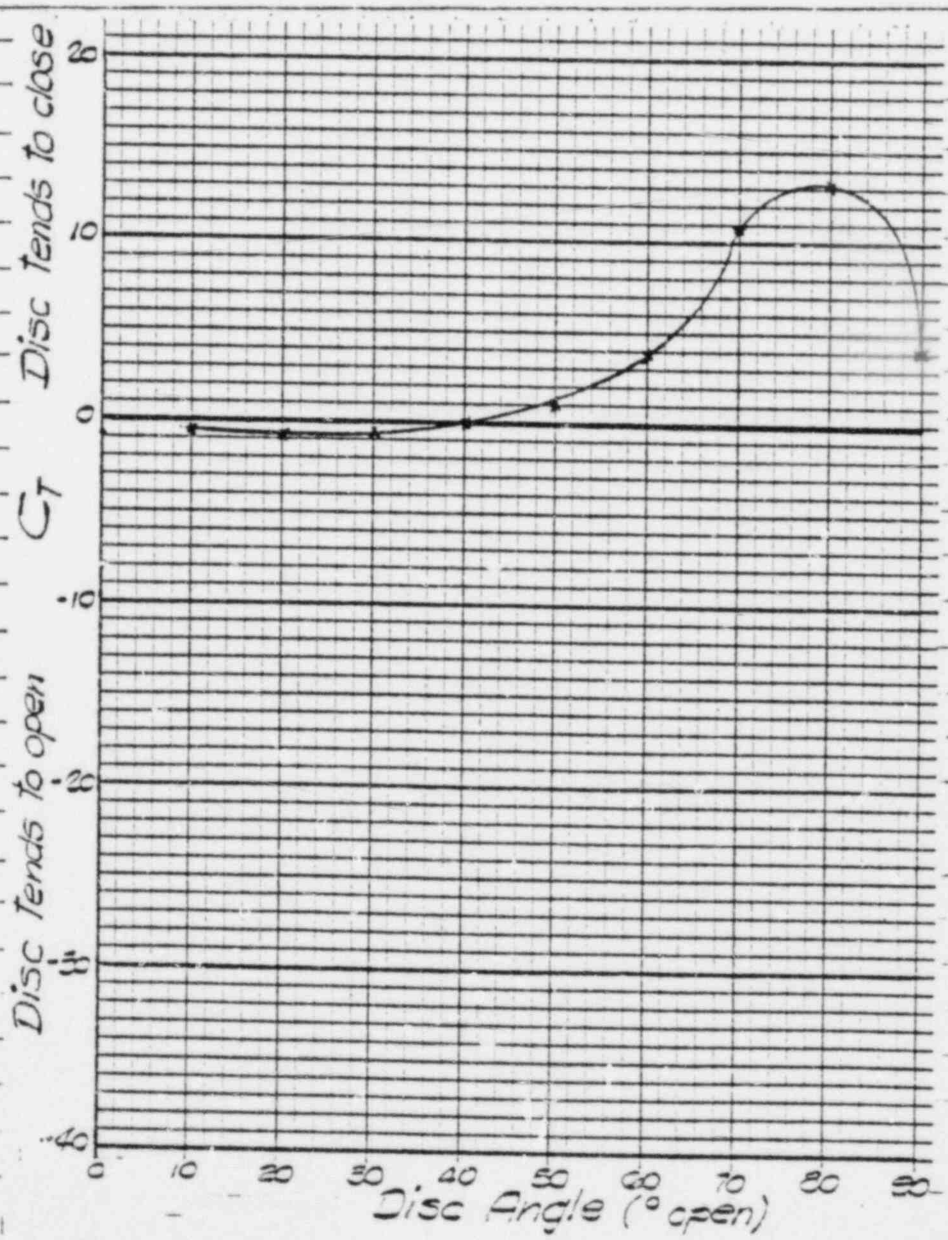
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 10 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 2 of 7 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY BHH.

Test No. 28

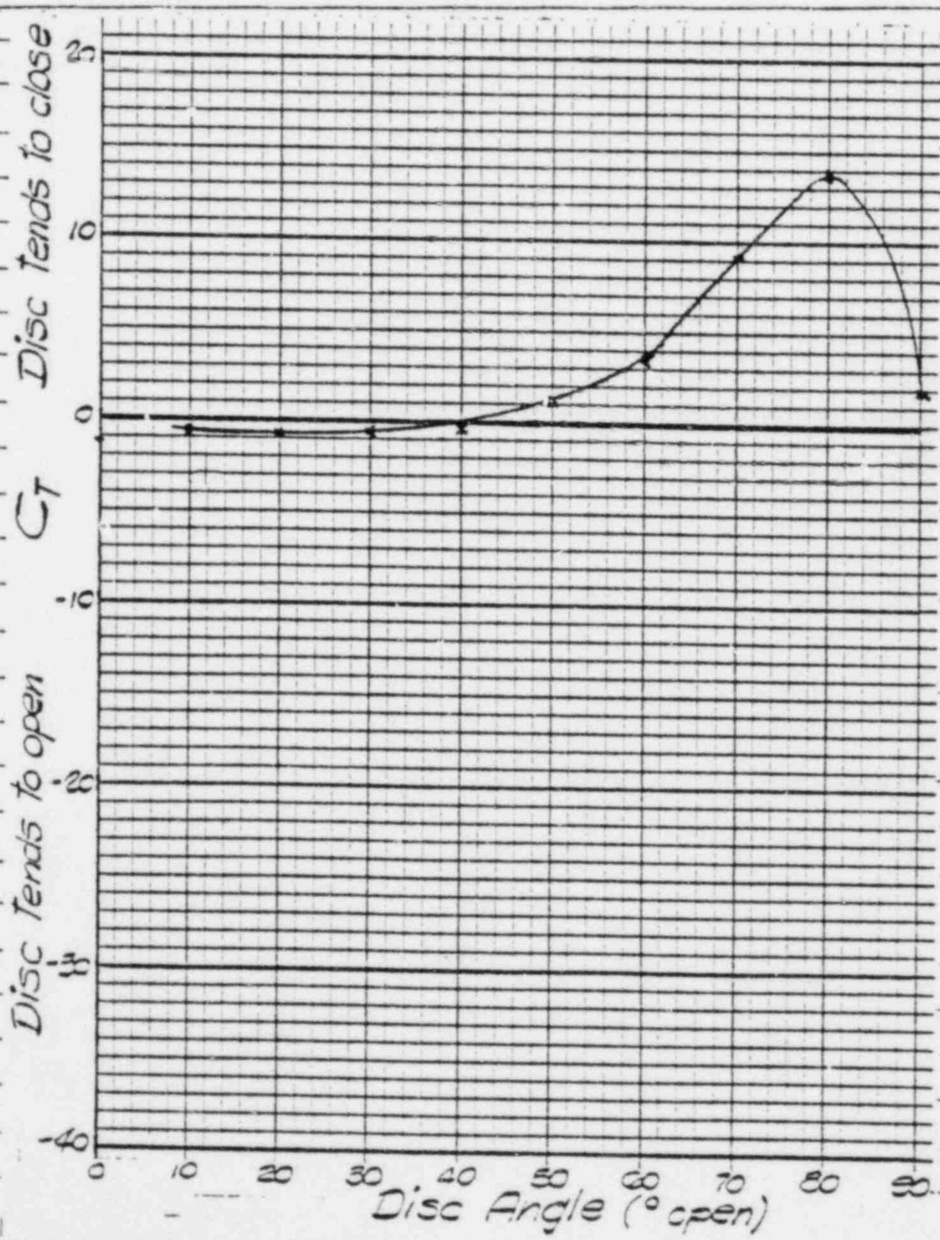
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 15 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 28 10 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4.5 | 2.5 | 2.0 | 1.0 | 4.1 | not recorded |
| 80 | 4.5 | 2.0 | 2.5 | 4.1 | 13.2 | |
| 70 | 5.0 | 1.5 | 3.5 | 4.8 | 10.8 | |
| 60 | 7.5 | 1.0 | 6.5 | 3.1 | 3.8 | |
| 50 | 8.5 | .5 | 8.0 | 1.0 | 1.0 | |
| 40 | 9.5 | 0 | 9.5 | 0 | 0 | |
| 30 | 9.5 | 0 | 9.5 | -0.4 | -.3 | |
| 20 | 9.5 | 0 | 9.5 | -1.0 | -.9 | |
| 10 | 9.5 | 0 | 9.5 | -0.6 | -.5 | |
| 0 | 9.5 | 0 | 9.5 | -1.0 | -.8 | |

Test 28 15 PSI

| | | | | | |
|---|---|---|---|---|---|
| 90 | 5.5 | 2.5 | 3.0 | .7 | 1.9 |
| 80 | 5.0 | 2.0 | 3.0 | 5.2 | 13.8 |
| 70 | 6.5 | 2.0 | 4.5 | 5.2 | 9.2 |
| 60 | 9.5 | 1.0 | 8.5 | 3.7 | 3.5 |
| 50 | 10.5 | 1.0 | 9.5 | 1.4 | 1.2 |
| 40 | 11.0 | 1.0 | 10.0 | -.4 | -.3 |
| 30 | 11.5 | 1.0 | 10.5 | -.6 | -.5 |
| 20 | 12.5 | .5 | 12.0 | -1.2 | -.8 |
| 10 | 12.5 | .5 | 12.0 | -.6 | -.4 |
| 0 | 12.0 | 0 | 12.0 | -1.7 | -1.1 |

| | | |
|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 3 OF 7 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | CALCULATED BY: D.H.G. | Test No. 28 |

ENGINEERING CALCULATION SHEET

LITHO IN U.S.A.—A-C

ALLIS-CHALMERS FORM 6715-1

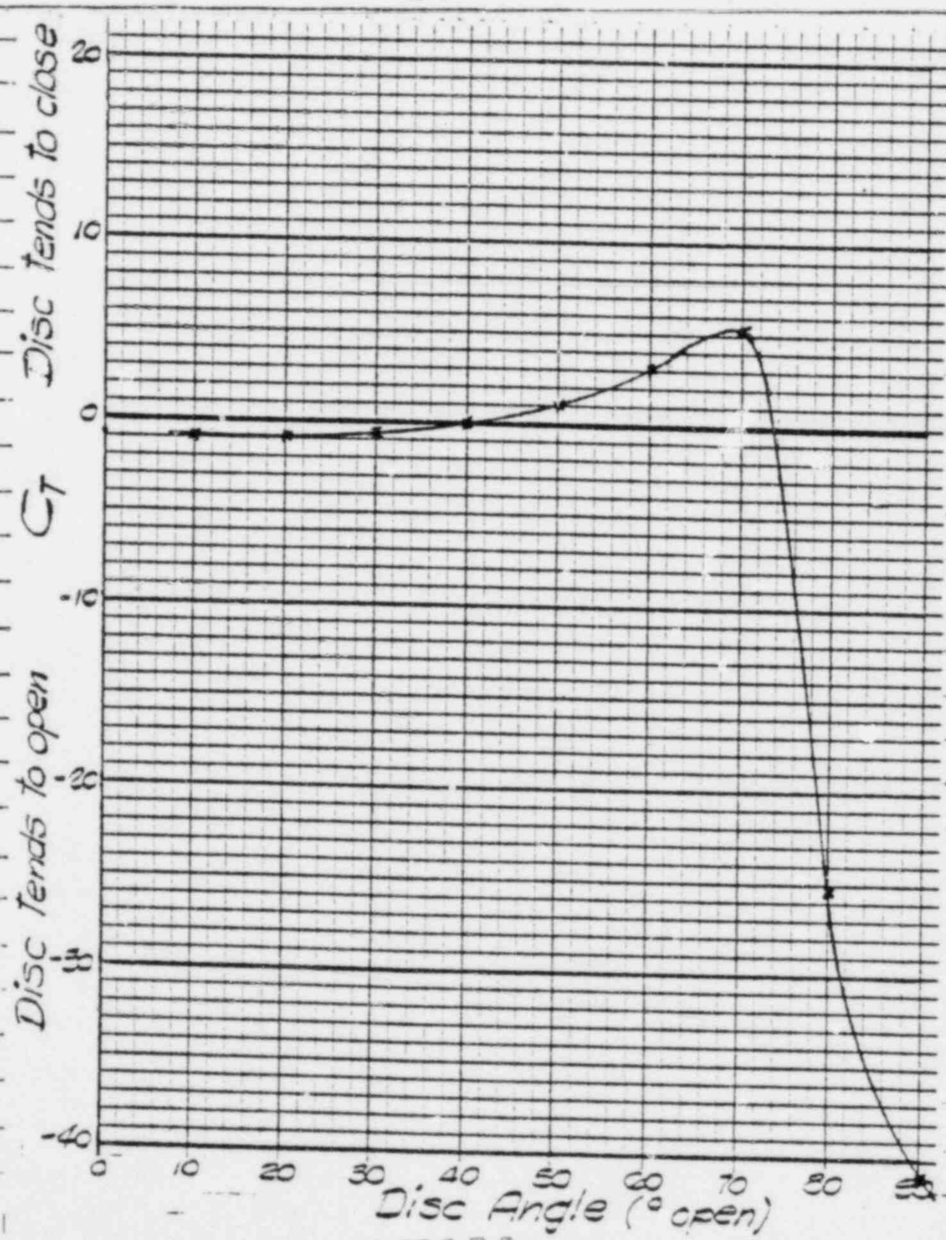
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 20PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 4 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY BHH

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

Test No. 28

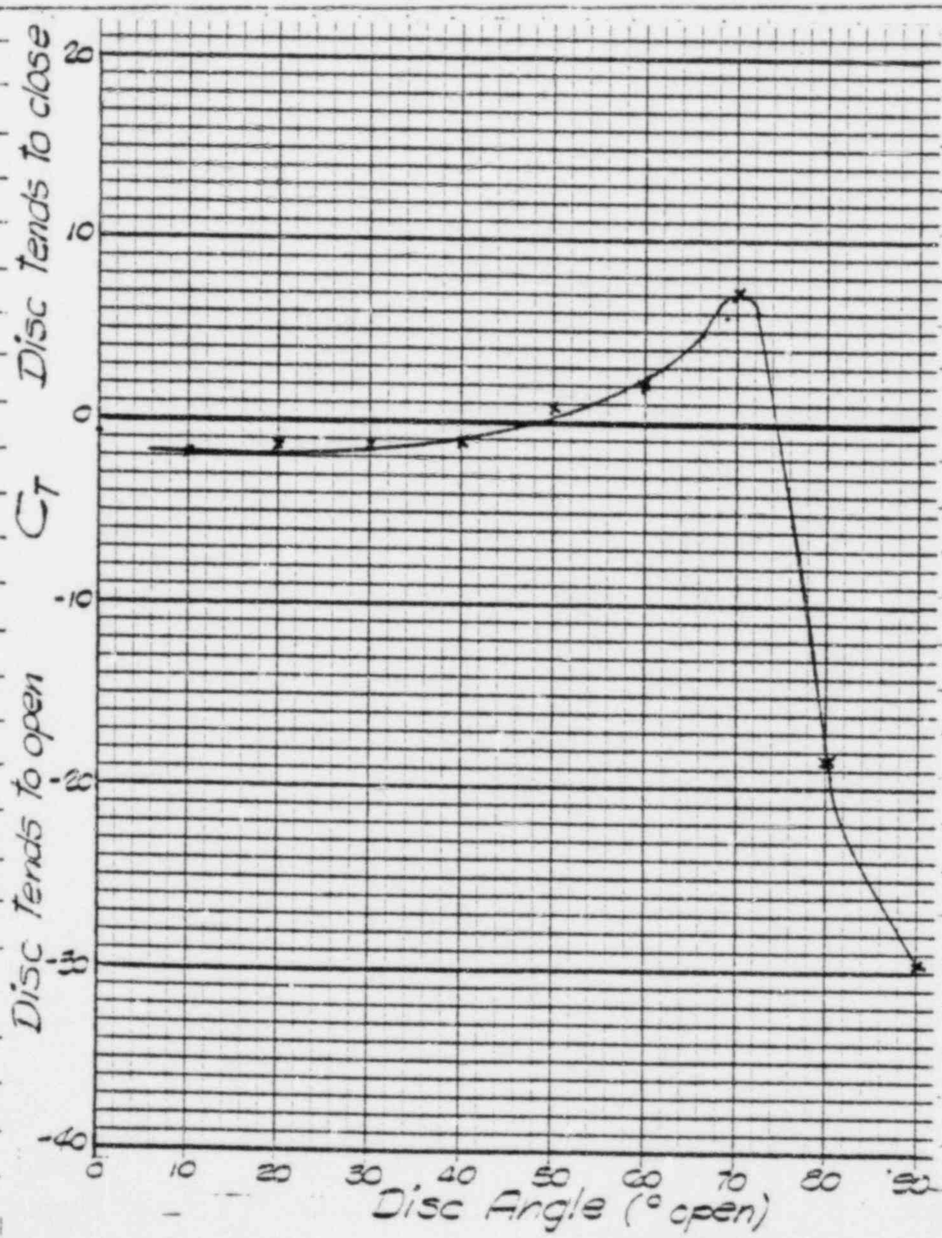
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 30 PSIG   Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 28 20 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 7.2 | 5.0 | 2.2 | -11.3 | -41.3 | not recorded |
| 80 | 7.0 | 5.5 | 1.5 | -4.7 | -2.53 | |
| 70 | 12.5 | 2.5 | 10.0 | 6.6 | 5.3 | |
| 60 | 15.5 | 2.5 | 13.0 | 5.2 | 3.2 | |
| 50 | 17.5 | 1.0 | 16.5 | 2.1 | 1.0 | |
| 40 | 19.0 | 1.25 | 17.75 | 0 | 0 | |
| 30 | 19.5 | 1.0 | 18.5 | -1.0 | -.4 | |
| 20 | 19.5 | 1.0 | 18.5 | -1.9 | -.8 | |
| 10 | 19.5 | 1.0 | 18.5 | -2.7 | -.9 | |
| 0 | 19.5 | 1.0 | 18.5 | -1.9 | -.8 | |

Test 28 30 PSI

| | | | | | |
|---|---|---|---|---|---|
| 90 | 13 | 8.0 | 5.0 | -18.6 | -29.7 |
| 80 | 13 | 9.0 | 4.0 | -9.3 | -18.6 |
| 70 | 15 | 7.0 | 8.0 | 7.2 | 7.2 |
| 60 | 24 | 3.5 | 20.5 | 5.2 | 2.0 |
| 50 | 27 | 3.0 | 24.0 | 2.7 | .9 |
| 40 | 28 | 1.5 | 26.5 | -4.1 | -1.2 |
| 30 | 28 | 1.5 | 26.5 | -4.1 | -1.2 |
| 20 | 28 | 1.0 | 27.0 | -4.1 | -1.2 |
| 10 | 28 | .5 | 27.5 | -6.2 | -1.8 |
| 0 | 28 | .5 | 27.5 | -2.3 | -.7 |

CUSTOMER: Air Flow Tests NASA/Langley Research Center
DATE: Nov. & Dec. 1979
SHEET 5 OF 7

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model
PRELIM. FINAL

DRAWING NUMBER
LITHO IN U.S.A.
CALCULATED BY BHG.

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 28

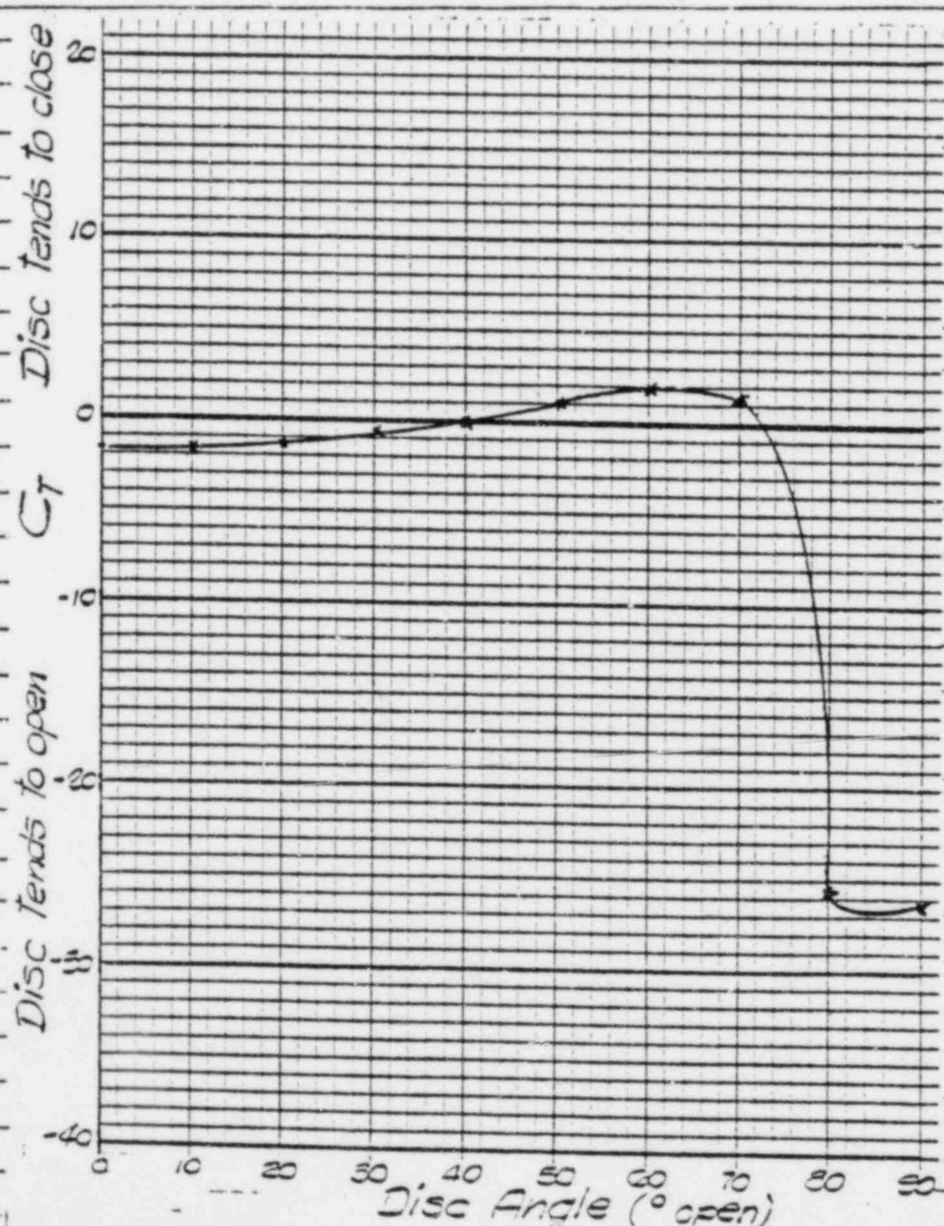
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 40 PSIG   Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | SHEET 6 OF 7 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. | FINAL

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LITHO IN U.S.A.

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY BHH

Test No. 28

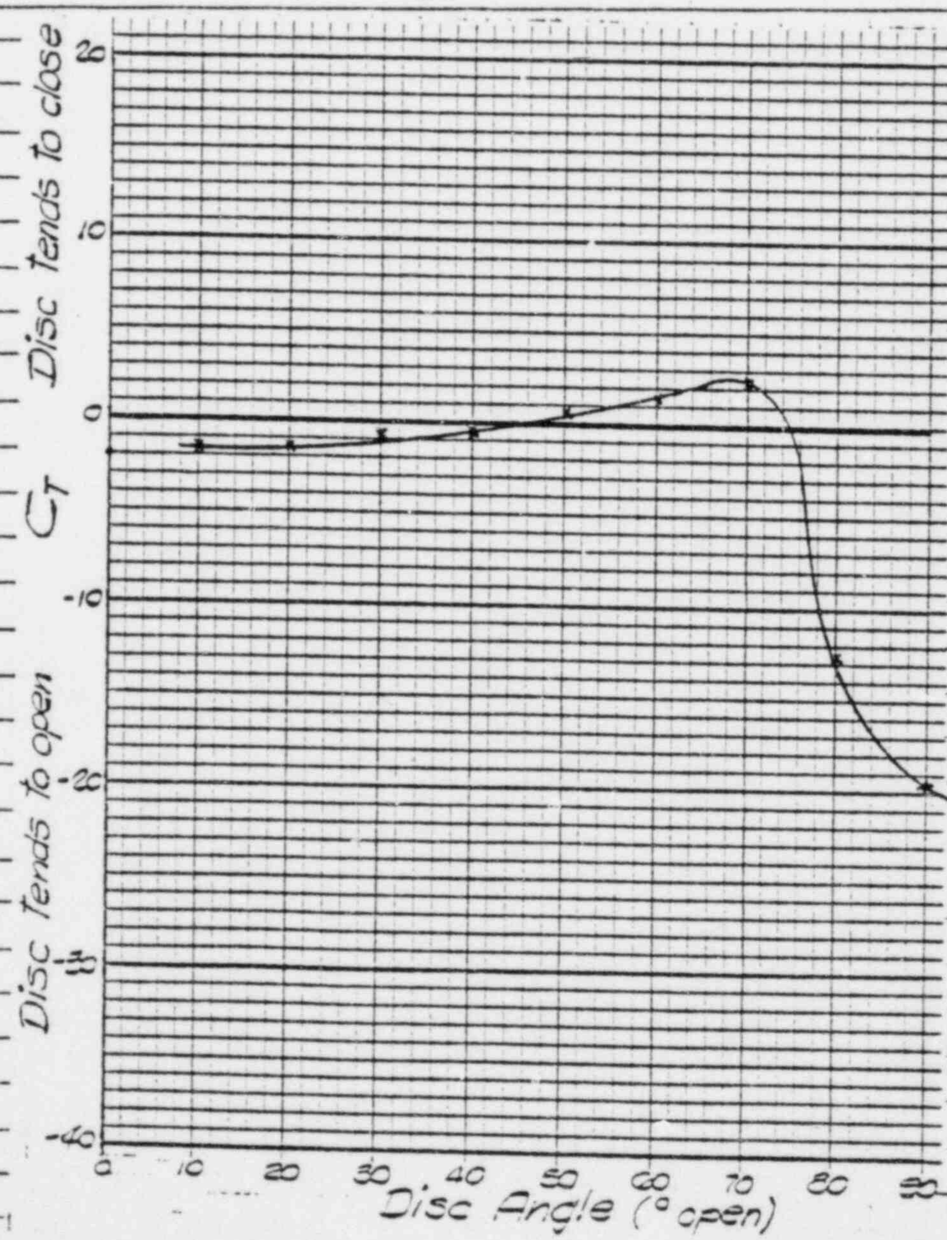
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 50 PSIG Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 28 40 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 18.0 | 11.0 | 7.0 | -23.1 | -26.4 | not recorded |
| 80 | 17.5 | 13.0 | 4.5 | -14.4 | -25.7 | |
| 70 | 20.0 | 10.0 | 10.0 | 1.7 | 1.3 | |
| 60 | 34.0 | 7.0 | 27.0 | 6.2 | 1.8 | |
| 50 | 35.5 | 4.0 | 31.5 | 4.1 | 1.0 | |
| 40 | 37.5 | 2.5 | 35.0 | 0 | 0 | |
| 30 | 38.0 | 1.0 | 37.0 | -2.5 | -0.5 | |
| 20 | 39.0 | 0 | 39.0 | -6.4 | -1.3 | |
| 10 | 39.0 | 0 | 39.0 | -8.3 | -1.7 | |
| 0 | 39.0 | 0 | 39.0 | -8.3 | -1.7 | |

Test 28 50 PSI

| | | | | | |
|---|---|---|---|---|---|
| 90 | 26 | 15 | 11 | -26.8 | -19.5 |
| 80 | 24 | 17.5 | 6.5 | -10.3 | -12.7 |
| 70 | 40 | 12.5 | 27.5 | 8.3 | 2.4 |
| 60 | 42 | 8 | 34 | 6.2 | 1.5 |
| 50 | 45 | 5 | 40 | 2.8 | .6 |
| 40 | 46.5 | 2.5 | 44 | -1.6 | -.3 |
| 30 | 47.5 | 1.5 | 46.0 | -4.1 | -.7 |
| 20 | 47.5 | 1 | 46.5 | -8.3 | -1.4 |
| 10 | 47 | 1 | 46 | -8.9 | -1.5 |
| 0 | 47 | 1 | 46 | -11.3 | -2.0 |

| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | | CALCULATED BY |
|---|---|---|
| | LITHO IN U.S.A.—A-C **ENGINEERING CALCULATION SHEET** ALLIS-CHALMERS FORM 6715-1 | BHG |

Test No. 28

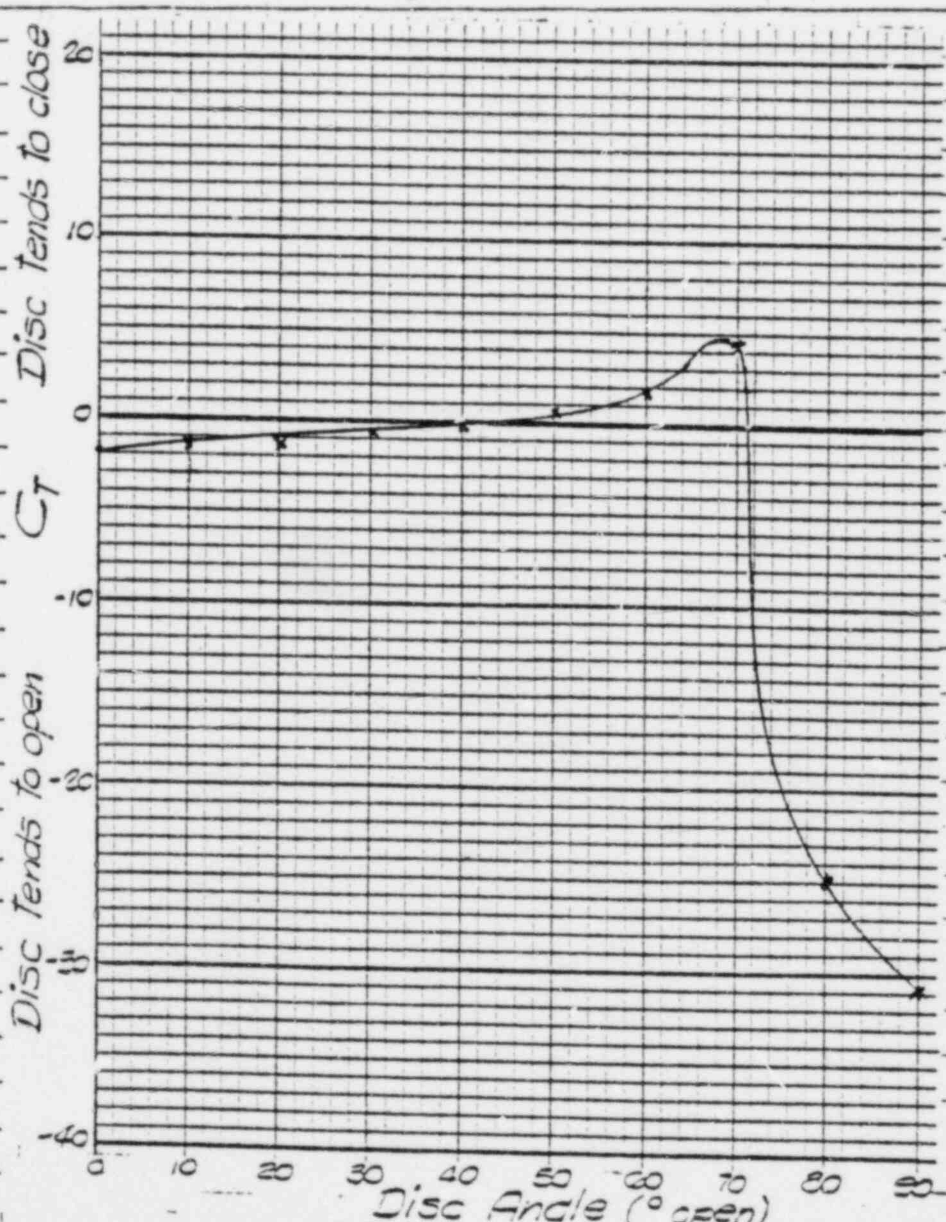
Valve disc thickness to diameter ratio: .12

Initial upstream pressure: 60 PSIG    Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 28 60 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25.0 | 17.5 | 7.5 | -28.0 | -30.8 | not recorded |
| 80 | 25.0 | 20.0 | 5.0 | -15.5 | -24.8 | |
| 70 | 35.0 | 15.0 | 20.0 | 11.3 | 4.5 | |
| 60 | 46.0 | 11.0 | 35.0 | 7.2 | 1.7 | |
| 50 | 50.0 | 6.0 | 44.0 | 3.7 | 0.7 | |
| 40 | 51.0 | 2.5 | 48.5 | -0.6 | -0.1 | |
| 30 | 52.0 | 1.0 | 51.0 | -4.5 | -0.7 | |
| 20 | 52.0 | 0 | 52.0 | -9.1 | -1.4 | |
| 10 | 52.0 | 0 | 52.0 | -9.3 | -1.4 | |
| 0 | 52.0 | 0 | 52.0 | -12.4 | -1.9 | |

CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 1 OF 6

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY [illegible]

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1 | Test No. 29

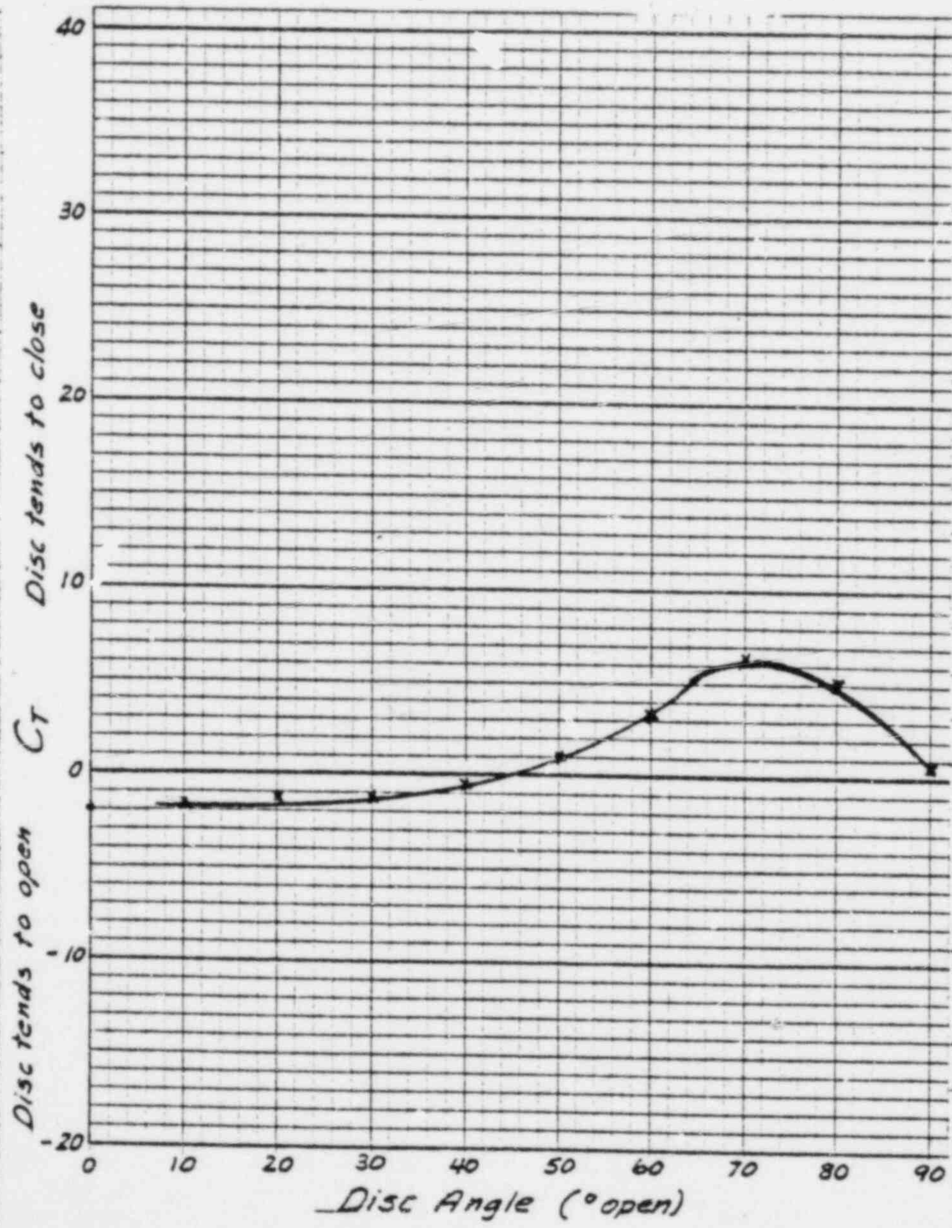
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 15PSIG   Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| | | |
|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 2 OF 6 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET | CALCULATED BY DHG |
| | | Test No. 29 |

LITHO IN U.S.A.—A-C · ALLIS-CHALMERS · FORM 6715-1

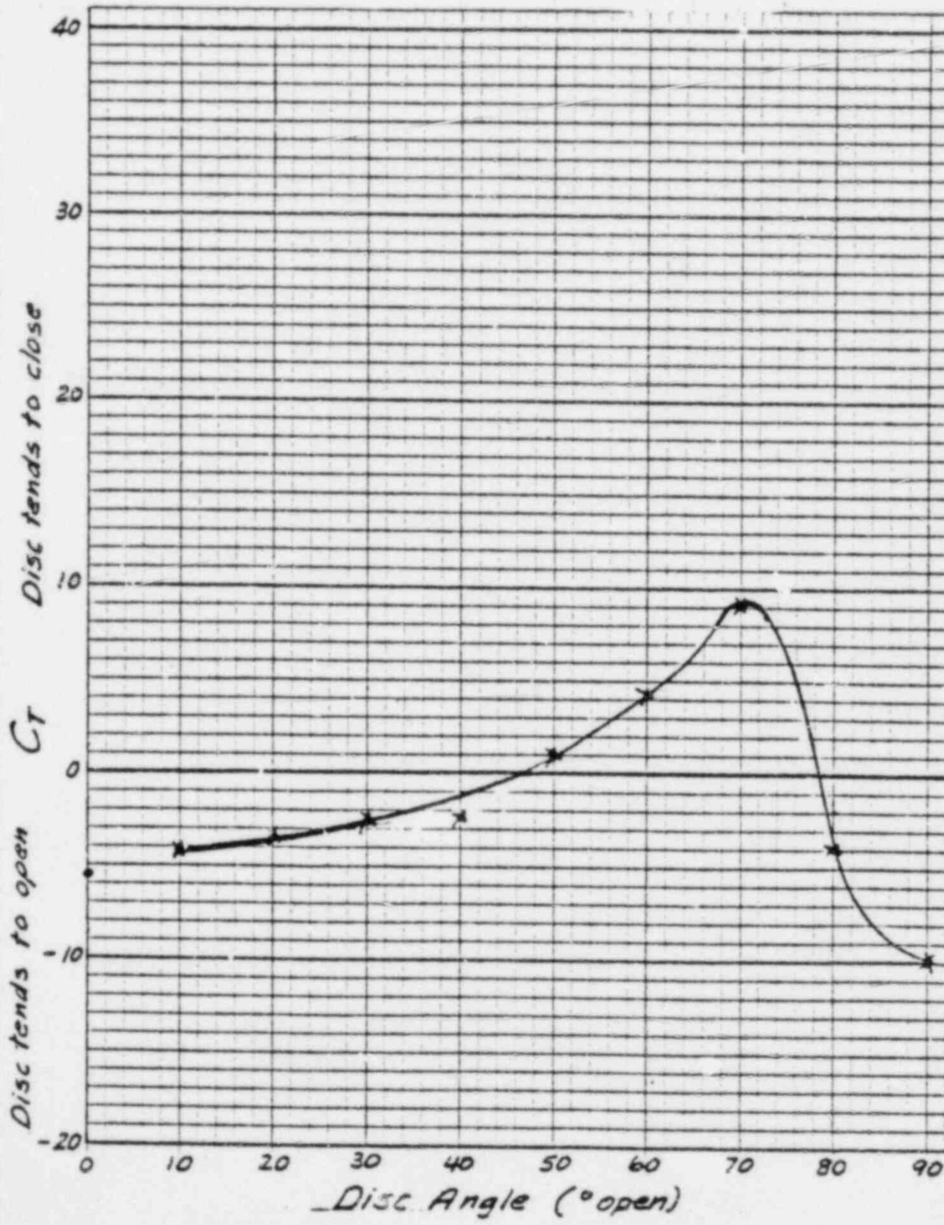
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 20 PSIG  Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 29 $P_T$ = 15 PSI

| °Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 5.0 | 2.5 | 2.5 | 0.2 | 0.6 | 6.4 |
| 80 | 5.0 | 2.5 | 2.5 | 1.6 | 5.1 | 6.4 |
| 70 | 7.0 | 2.0 | 5.0 | 3.9 | 6.2 | 7.8 |
| 60 | 9.0 | 1.5 | 7.5 | 3.1 | 3.3 | 9.8 |
| 50 | 10.5 | 1.0 | 9.5 | 1.2 | 1.0 | 11.8 |
| 40 | 12.0 | 0.5 | 11.5 | -0.8 | -0.6 | 11.8 |
| 30 | 12.0 | 0 | 12.0 | -1.6 | -1.1 | 12.5 |
| 20 | 12.0 | 0 | 12.0 | -2.0 | -1.3 | 13.2 |
| 10 | 12.5 | 0 | 12.5 | -2.8 | -1.8 | 13.8 |
| 0 | 12.5 | 0 | 12.5 | -3.1 | -2.0 | 13.8 |

Test 29 20 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 7 | 3.0 | 4.0 | -5.0 | -10.0 | 2.4 |
| 80 | 9 | 3.0 | 6.0 | -3.0 | -4.0 | 3.7 |
| 70 | 10 | 3.0 | 7.0 | 8.0 | 9.2 | 5.1 |
| 60 | 14 | 2.5 | 11.5 | 6.0 | 4.2 | 8.4 |
| 50 | 17 | 2.0 | 15.0 | 2.0 | 1.1 | 11.1 |
| 40 | 18 | 1.0 | 17.0 | -5.0 | -2.4 | 11.8 |
| 30 | 18 | 0.5 | 17.5 | -6.0 | -2.7 | 13.2 |
| 20 | 19 | 0 | 19.0 | -8.0 | -3.4 | 13.8 |
| 10 | 19 | 0 | 19.0 | -10.0 | -4.2 | 15.2 |
| 0 | 19 | 0 | 19.0 | -13.0 | -5.5 | 15.2 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 3 of 6 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

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LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

PRELIM. FINAL

CALCULATED BY [illegible]

Test No. 29

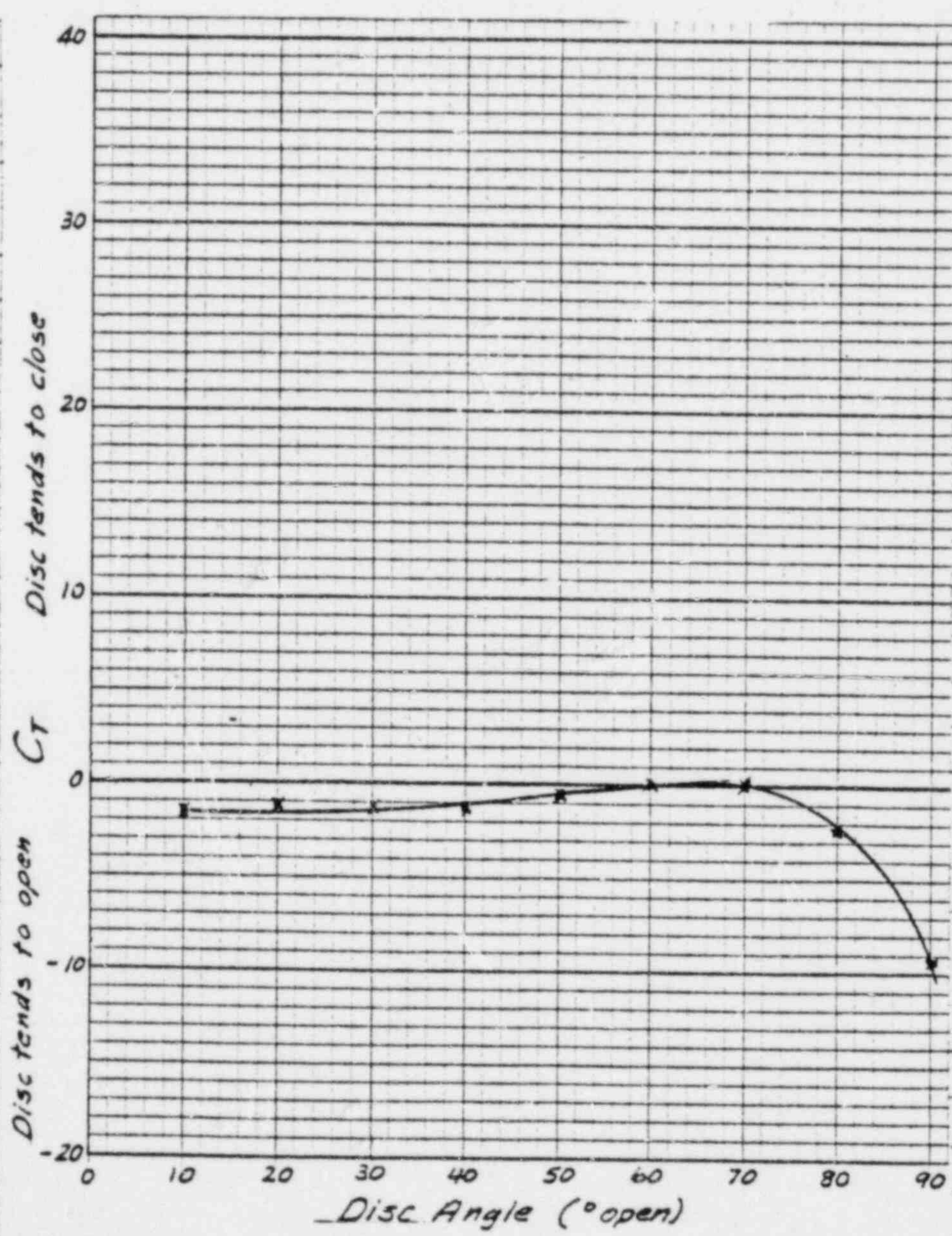
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 30 PSIG  Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A. - A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [signature]

Test No. 29

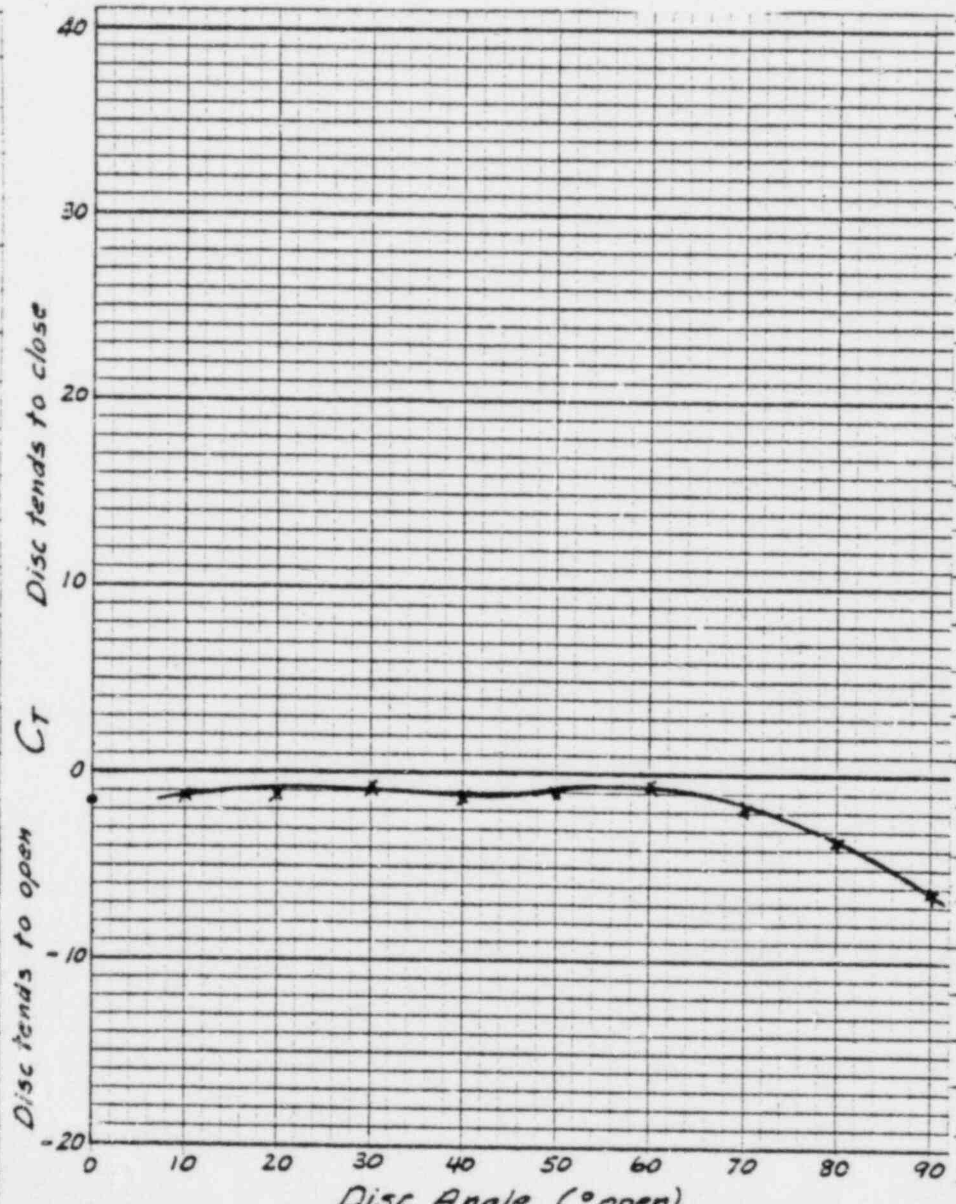
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 40 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 29 30 PSIG

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 12 | 7 | 5 | -5.9 | -9.44 | 3.7 |
| 80 | 18 | 7 | 11 | -3.15 | -2.3 | 5.1 |
| 70 | 20 | 7 | 13 | 0 | 0 | 7.8 |
| 60 | 22.5 | 5 | 17.5 | 0 | 0 | 9.1 |
| 50 | 25 | 2.5 | 22.5 | -1.57 | -.558 | 11.8 |
| 40 | 27.5 | 1.5 | 26 | -3.93 | -1.2 | 13.8 |
| 30 | 28 | 0 | 28 | -3.93 | -1.12 | 16.5 |
| 20 | 29 | 0 | 29 | -3.93 | -1.08 | 18.5 |
| 10 | 30 | 0 | 30 | -5.9 | -1.57 | 18.5 |
| 0 | 30 | 0 | 30 | -7.87 | -1.57 | 18.5 |

Test 29 40 PSIG

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 20 | 10 | 10 | -7.86 | -6.29 | 9.8 |
| 80 | 20 | 10 | 10 | -4.68 | -3.74 | 10.5 |
| 70 | 25 | 10 | 15 | -3.74 | -1.99 | 11.8 |
| 60 | 30 | 7.5 | 22.5 | -1.87 | -.66 | 17.2 |
| 50 | 35 | [illegible] | 30 | -3.92 | -1.05 | 20.6 |
| 40 | 37.5 | 2.5 | 35 | -5.97 | -1.36 | 22.6 |
| 30 | 38 | 0 | 38 | -4.68 | -.985 | 23.9 |
| 20 | 39 | 0 | 39 | -5.61 | -1.15 | 24.6 |
| 10 | 39.5 | 0 | 39.5 | -5.97 | -1.21 | 25.3 |
| 0 | 40 | 0 | 40 | -7.86 | -1.56 | 25.3 |

| CUSTOMER | DATE | SHEET |
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SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. FINAL

DRAWING NUMBER

LITHO IN U.S.A.-A-C

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY BHG.

Test No. 29

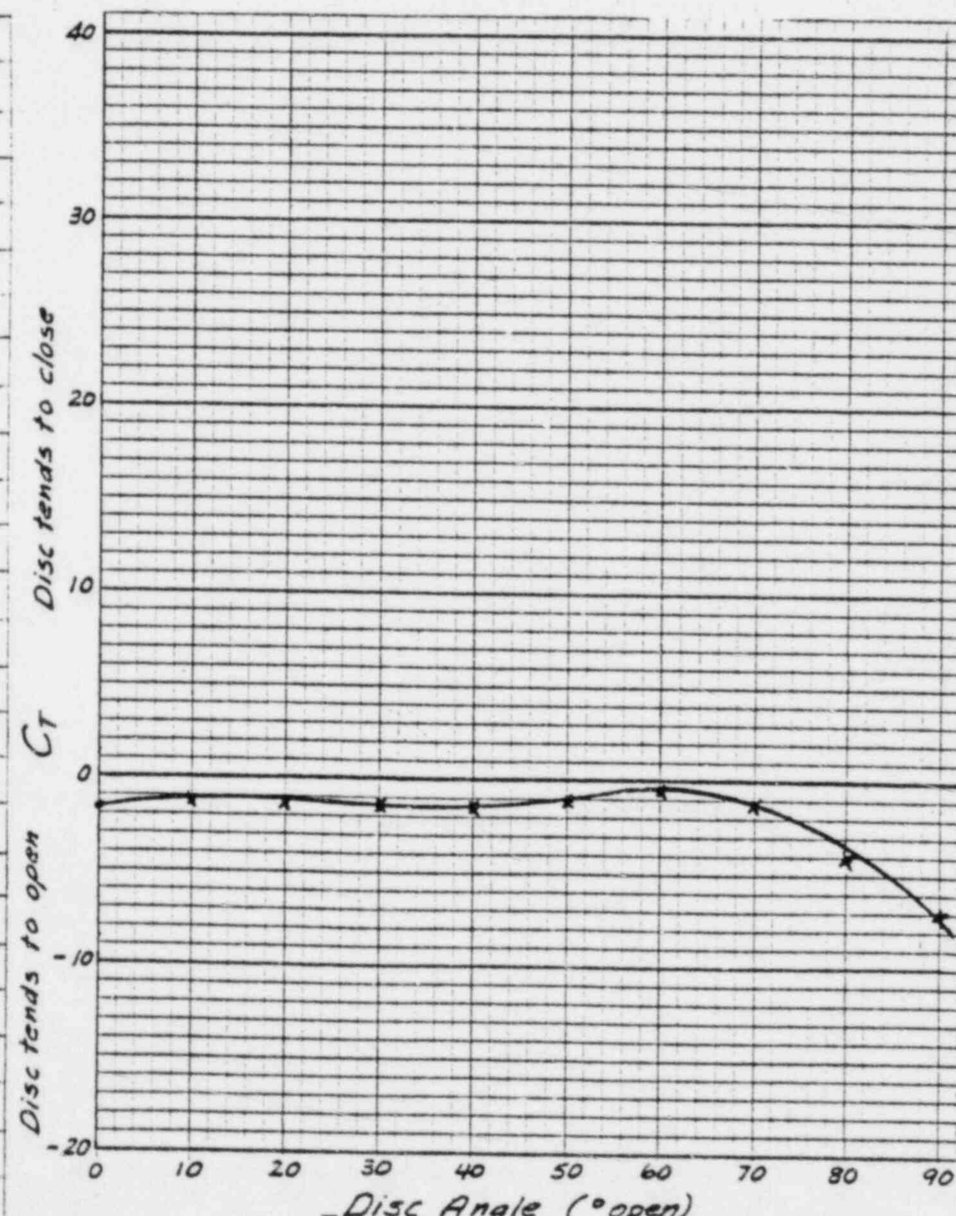
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 50 PSIG Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests _ NASA/Langley Research Center | Nov. & Dec. 1979 | 6 OF 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY BHG

Test No. 29

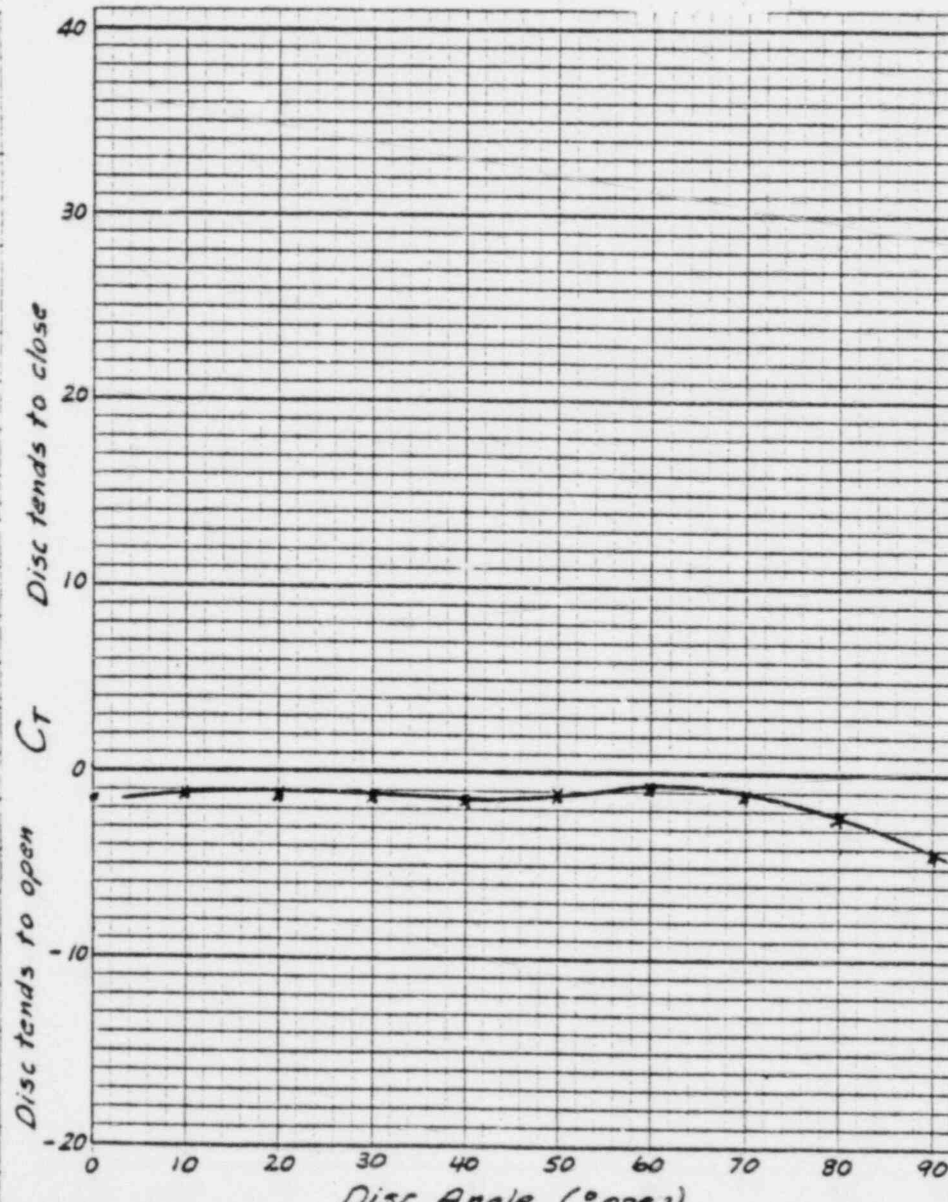
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 60 PSIG   Valve orientation ref. Figure 9

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 29 50 PSIG

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 25 | 15 | 10 | -8.88 | -7.10 | 15.8 |
| 80 | 25 | 15 | 10 | -5.14 | -4.11 | 17.2 |
| 70 | 32.5 | 15 | 17.5 | -2.81 | -1.23 | 20.6 |
| 60 | 37.5 | 10 | 27.5 | -2.25 | -.65 | 25.3 |
| 50 | 42.5 | 7.5 | 35 | -5.14 | -1.17 | 28.6 |
| 40 | 45 | 2.5 | 42.5 | -7.86 | -1.48 | 30.7 |
| 30 | 46 | 2 | 44 | -7.48 | -1.36 | 32.8 |
| 20 | 47.5 | 1 | 46.5 | -7.86 | -1.35 | 33.3 |
| 10 | 48 | 1 | 47 | -7.48 | -1.27 | 34.0 |
| 0 | 49 | 0 | 49 | -10.61 | -1.73 | 34.7 |

Test 29 60 PSIG

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 30 | 15.5 | 14.5 | 7.87 | -4.34 | 28.0 |
| 80 | 32.5 | 15.5 | 17 | 5.15 | -2.42 | 28.6 |
| 70 | 40 | 15.5 | 24.5 | 3.93 | -1.28 | 32.0 |
| 60 | 47.5 | 13.5 | 34 | 3.93 | -.93 | 34.7 |
| 50 | 52 | 10 | 42 | 6.56 | -1.25 | 40.1 |
| 40 | 55 | 5 | 50 | 9.82 | -1.57 | 42.8 |
| 30 | 57 | 2.5 | 54.5 | 9.82 | -1.44 | 44.1 |
| 20 | 58 | 2.5 | 55.5 | 9.82 | -1.42 | 44.8 |
| 10 | 59 | 2 | 57 | 8.42 | -1.18 | 45.5 |
| 0 | 60 | 0 | 60 | 11.79 | -1.57 | 45.5 |

CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 1 OF 6

SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.–A-C | CALCULATED BY BHH

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 30

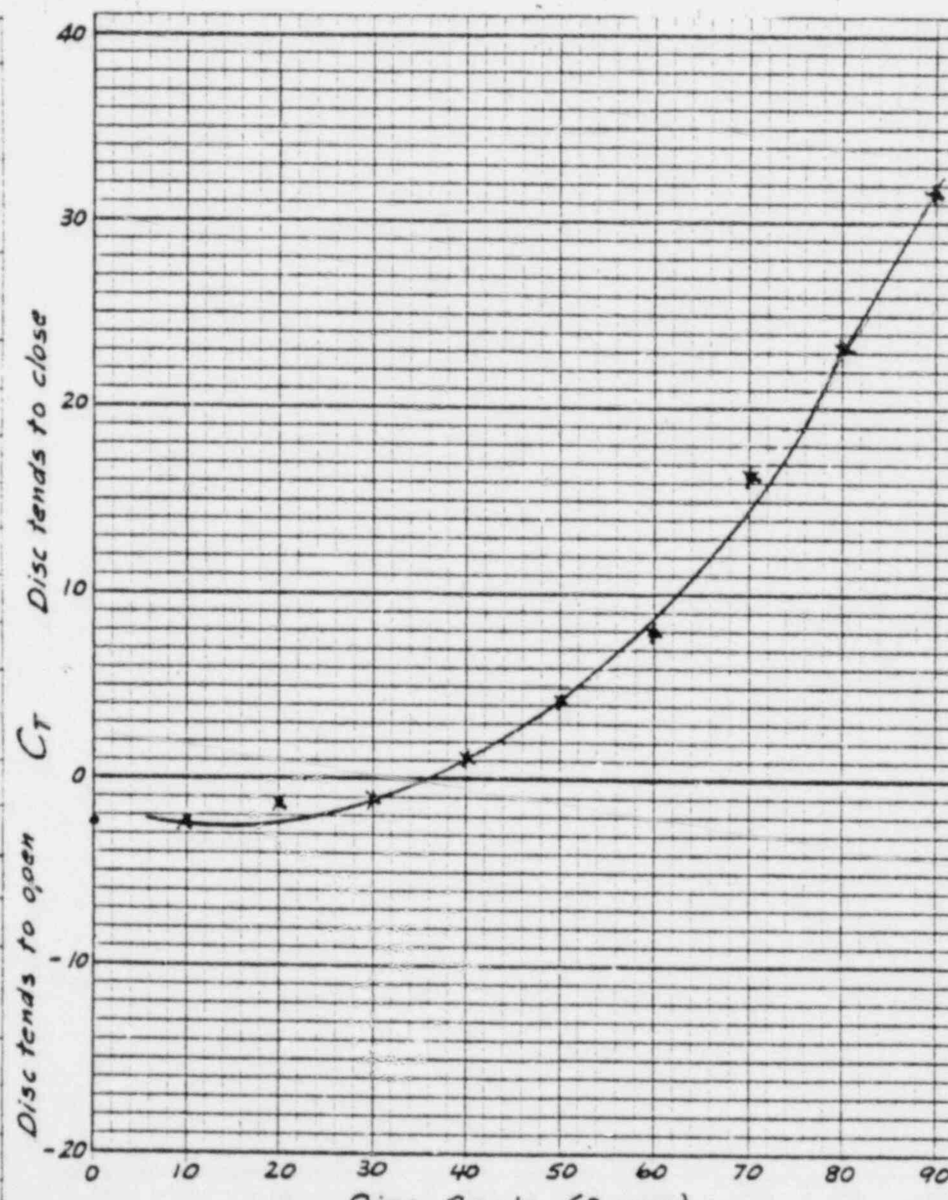
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 15 PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 30

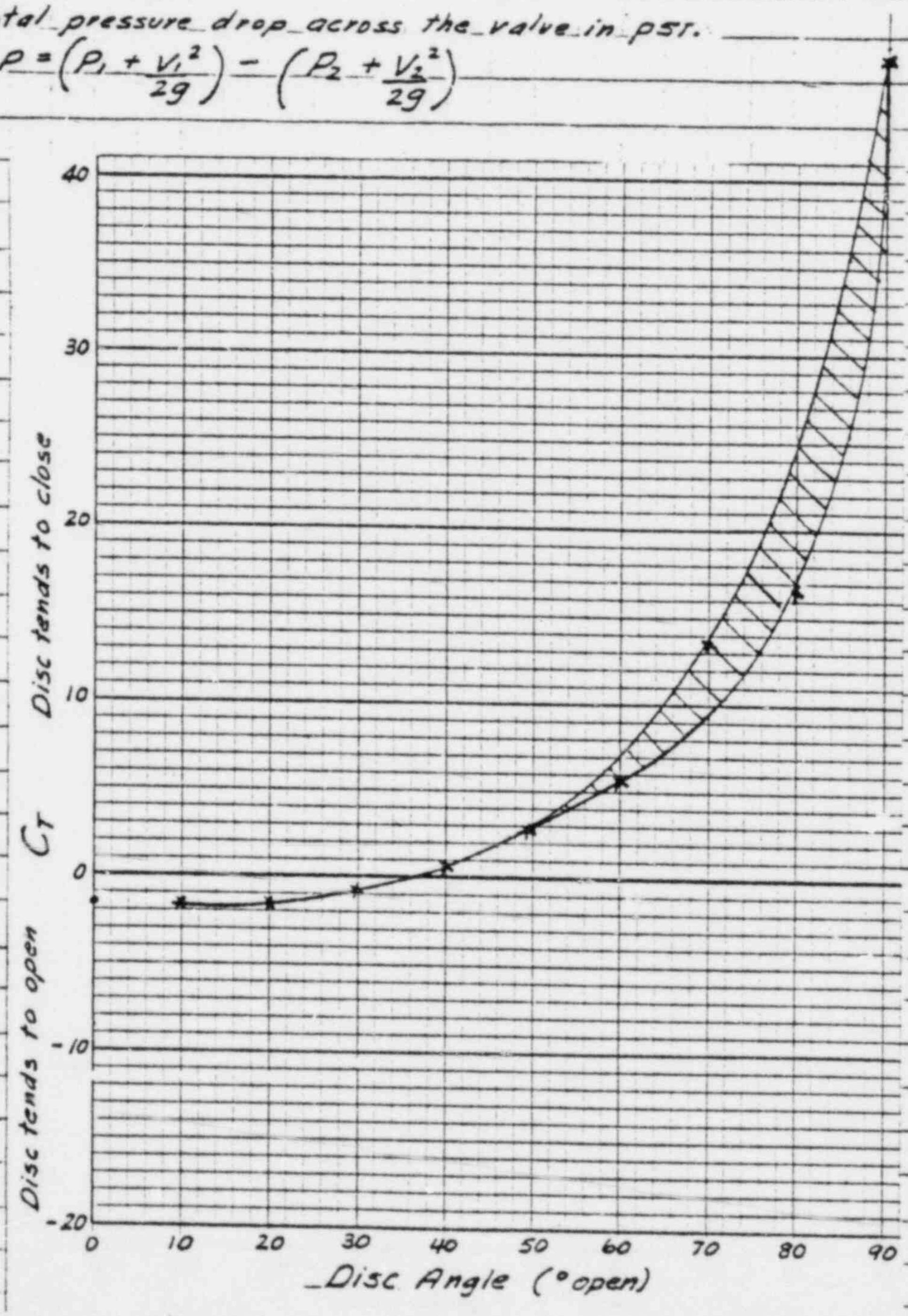
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 20PSIG Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 30 $\Delta P_{T_1}$ = 15 PSI

| °Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 4 | 2 | 2 | 7.9 | 31.6 | 5.1 |
| 80 | 5 | 2 | 3 | 8.7 | 23.2 | 5.1 |
| 70 | 6 | 1 | 5 | 10.2 | 16.3 | 6.4 |
| 60 | 9 | 1 | 8 | 7.9 | 7.9 | 8.4 |
| 50 | 10 | 1 | 9 | 4.7 | 4.2 | 10.5 |
| 40 | 11 | 0 | 11 | 1.6 | 1.2 | 11.8 |
| 30 | 12 | 0 | 12 | -1.6 | -1.1 | 12.5 |
| 20 | 12 | 0 | 12 | -2.0 | -1.3 | 13.2 |
| 10 | 12 | 0 | 12 | -3.5 | -2.3 | 13.8 |
| 0 | 12 | 0 | 12 | -3.5 | -2.3 | 13.8 |

Test 30 20 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 7 | 5 | 2 | 11.8 | 47.2 | 3.7 |
| 80 | 11 | 3 | 8 | 16.5 | 16.5 | 3.7 |
| 70 | 12 | 3 | 9 | 15.3 | 13.6 | 5.1 |
| 60 | 15 | 2 | 13 | 9.4 | 5.8 | 8.4 |
| 50 | 17 | 1 | 16 | 5.5 | 2.8 | 11.8 |
| 40 | 18 | 0 | 18 | 1.6 | 0.7 | 12.5 |
| 30 | 19 | 0 | 19 | -2.0 | -0.8 | 13.2 |
| 20 | 19 | 0 | 19 | -3.5 | -1.5 | 13.8 |
| 10 | 19 | 0 | 19 | -3.9 | -1.6 | 13.8 |
| 0 | 19 | 0 | 19 | -3.9 | -1.6 | 13.8 |

| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 3 OF 6 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL | |
| DRAWING NUMBER | LITHO IN U.S.A.—A-C ENGINEERING CALCULATION SHEET ALLIS-CHALMERS FORM 6715-1 | CALCULATED BY [illegible] | Test No. 30 |

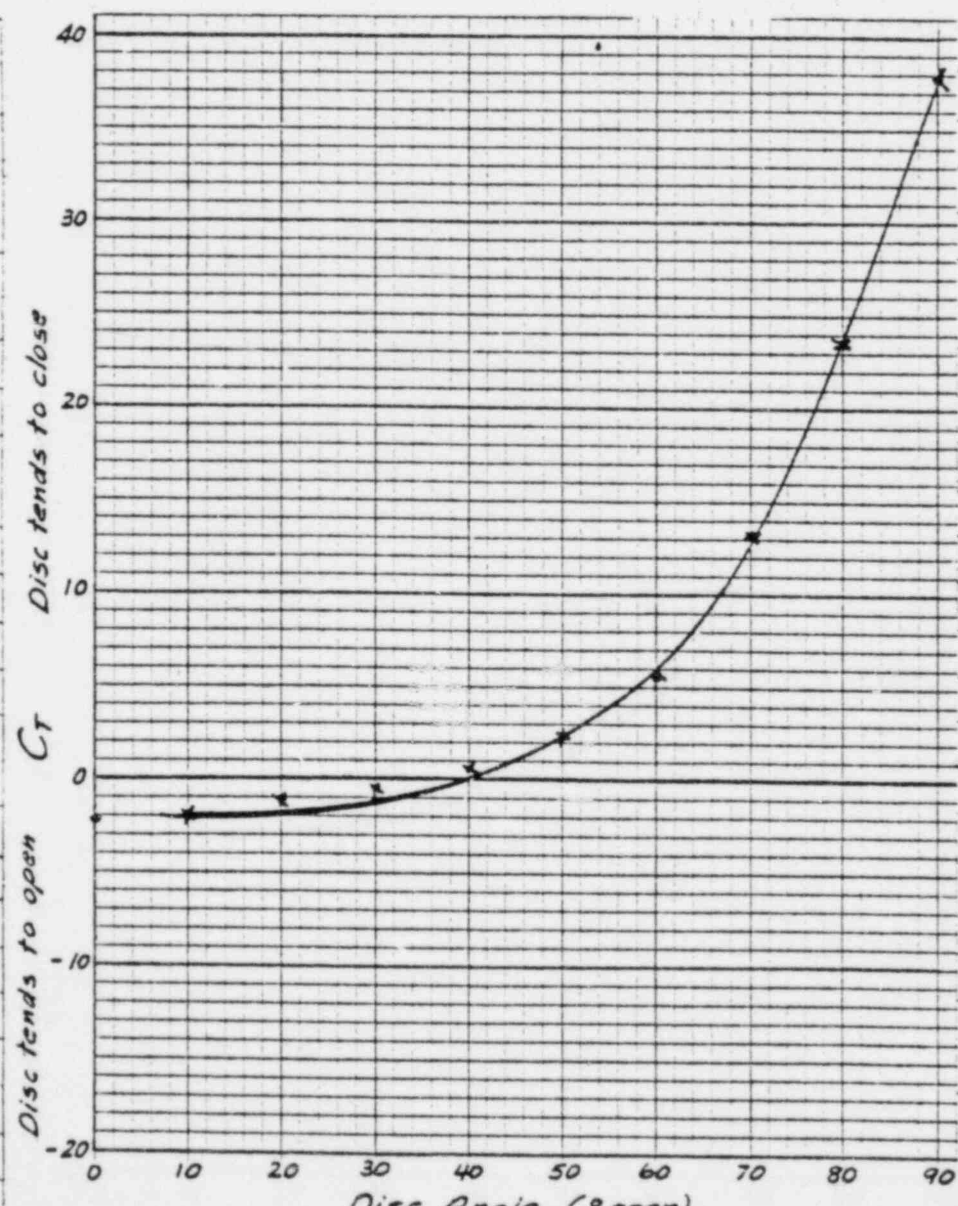
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 30 PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.-A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 30

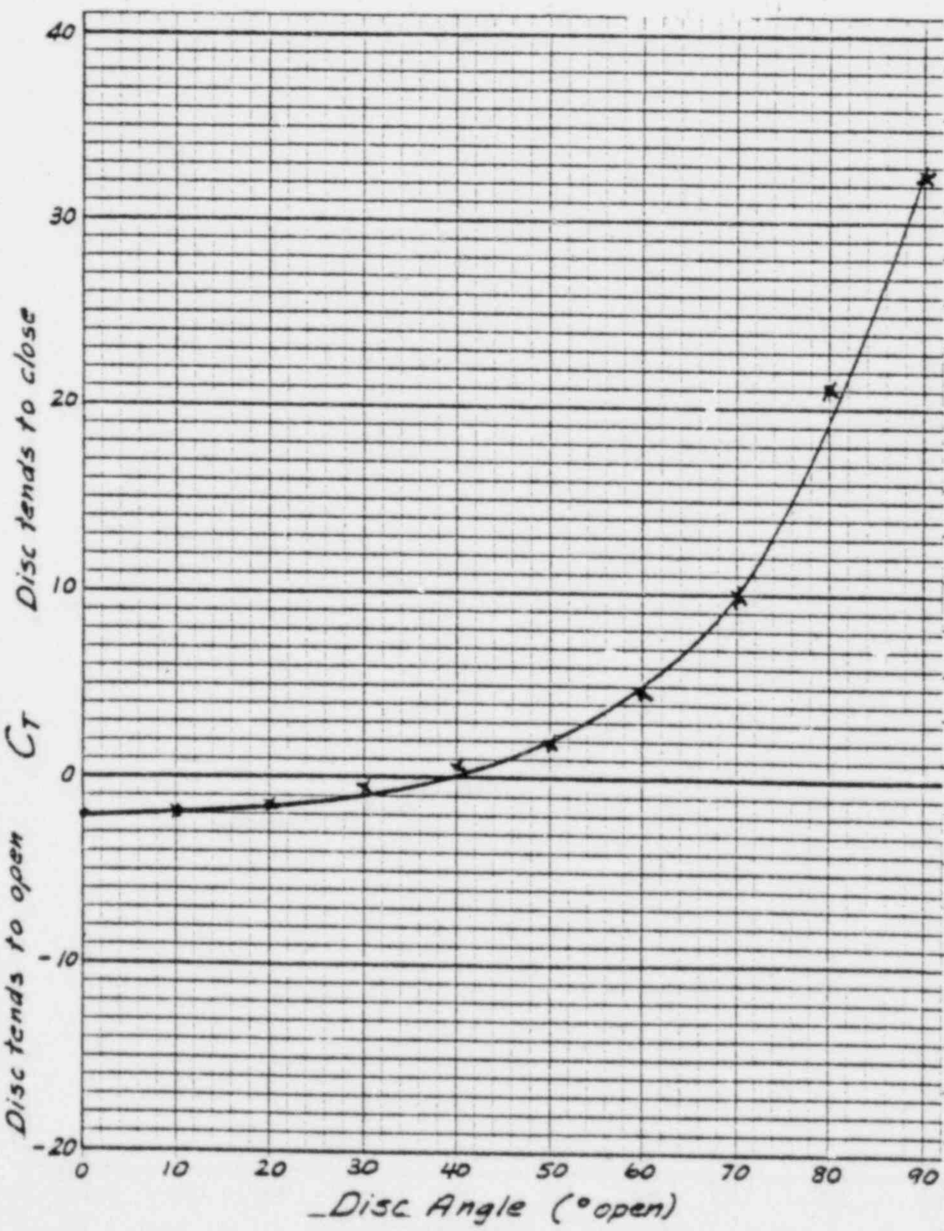
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 40 PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 30 30 PSI

| ° Open | $P_1$ | $P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 12 | 8 | 4 | 18.9 | 37.8 | 5.1 |
| 80 | 14 | 6 | 8 | 23.6 | 23.6 | 7.1 |
| 70 | 18 | 6 | 12 | 19.7 | 13.1 | 9.8 |
| 60 | 22 | 5 | 17 | 11.8 | 5.6 | 13.2 |
| 50 | 25 | 3 | 22 | 6.3 | 2.3 | 16.5 |
| 40 | 27 | 2 | 25 | 1.6 | 0.5 | 18.4 |
| 30 | 28 | 0 | 28 | -1.6 | -0.5 | 19.2 |
| 20 | 29 | 0 | 29 | -4.7 | -1.3 | 19.9 |
| 10 | 29 | 0 | 29 | -7.1 | -2.0 | 20.6 |
| 0 | 29 | 0 | 29 | -7.9 | -2.2 | 20.6 |

Test 30 40 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 18 | 12 | 6 | 24.4 | 32.5 | 15.8 |
| 80 | 21 | 10 | 11 | 29.1 | 21.2 | 17.2 |
| 70 | 26 | 8 | 18 | 22.0 | 9.8 | 19.9 |
| 60 | 30 | 7 | 23 | 13.4 | 4.7 | 23.9 |
| 50 | 35 | 4 | 31 | 7.1 | 1.8 | 26.6 |
| 40 | 36 | 2 | 34 | 2.0 | 0.5 | 28.6 |
| 30 | 38 | 0 | 38 | -2.4 | -0.5 | 30.0 |
| 20 | 39 | 0 | 39 | -7.1 | -1.5 | 30.7 |
| 10 | 39 | 0 | 39 | -9.4 | -1.9 | 31.3 |
| 0 | 39 | 0 | 39 | -9.8 | -2.0 | 31.3 |

| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 5 OF 6 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | | PRELIM. | FINAL |
| DRAWING NUMBER | LITHO IN U.S.A.–A-C | CALCULATED BY: BHH | |
| | ENGINEERING CALCULATION SHEET | Test No. 30 | |
| | ALLIS-CHALMERS FORM 6715-1 | | |

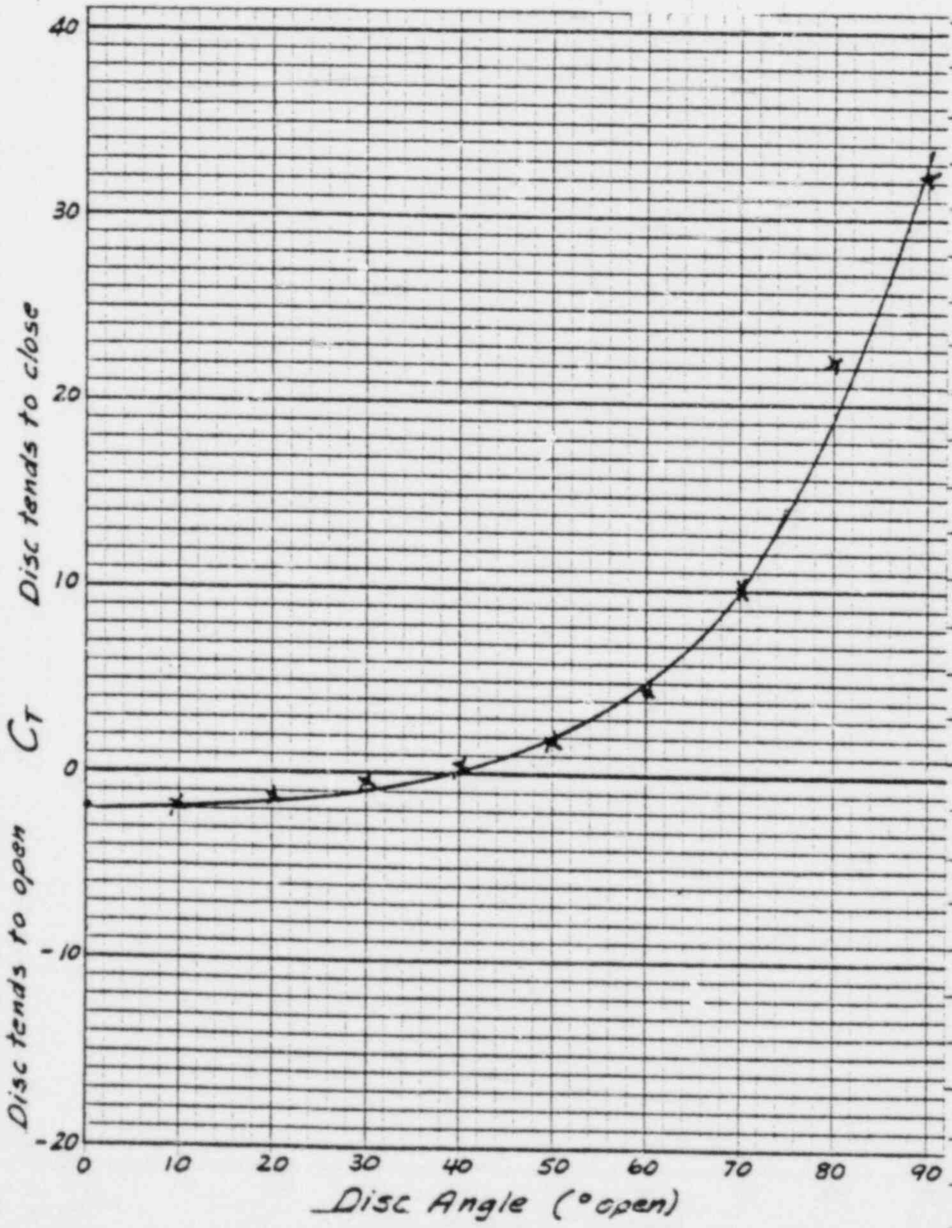
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 50 PSIG  Valve orientation ref. Figure 11

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER Air Flow Tests NASA/Langley Research Center | DATE Nov. & Dec. 1979 | SHEET 6 OF 6

SUBJECT Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY BHG

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 30

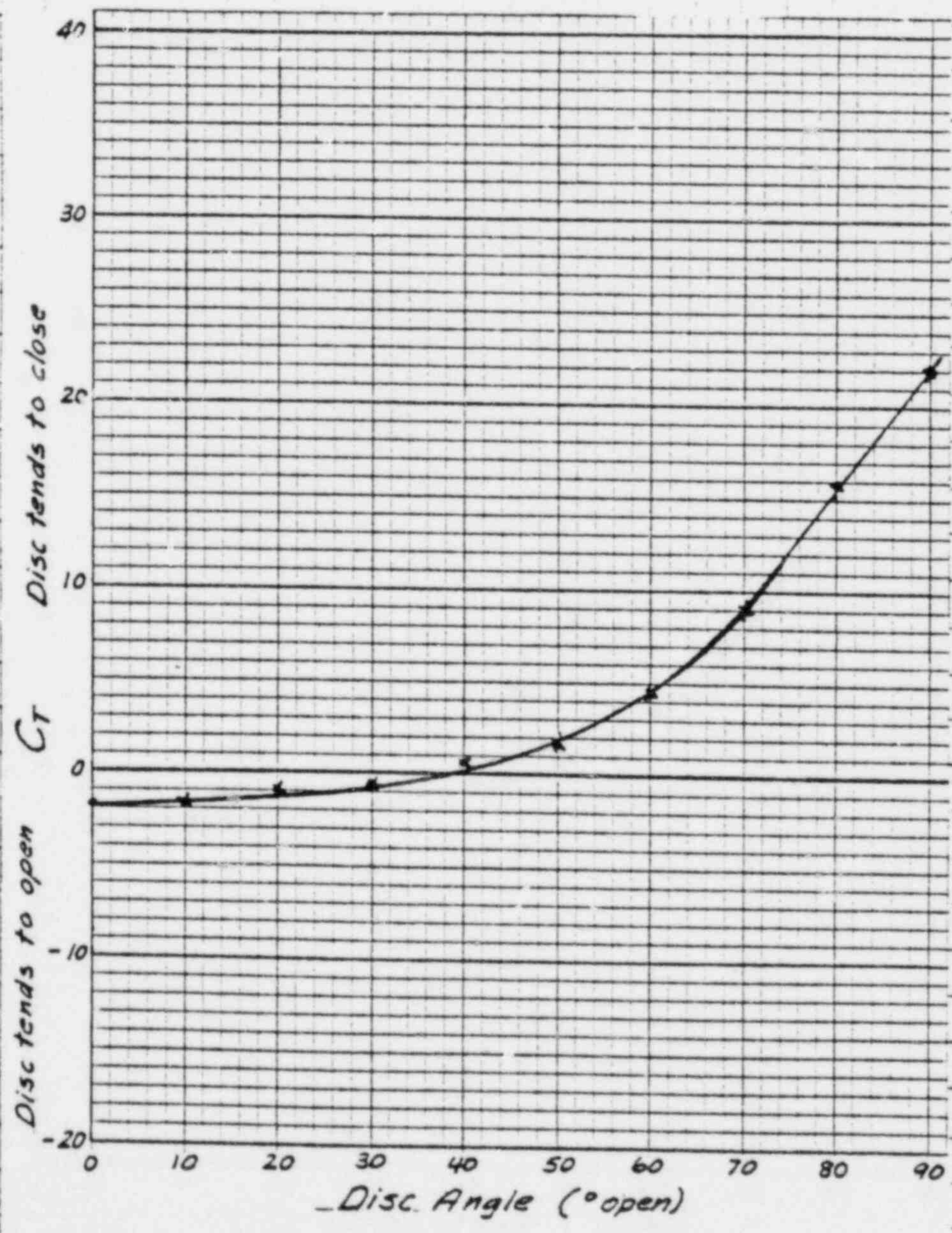
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 60PSIG Valve orientation ref. Figure 11

Torque equation and coefficient: $Td = C_T \times D^3 \times \Delta P$

where Td is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 30 50 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 24 | 17 | 7 | 28.3 | 32.3 | 25.3 |
| 80 | 26 | 14 | 12 | 33.4 | 22.3 | 25.3 |
| 70 | 34 | 13 | 21 | 26.8 | 10.2 | 31.3 |
| 60 | 39 | 11 | 28 | 15.7 | 4.5 | 35.4 |
| 50 | 43 | 7 | 36 | 7.9 | 1.8 | 38.7 |
| 40 | 45 | 3 | 42 | 2.4 | 0.5 | 40.1 |
| 30 | 46 | 1 | 45 | -2.4 | -0.4 | 41.4 |
| 20 | 47 | 0 | 47 | -7.9 | -1.3 | 42.1 |
| 10 | 47 | 0 | 47 | -11.4 | -1.9 | 42.1 |
| 0 | 47 | 0 | 47 | -11.4 | -1.9 | 42.8 |

Test 30 60 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 28 | 18 | 10 | 27.5 | 22.0 | 34.7 |
| 80 | 32 | 15 | 17 | 33.8 | 15.9 | 36.0 |
| 70 | 40 | 14 | 26 | 29.5 | 9.1 | 38.7 |
| 60 | 46 | 13 | 33 | 18.1 | 4.4 | 42.8 |
| 50 | 51 | 8 | 43 | 9.8 | 1.8 | 45.5 |
| 40 | 54 | 4 | 50 | 3.1 | 0.5 | 47.5 |
| 30 | 55 | 2 | 53 | -3.1 | -0.5 | 48.8 |
| 20 | 56 | 0 | 56 | -7.9 | -1.1 | 50.2 |
| 10 | 56 | 0 | 56 | -11.8 | -1.7 | 50.8 |
| 0 | 55 | 0 | 55 | -11.8 | -1.7 | 50.8 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
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SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

DRAWING NUMBER | PRELIM. | FINAL

CALCULATED BY [illegible]

LITHO IN U.S.A.-A-C

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 31

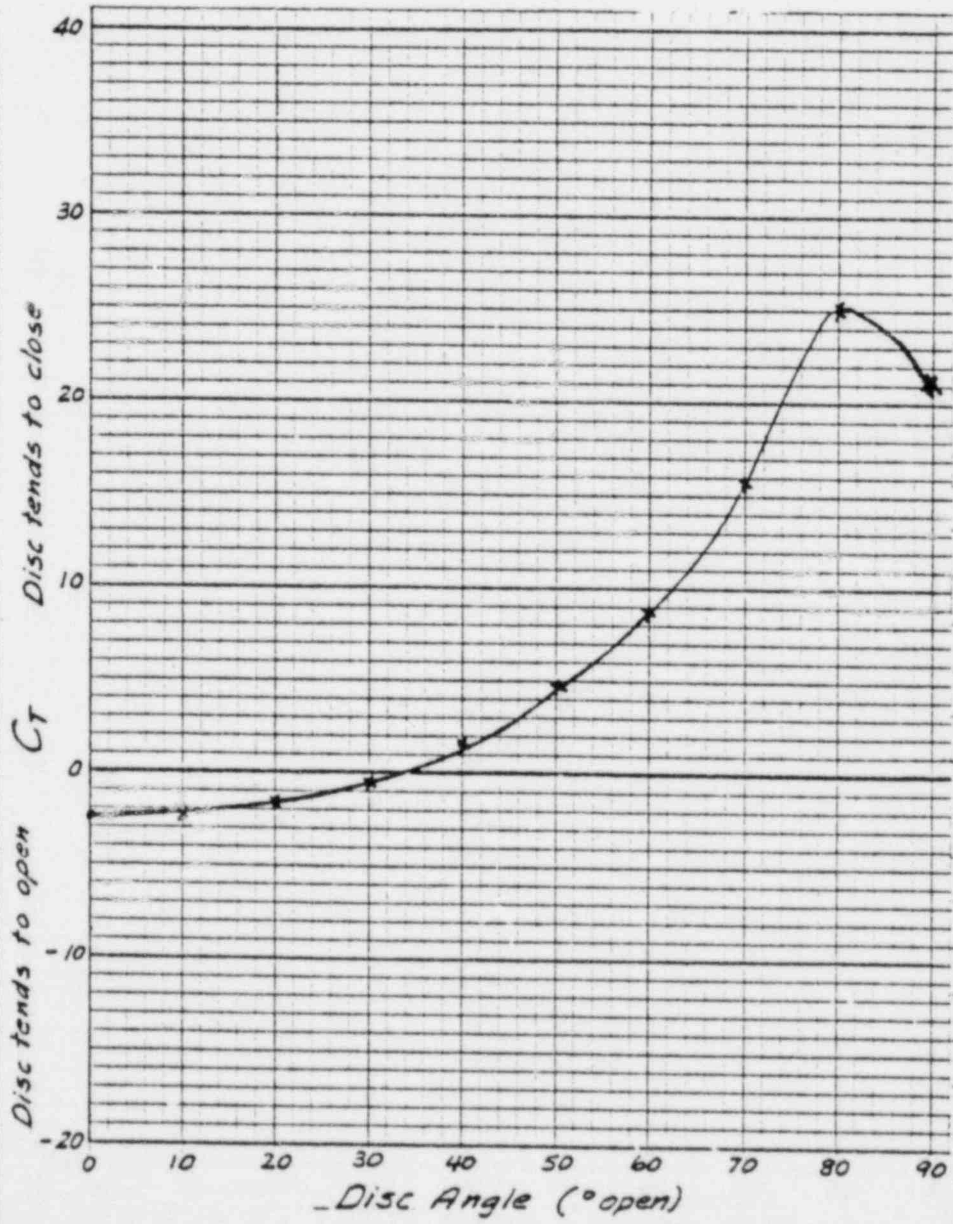
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 15 PSIG   Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



CUSTOMER: Air Flow Tests - NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 2 OF 6

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A. - A-C | CALCULATED BY [illegible]

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS | FORM 6715-1 | Test No. 31

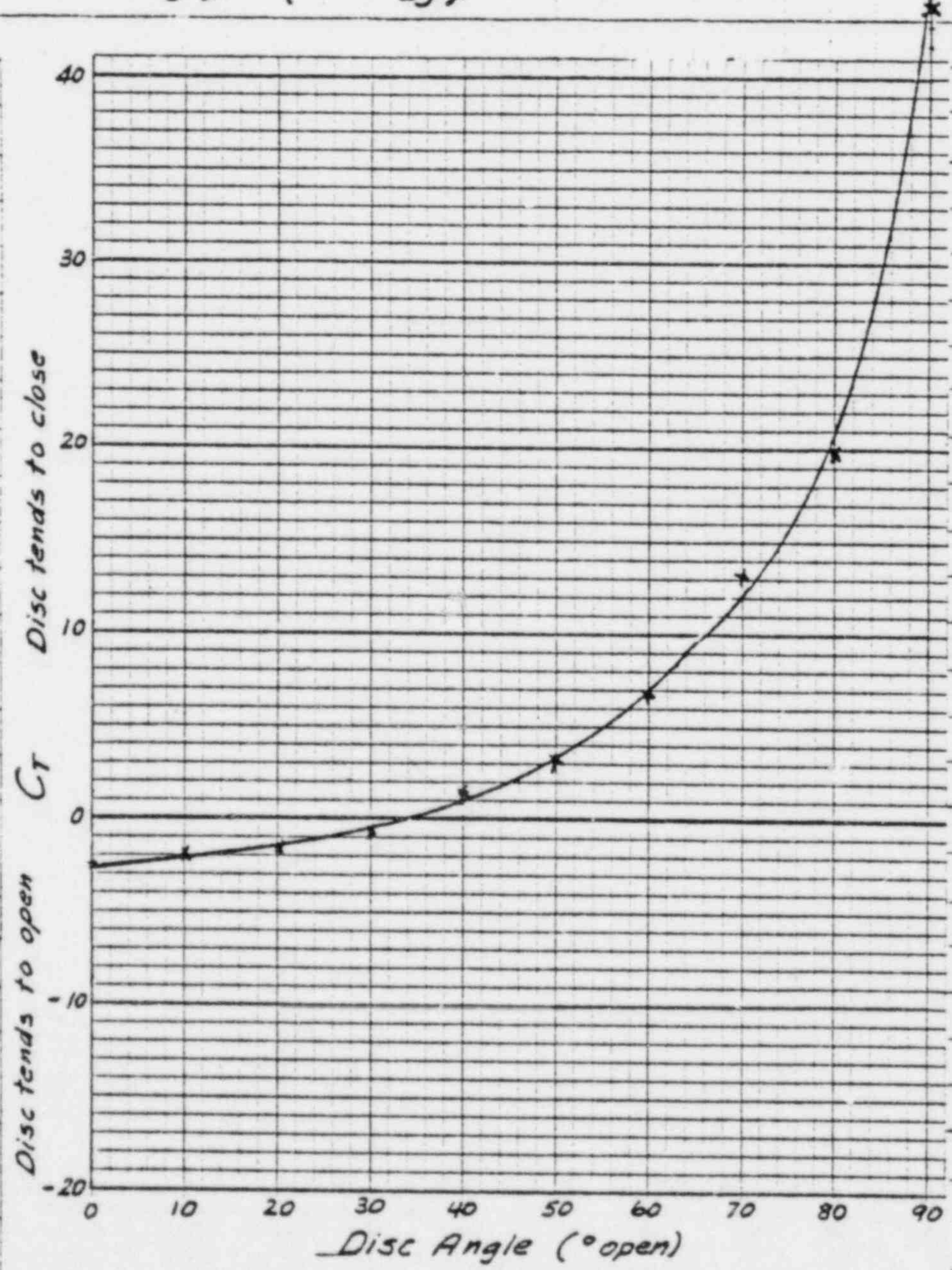
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 20 PSIG  Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 31 $P_{T_1}$ = 20 PSI

| ° Open | $P_1$ | *$P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 7 | 5 | 2 | 11.0 | 44.0 | 5.8 |
| 80 | 10 | 3 | 7 | 17.3 | 19.8 | 7.1 |
| 70 | 13 | 3 | 10 | 16.5 | 13.2 | 8.4 |
| 60 | 15 | 2 | 13 | 11.0 | 6.8 | 11.8 |
| 50 | 17 | 1 | 16 | 6.3 | 3.2 | 13.8 |
| 40 | 18 | 0 | 18 | 3.1 | 1.4 | 15.2 |
| 30 | 19 | 0 | 19 | -1.6 | -0.7 | 17.2 |
| 20 | 19 | 0 | 19 | -3.9 | -1.6 | 18.5 |
| 10 | 19 | 0 | 19 | -4.7 | -2.[illegible] | 18.5 |
| 0 | 19 | 0 | 19 | -5.9 | -2.5 | 18.5 |

Test 31 $\Delta P_{T_1}$ = 15 PSI

| ° Open | $P_1$ | *$P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 5 | 2 | 3 | 7.9 | 21.1 | 9.1 |
| 80 | 5 | 2 | 3 | 9.4 | 25.1 | 8.4 |
| 70 | 7 | 1 | 6 | 11.8 | 15.7 | 9.8 |
| 60 | 9 | 1 | 8 | 8.7 | 8.7 | 11.1 |
| 50 | 10 | 1 | 9 | 5.5 | 4.9 | 11.8 |
| 40 | 11 | 0 | 11 | 2.4 | 1.7 | 13.2 |
| 30 | 12 | 0 | 12 | -0.8 | -0.5 | 13.8 |
| 20 | 12 | 0 | 12 | -2.4 | -1.6 | 14.5 |
| 10 | 12 | 0 | 12 | -3.1 | -2.1 | 15.2 |
| 0 | 12 | 0 | 12 | -3.5 | -2.3 | 15.8 |

| CUSTOMER | DATE | SHEET |
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| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 31

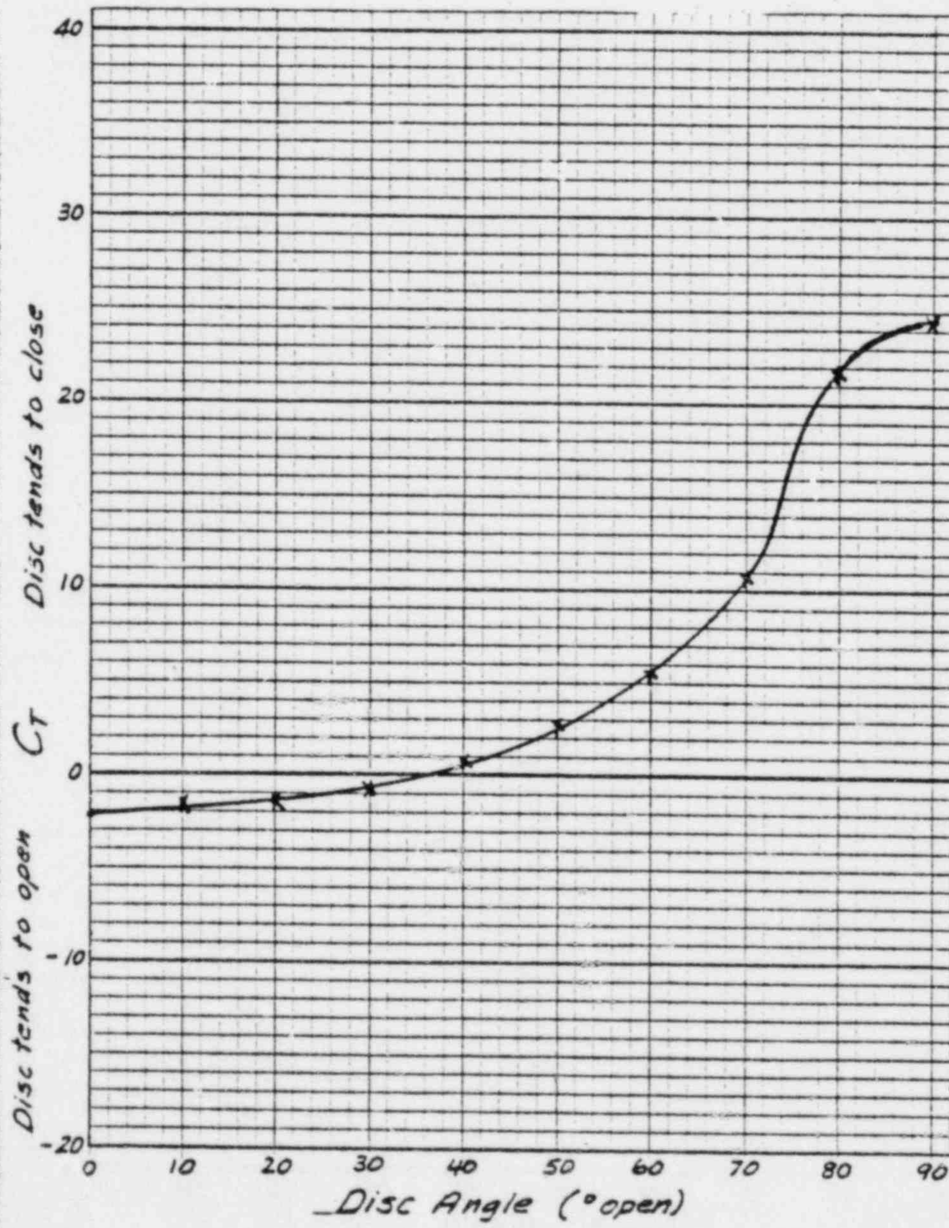
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 30 PSIG   Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 6 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | CALCULATED BY | |

ENGINEERING CALCULATION SHEET

LITHO IN U.S.A.—A-C

ALLIS-CHALMERS FORM 6715-1

Test No. 31

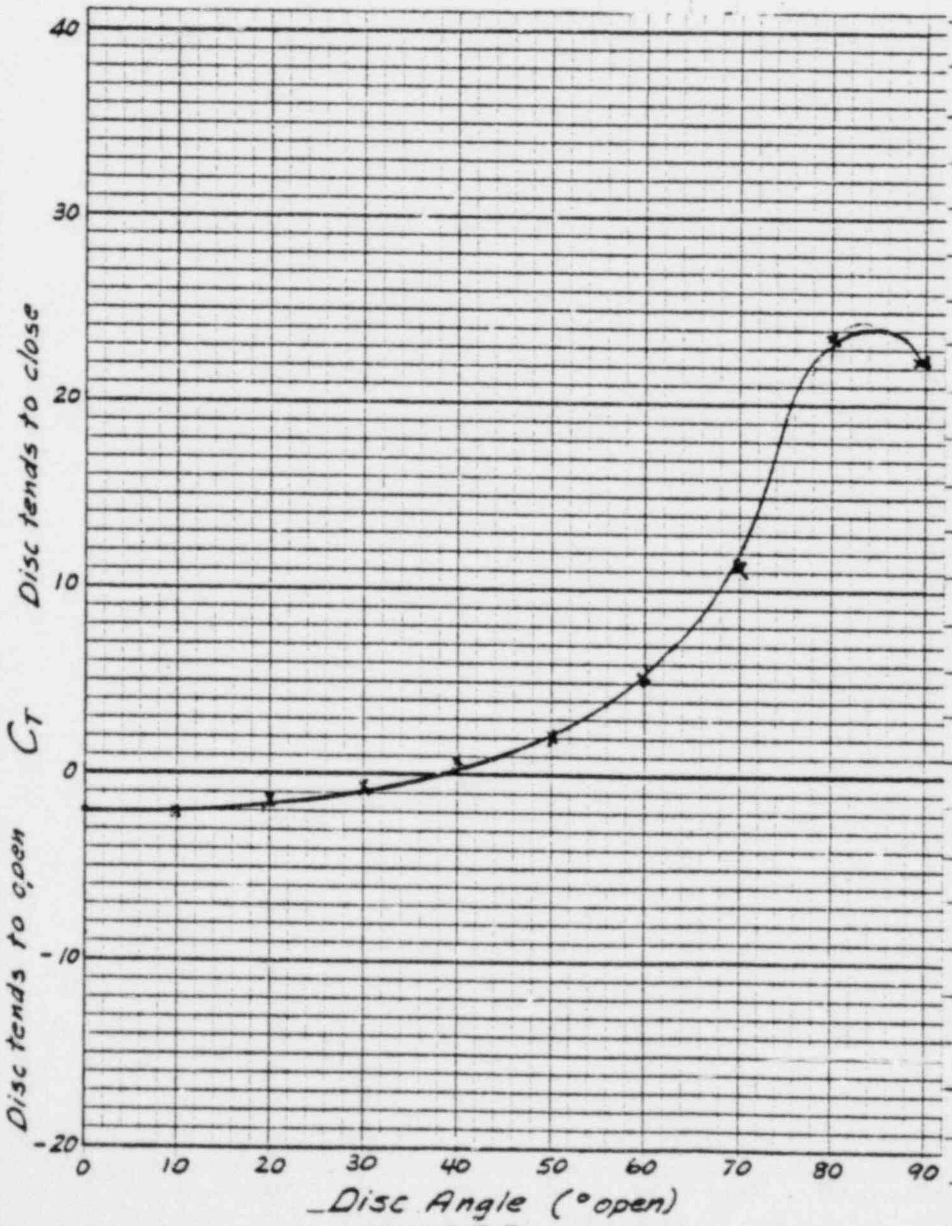
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 40 PSIG Valve orientation ref. Figure: 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$

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Test 31 $\Delta P_{T_1}$ = 40 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 19 | 12 | 7 | 19.7 | 22.5 | 16.5 |
| 80 | 21 | 11 | 10 | 29.5 | 23.6 | 18.5 |
| 70 | 29 | 10 | 19 | 26.8 | 11.3 | 21.9 |
| 60 | 32 | 7 | 25 | 16.5 | 5.3 | 25.3 |
| 50 | 35 | 4 | 31 | 8.7 | 2.2 | 28.6 |
| 40 | 37 | 2 | 35 | 3.1 | 0.7 | 31.3 |
| 30 | 39 | 0 | 39 | -2.4 | -0.5 | 32.7 |
| 20 | 40 | 0 | 40 | -6.3 | -1.3 | 33.3 |
| 10 | 40 | 0 | 40 | -9.8 | -2.0 | 33.3 |
| 0 | 40 | 0 | 40 | -9.8 | -2.0 | 33.3 |

Test 31 $\Delta P_{T_1}$ = 30 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 13 | 8 | 5 | 15.3 | 24.5 | 9.8 |
| 80 | 15 | 6 | 9 | 15.3 | 24.5 | 9.8 |
| 70 | 20 | 6 | 14 | 20.5 | 11.7 | 13.8 |
| 60 | 24 | 5 | 19 | 13.4 | 5.6 | 17.2 |
| 50 | 26 | 3 | 23 | 7.9 | 2.7 | 18.5 |
| 40 | 28 | 2 | 26 | 2.4 | 0.7 | 21.2 |
| 30 | 29 | 0 | 29 | -3.1 | -0.9 | 22.6 |
| 20 | 29 | 0 | 29 | -5.5 | -1.5 | 23.9 |
| 10 | 29 | 0 | 29 | -5.9 | -1.6 | 25.3 |
| 0 | 29 | 0 | 29 | -7.9 | -2.2 | 25.3 |

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| CUSTOMER | DATE | SHEET |
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| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 5 of 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [illegible]

Test No. 31

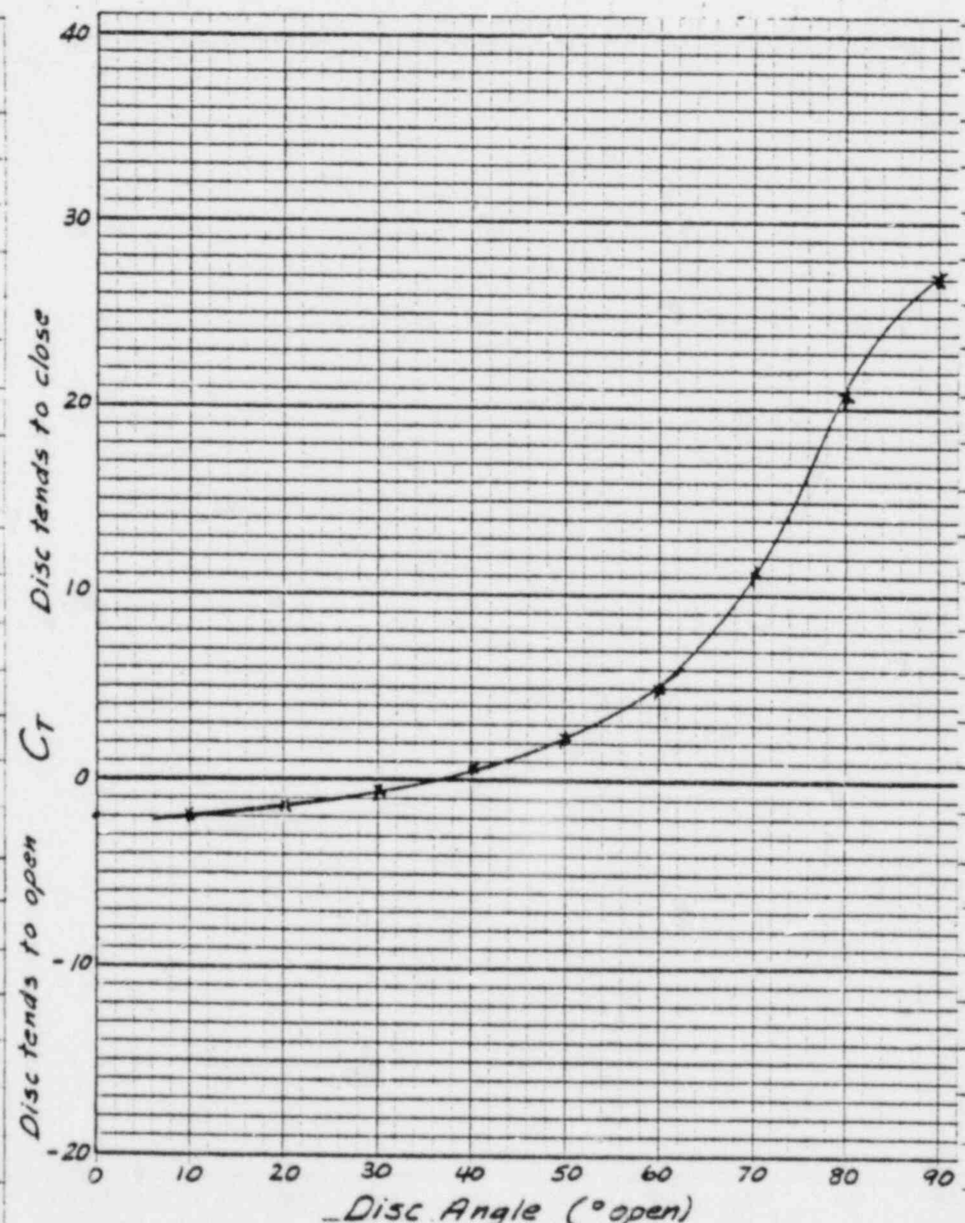
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 50 PSIG Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

| | | |
|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 6 OF 6 |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | PRELIM. | FINAL |
| DRAWING NUMBER | CALCULATED BY: BHH. | |

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

Test No. 31

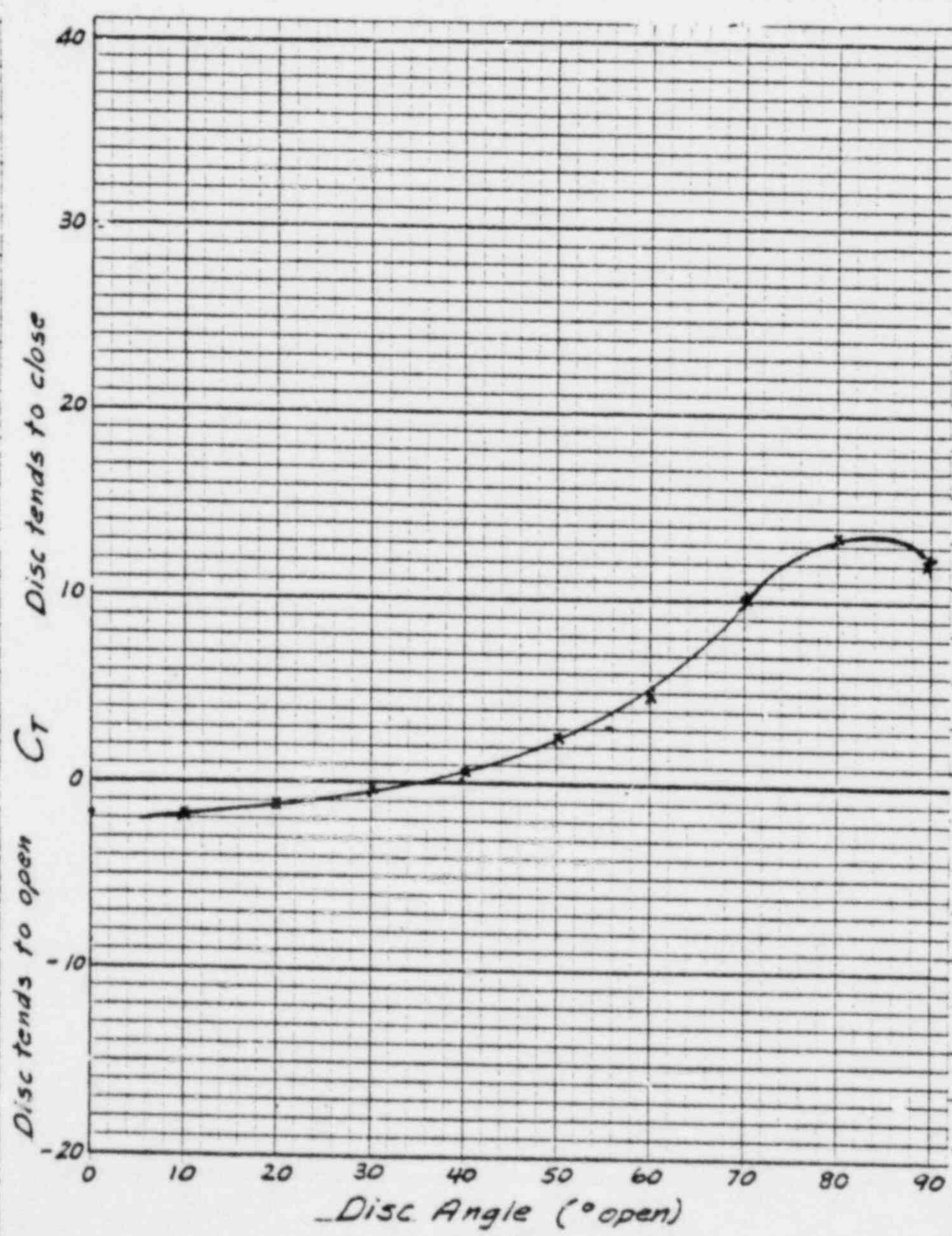
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 60 PSIG    Valve orientation ref. Figure 12

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 31 $\Delta P_{T_1}$ = 60 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 31 | 17 | 14 | 21.6 | 12.3 | 38.1 |
| 80 | 37 | 17 | 20 | 33.4 | 13.4 | 38.7 |
| 70 | 41 | 16 | 25 | 31.5 | 10.1 | 40.1 |
| 60 | 47 | 12 | 35 | 21.6 | 4.9 | 44.1 |
| 50 | 51 | 8 | 43 | 13.8 | 2.6 | 47.5 |
| 40 | 55 | 4 | 51 | 4.7 | 0.7 | 50.2 |
| 30 | 56 | 2 | 54 | -2.0 | -0.3 | 51.5 |
| 20 | 57 | 0 | 57 | -7.9 | -1.1 | 52.2 |
| 10 | 57 | 0 | 57 | -11.8 | -1.7 | 52.2 |
| 0 | 57 | 0 | 57 | -11.8 | -1.7 | 52.2 |

Test 31 $\Delta P_{T_1}$ = 50 PSI

| ° Open | $P_1$ | $P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 24 | 17 | 7 | 23.6 | 27.0 | 29.3 |
| 80 | 27 | 14 | 13 | 33.4 | 20.6 | 30.0 |
| 70 | 34 | 13 | 21 | 29.5 | 11.2 | 34.0 |
| 60 | 40 | 10 | 30 | 18.9 | 5.0 | 38.7 |
| 50 | 44 | 6 | 38 | 11.0 | 2.3 | 40.7 |
| 40 | 45 | 3 | 42 | 3.9 | 0.7 | 42.1 |
| 30 | 47 | 1 | 46 | -2.4 | -0.4 | 44.8 |
| 20 | 48 | 0 | 48 | -7.9 | -1.3 | 45.5 |
| 10 | 48 | 0 | 48 | -11.8 | -2.0 | 45.5 |
| 0 | 48 | 0 | 48 | -11.8 | -2.0 | 45.5 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 1 of 6 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. | FINAL

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LITHO IN U.S.A.—A-C

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY

Test No. 32

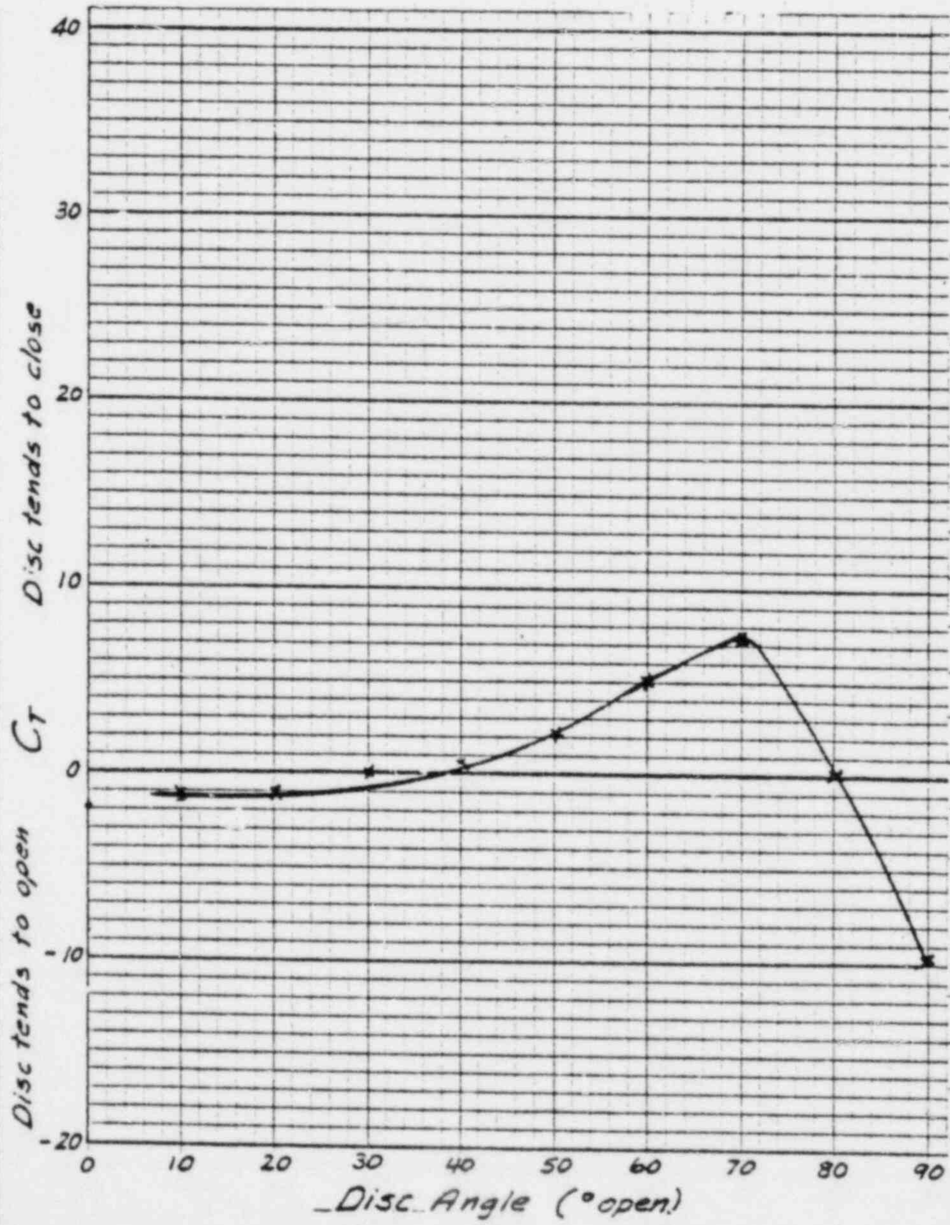
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 15 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



| | | | |
|---|---|---|---|
| CUSTOMER: Air Flow Tests NASA/Langley Research Center | DATE: Nov. & Dec. 1979 | SHEET 2 OF 6 | |
| SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model | | PRELIM. | FINAL |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET (LITHO IN U.S.A.—A-C; ALLIS-CHALMERS; FORM 6715-1) | CALCULATED BY: [illegible] | |
| | | Test No. 32 | |

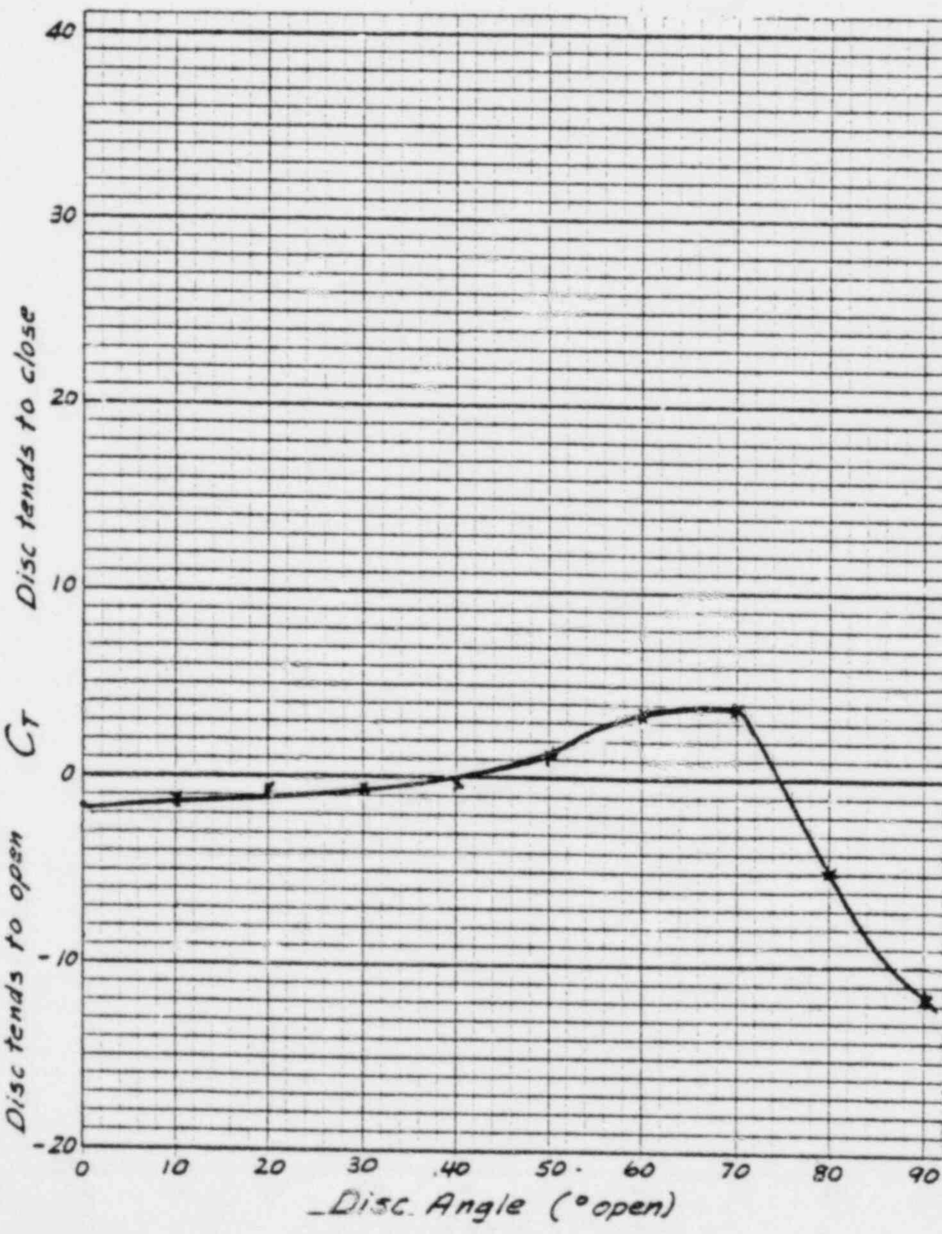
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 20 PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

Test 32 $P_{T_1}$ = 20 PSI

| ° Open | $P_1$ | *$P_2$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 7 | 3 | 4 | -5.9 | -11.8 | 58.9 |
| 80 | 8 | 3 | 5 | -3.1 | -5.0 | 58.9 |
| 70 | 11 | 3 | 8 | 3.9 | 3.9 | 56.2 |
| 60 | 14 | 3 | 11 | 4.7 | 3.4 | 52.9 |
| 50 | 17 | 2 | 15 | 2.0 | 1.1 | 50.8 |
| 40 | 18 | 1 | 17 | -0.8 | -0.4 | 49.5 |
| 30 | 18 | 1 | 17 | -1.2 | -0.6 | 48.8 |
| 20 | 19 | 0 | 19 | -1.6 | -0.7 | 47.5 |
| 10 | 19 | 0 | 19 | -3.1 | -1.3 | 46.1 |
| 0 | 19 | 0 | 19 | -3.9 | -1.6 | 45.5 |

Test 32 $P_{T_1}$ = 15 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 5 | 3 | 2 | -2.4 | -9.6 | 56.2 |
| 80 | 5 | 2 | 3 | 0 | 0 | 56.2 |
| 70 | 7 | 2 | 5 | 4.7 | 7.5 | 55.6 |
| 60 | 8 | 2 | 6 | 3.9 | 5.2 | 52.9 |
| 50 | 10 | 1 | 9 | 2.4 | 2.1 | 52.2 |
| 40 | 12 | 1 | 11 | 0.8 | 0.6 | 50.2 |
| 30 | 12 | 0 | 12 | 0 | 0 | 49.5 |
| 20 | 13 | 0 | 13 | -1.6 | -1.0 | 48.8 |
| 10 | 13 | 0 | 13 | -2.0 | -1.2 | 48.8 |
| 0 | 13 | 0 | 13 | -3.1 | -1.9 | 48.8 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 3 of 6 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

PRELIM. | FINAL

DRAWING NUMBER | LITHO IN U.S.A.—A-C | CALCULATED BY [illegible]

## ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS — FORM 6715-1

Test No. 32

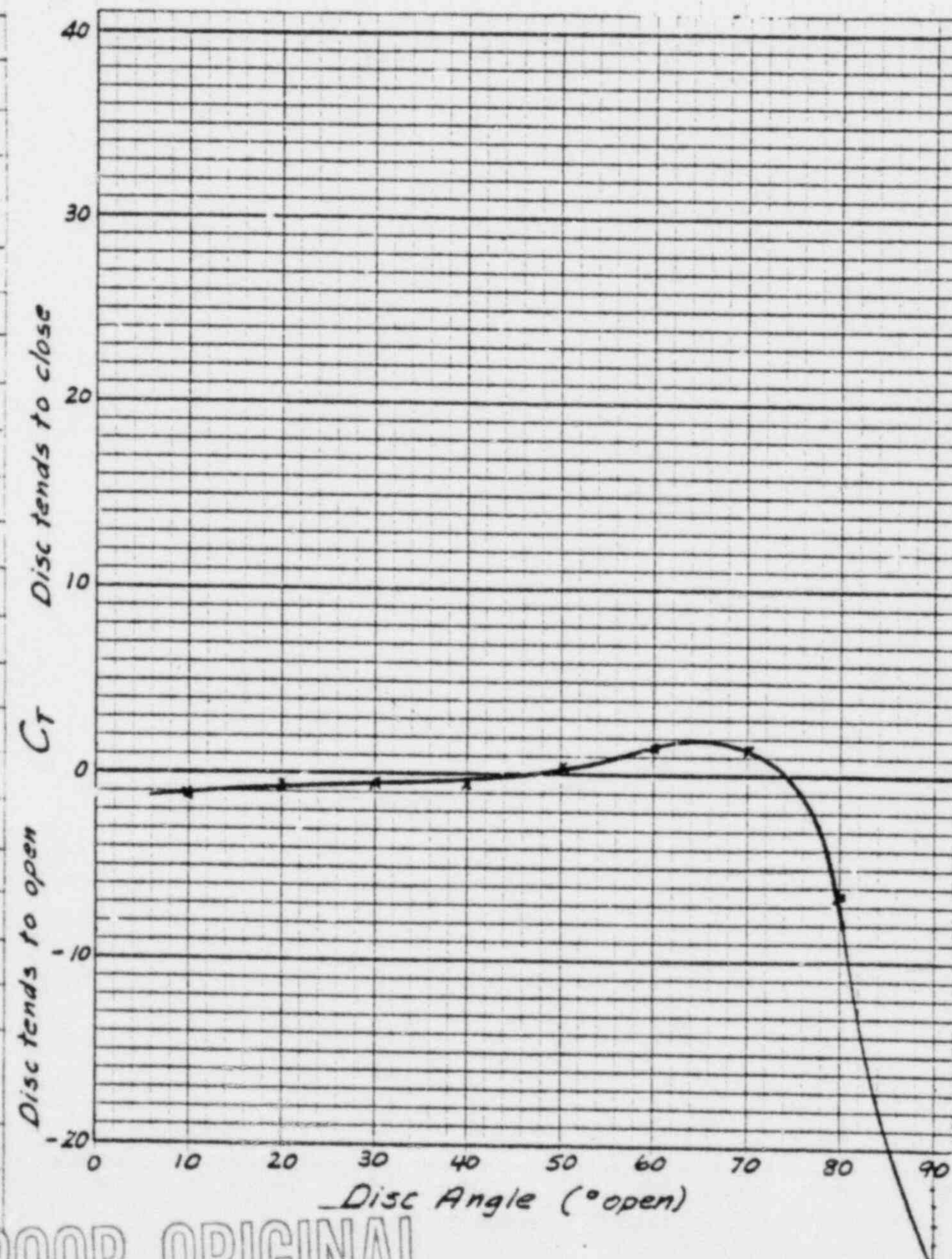
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 30 PSIG  Valve orientation ref. Figure 10.

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 4 of 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

DRAWING NUMBER

LITHO IN U.S.A.—A-C

**ENGINEERING CALCULATION SHEET**

ALLIS-CHALMERS FORM 6715-1

CALCULATED BY [signature]

Test No. 32

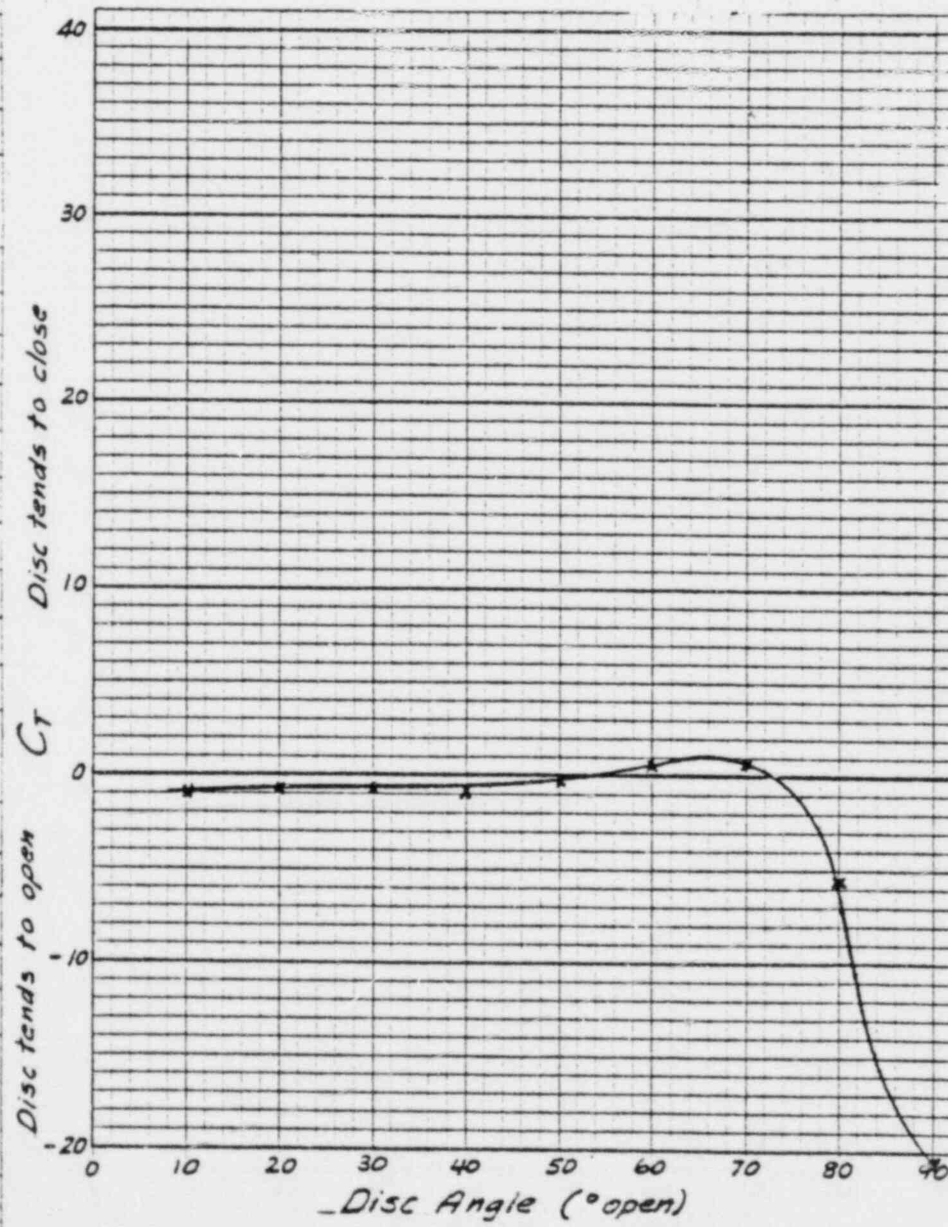
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 40PSIG  Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 32 $P_{T_1}$ = 40 PSIG

| DA | $P_{T_5}$ | $P_{T_6}$ | ΔP | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 18 | 12 | 6 | -15.7 | -21 | 48.8 |
| 80 | 21 | 11 | 10 | - 6.9 | 5.5 | 46.8 |
| 70 | 26 | 7 | 19 | 1.2 | .51 | 45 5 |
| 60 | 33 | 5 | 28 | 2 | .57 | 40.1 |
| 50 | 35 | 2 | 33 | - .8 | -.195 | 37.4 |
| 40 | 37 | 1 | 36 | - 4.03 | -.9 | 34.7 |
| 30 | 38 | 0 | 38 | - 2.8 | -.59 | 33.3 |
| 20 | 38 | 0 | 38 | - 4.03 | -.85 | 32.7 |
| 10 | 38.5 | 0 | 38.5 | - 4.8 | -1.0 | 0 |

Test 32 $P_{T_1}$ = 30 PSIG

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 12 | 8.5 | 3.5 | -11.7 | -26.7 | 56.2 |
| 80 | 14 | 8 | 6 | - 4.8 | -6.4 | 25.6 |
| 70 | 18 | 7 | 11 | 2 | 1.5 | 52.2 |
| 60 | 22 | 5 | 17 | 3.2 | 1.5 | 48.8 |
| 50 | 26 | 2 | 24 | .8 | .27 | 46.1 |
| 40 | 27 | 1 | 26 | -1.6 | -.5 | 45.5 |
| 30 | 28 | 0 | 28 | -1.2 | -.34 | 43.4 |
| 20 | 28 | 0 | 28 | -2.4 | -.69 | 42 8 |
| 10 | 28.5 | 0 | 28.5 | -4.03 | -1.13 | 42.8 |

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 5 - 6 |

| SUBJECT | PRELIM. | FINAL |
|---|---|---|
| Allis-Chalmers 6" Streamseal Butterfly Valve Model | | |

| DRAWING NUMBER | | CALCULATED BY |
|---|---|---|
| | **ENGINEERING CALCULATION SHEET** | BHH |
| | | Test No. 32 |

LITHO IN U.S.A. ALLIS-CHALMERS FORM 6715-1

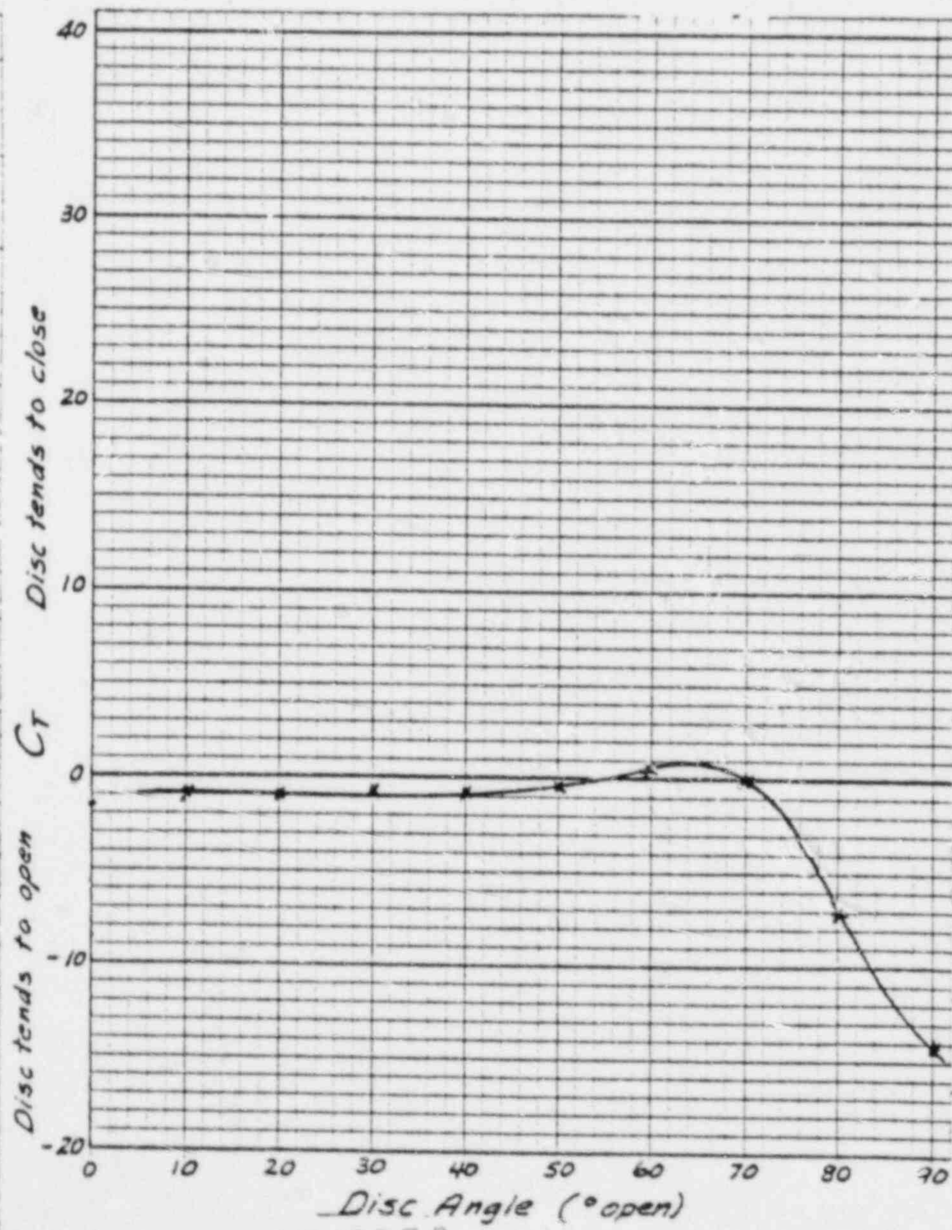
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 50PSIG Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, D is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$




POOR ORIGINAL

| CUSTOMER | DATE | SHEET |
|---|---|---|
| Air Flow Tests NASA/Langley Research Center | Nov. & Dec. 1979 | 6 of 6 |

SUBJECT: Allis-Chalmers 6" Streamseal Butterfly Valve Model

DRAWING NUMBER

PRELIM. FINAL

LITHO IN U.S.A.—A-C

CALCULATED BY [illegible]

# ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS FORM 6715-1

Test No. 32

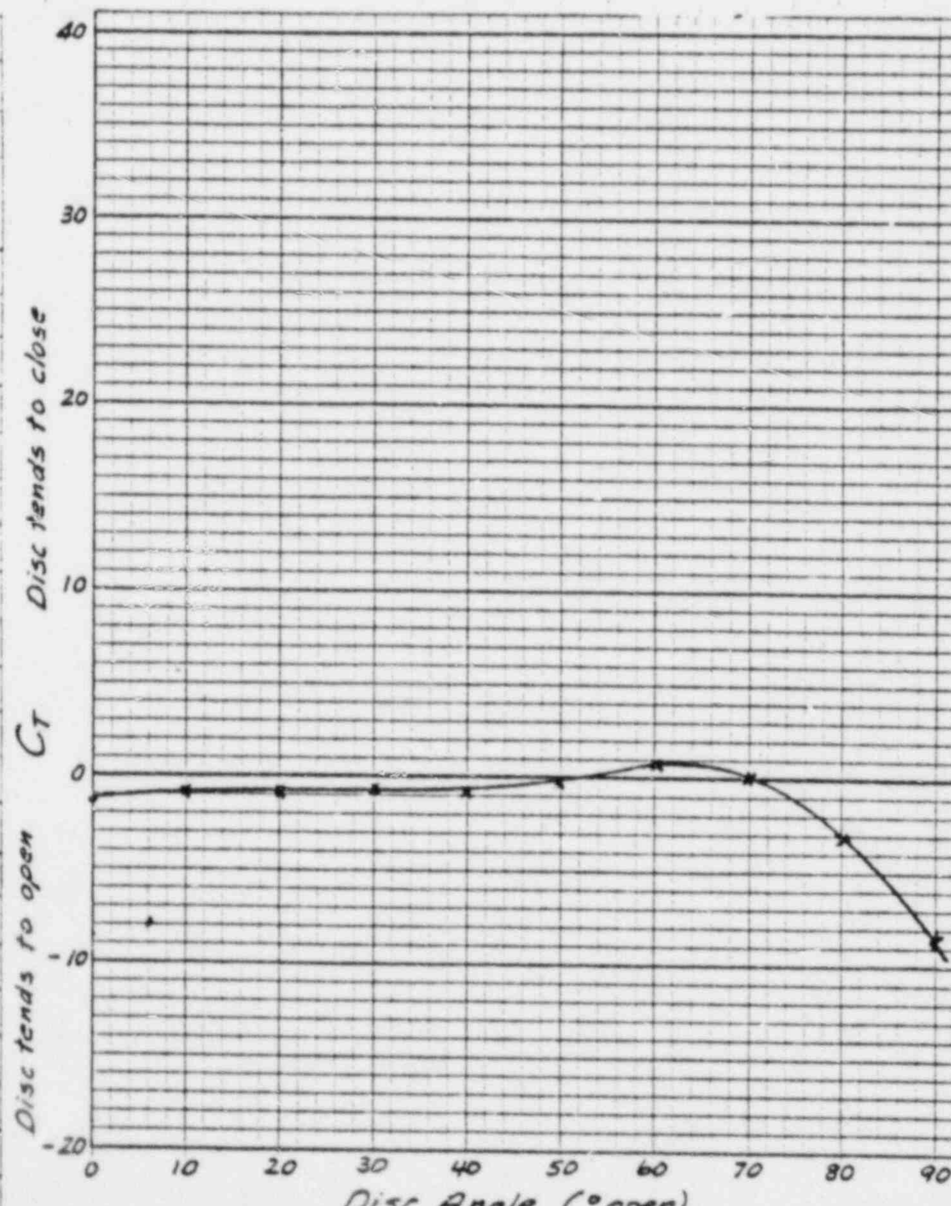
Valve disc thickness to diameter ratio: .17

Initial upstream pressure: 60 PSIG Valve orientation ref. Figure 10

Torque equation and coefficient: $T_d = C_T \times D^3 \times \Delta P$

where $T_d$ is the dynamic torque in foot-pounds, $C_T$ is the torque coefficient, $D$ is the valve diameter in feet and $\Delta P$ is the total pressure drop across the valve in psi.

$$\Delta P = \left(P_1 + \frac{V_1^2}{2g}\right) - \left(P_2 + \frac{V_2^2}{2g}\right)$$



Test 32 $P_{T_1}$ = 60 PSI

| ° Open | $P_1$ | *$P_2$ | $\Delta P$ | $T_D$ | $C_T$ | Temp °F |
|---|---|---|---|---|---|---|
| 90 | 31 | 16 | 15 | -15.7 | -8.4 | 33.3 |
| 80 | 34 | 16 | 18 | - 7.1 | -3.2 | 34.7 |
| 70 | 40 | 17 | 23 | 0 | 0 | 36.7 |
| 60 | 45 | 13 | 32 | 3.1 | 0.8 | 38.7 |
| 50 | 51 | 8 | 43 | -1.6 | -0.3 | 44.8 |
| 40 | 54 | 5 | 49 | -4.7 | -0.8 | 45.5 |
| 30 | 55 | 3 | 52 | -3.9 | -0.6 | 45.5 |
| 20 | 55 | 2 | 53 | -5.9 | -0.9 | 46.1 |
| 10 | 56 | 1 | 55 | -5.9 | -0.9 | 47.5 |
| 0 | 56 | 0 | 56 | -9.4 | -1.3 | 48.2 |

Test 32 $P_{T_1}$ = 50 PSI

| | | | | | | |
|---|---|---|---|---|---|---|
| 90 | 24 | 14 | 10 | -17.7 | -14.1 | 25.3 |
| 80 | 25 | 14 | 11 | -9.8 | -7.1 | 26.6 |
| 70 | 35 | 13 | 22 | 0 | 0 | 33.3 |
| 60 | 39 | 11 | 28 | 2.0 | 0.6 | 35.4 |
| 50 | 43 | 7 | 36 | -1.6 | -0.4 | 38.7 |
| 40 | 45 | 3 | 42 | -4.3 | -0.8 | 40.1 |
| 30 | 46 | 2 | 44 | -3.9 | -0.7 | 41.4 |
| 20 | 46 | 2 | 44 | -4.7 | -0.9 | 42.1 |
| 10 | 47 | 1 | 46 | -4.7 | -0.8 | 42.1 |
| 0 | 47 | 0 | 47 | -9.4 | -1.6 | 42.8 |

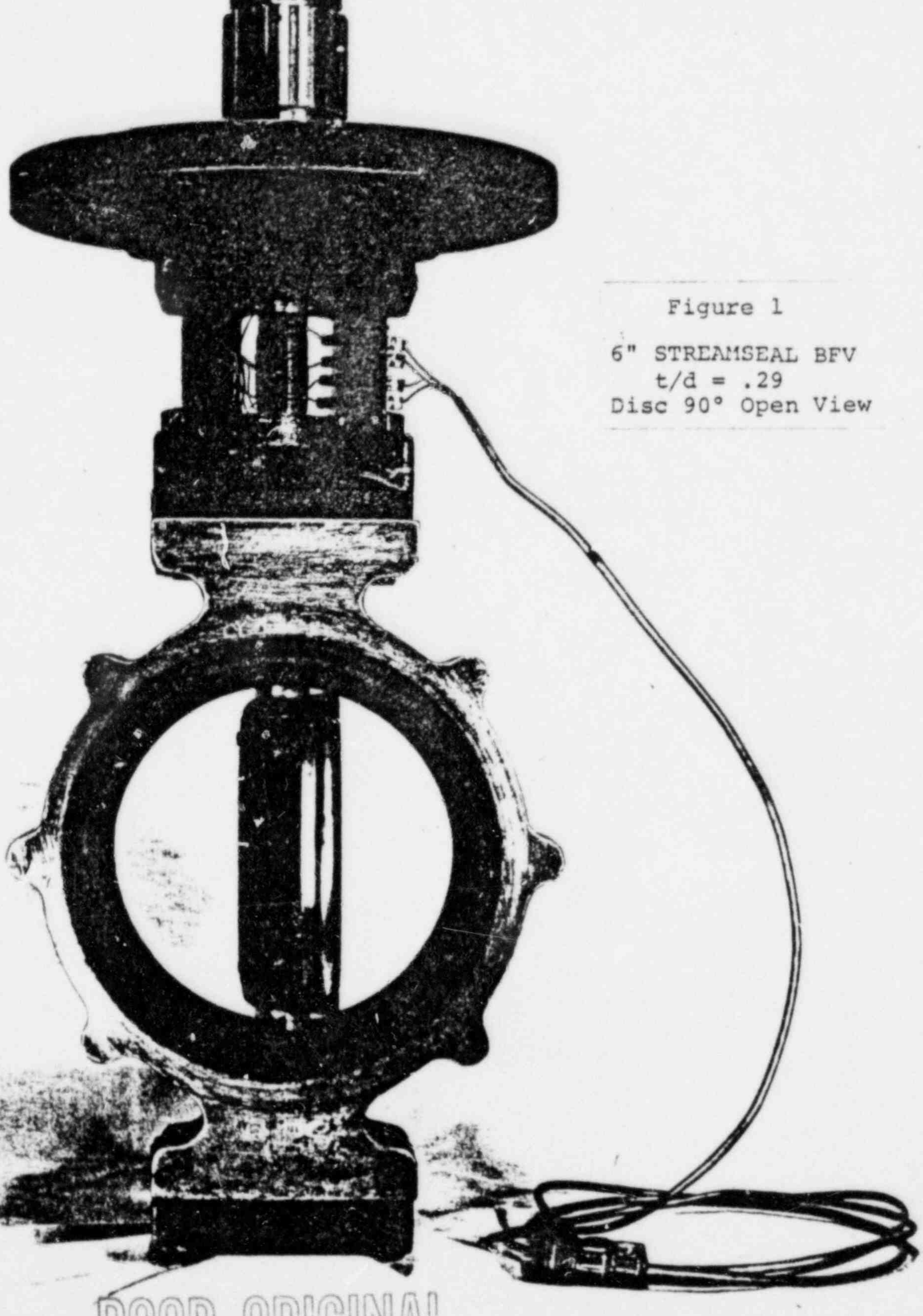


Figure 1

6" STREAMSEAL BFV
t/d = .29
Disc 90° Open View

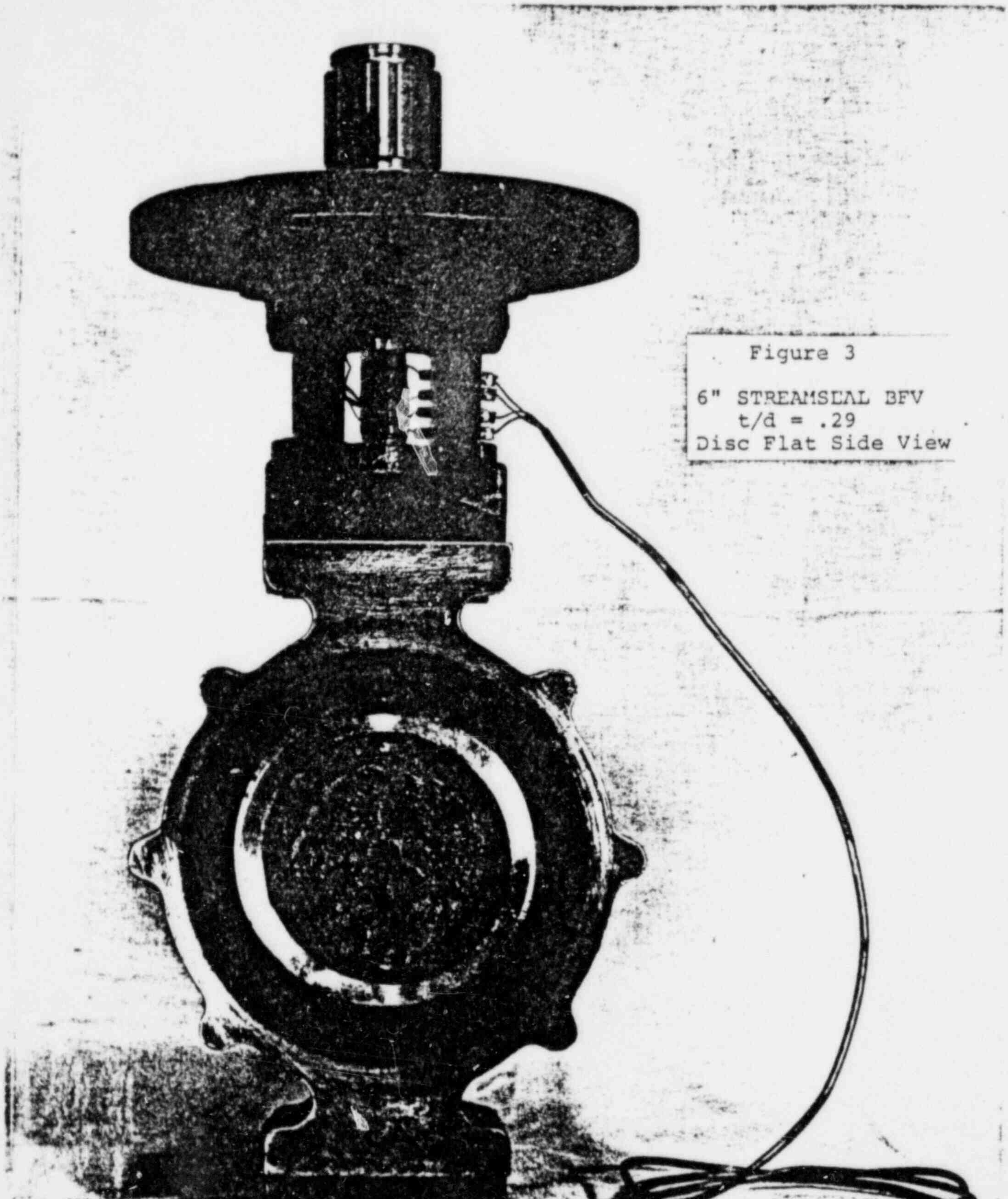


Figure 3

6" STREAMSEAL BFV
t/d = .29
Disc Flat Side View

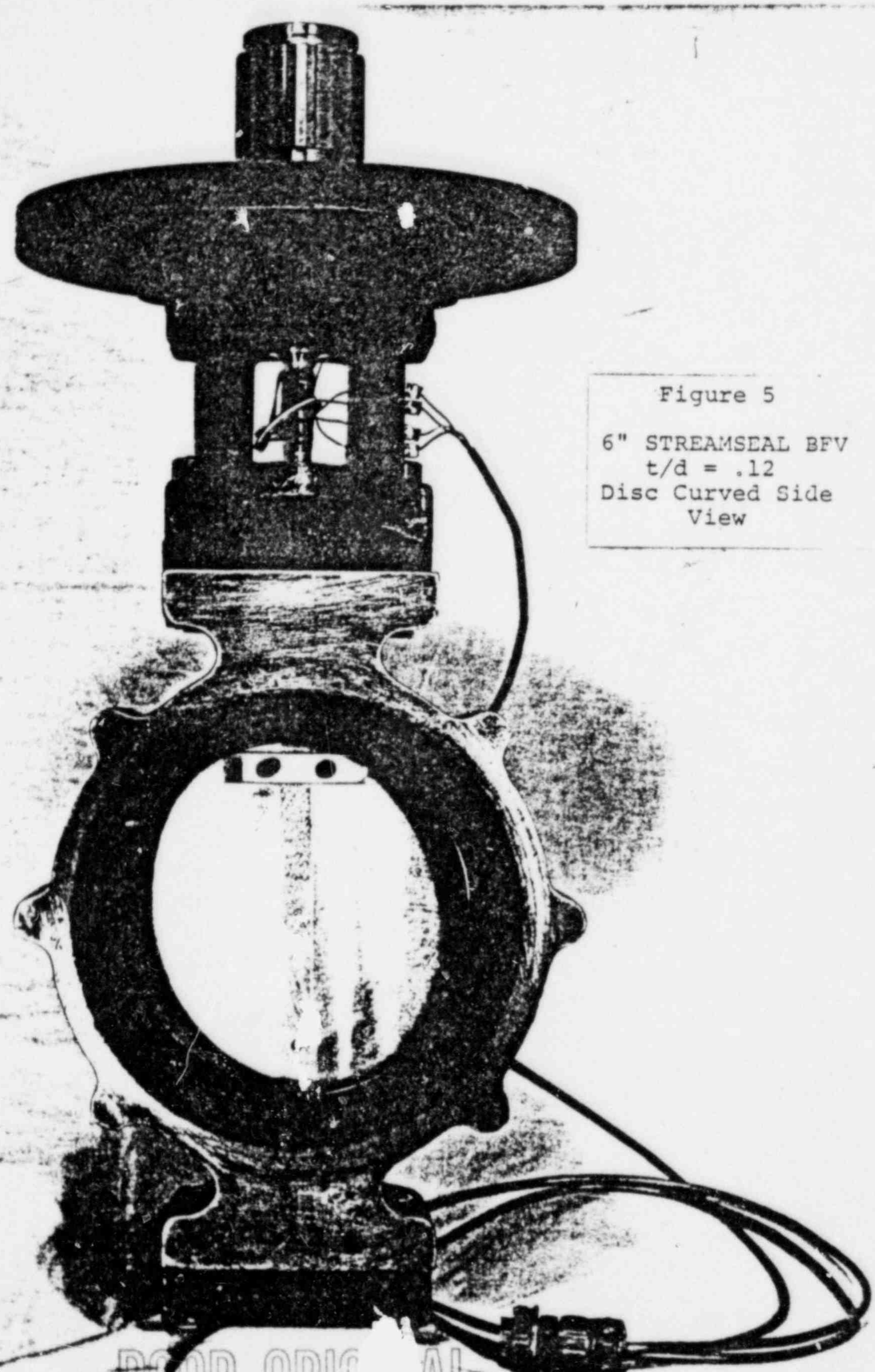


Figure 5

6" STREAMSEAL BFV
t/d = .12
Disc Curved Side
View

Figure 7

6" STREAMSEAL BFV
Left - t/d = .29
Center - t/d = .17
Right - t/d = .12

| | | | |
|---|---|---|---|
| CUSTOMER: NASA / LANGLEY | DATE: 12-19-79 | SHEET 1 OF 2 | |
| SUBJECT: TEST VALVE ORIENTATION | PRELIM. | FINAL | |
| DRAWING NUMBER | ENGINEERING CALCULATION SHEET | CALCULATED BY: GILGORE | |



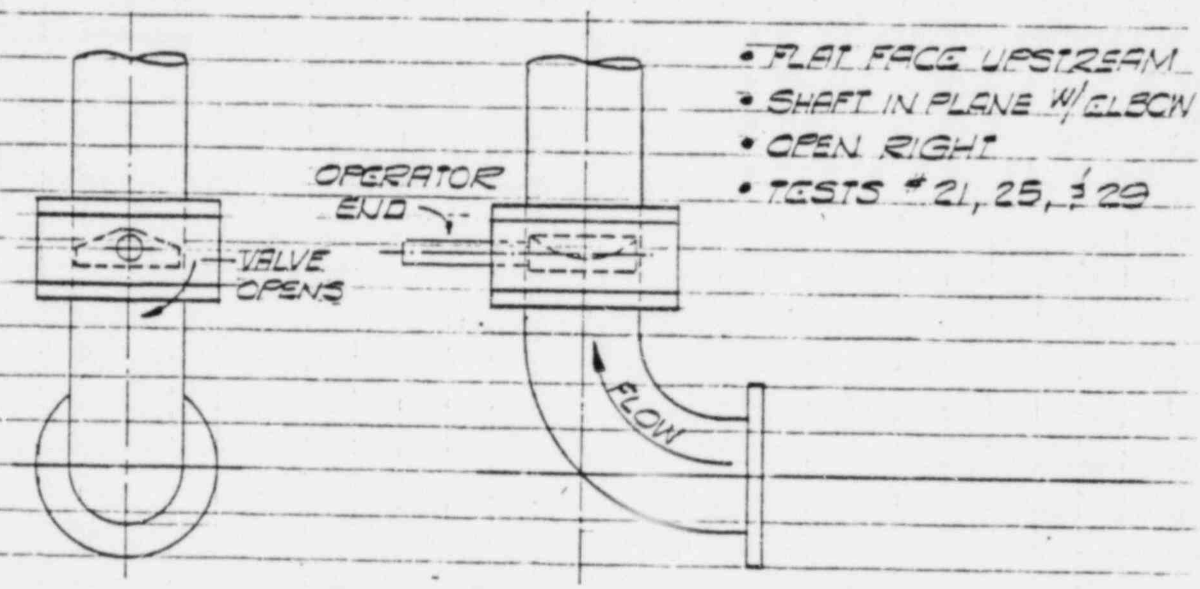



FIG. 9

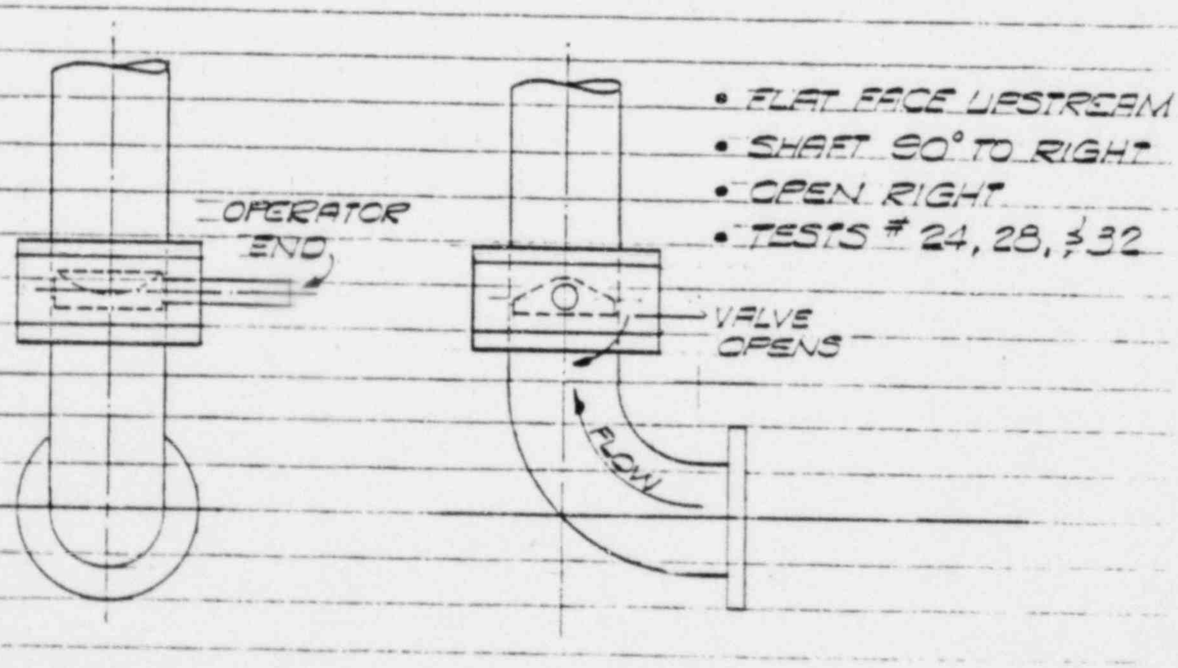



FIG. 10

CUSTOMER NASA / LANGLEY — DATE 12·19·79 — SHEET 2 OF 2

SUBJECT TEST VALVE ORIENTATION — PRELIM. — FINAL

DRAWING NUMBER — LITHO IN U.S.A.—A-C — CALCULATED BY GILGORE

ENGINEERING CALCULATION SHEET

ALLIS-CHALMERS — FORM 6715-1

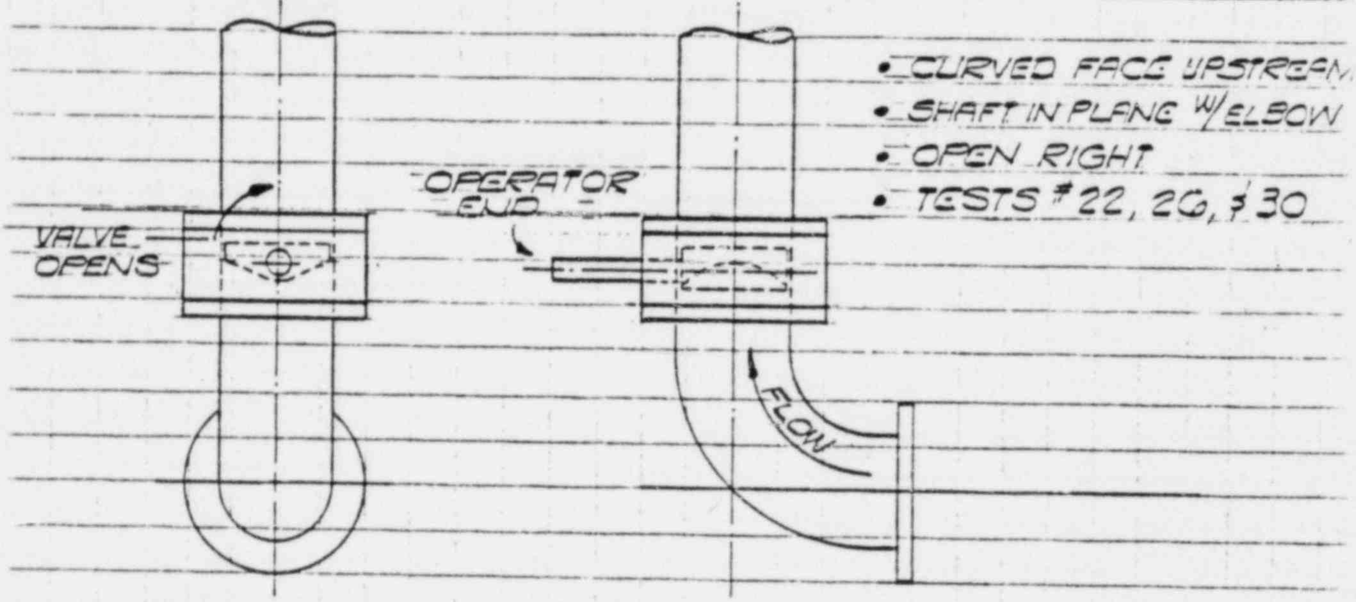



FIG. II

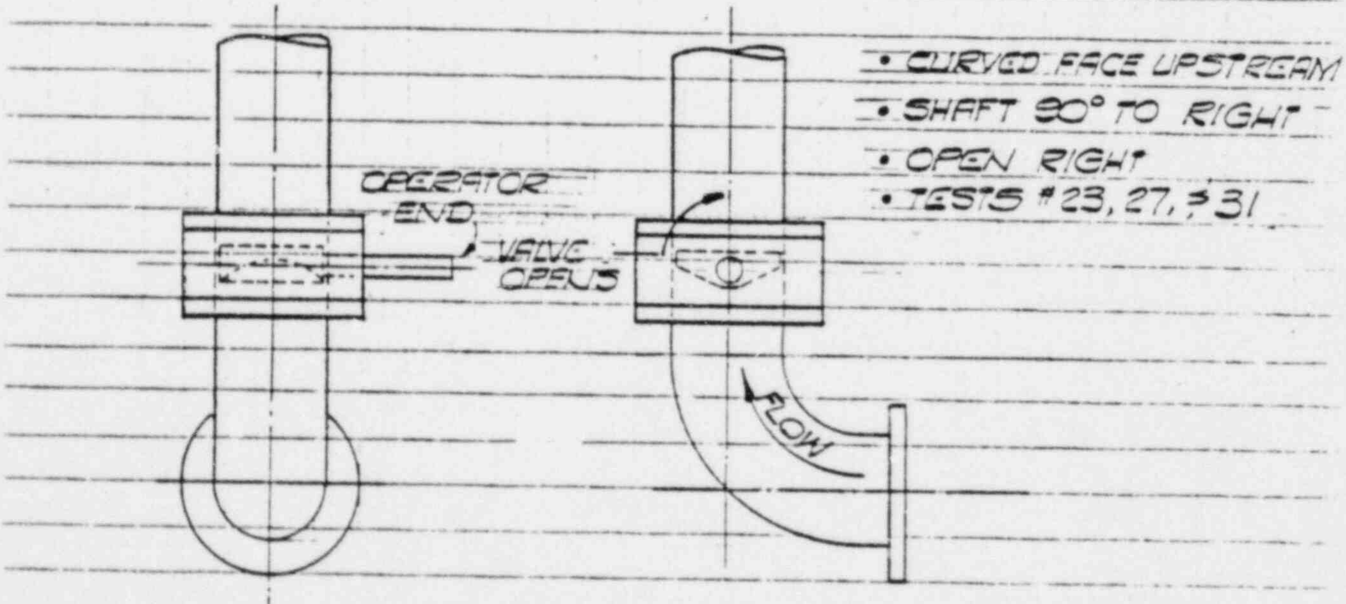
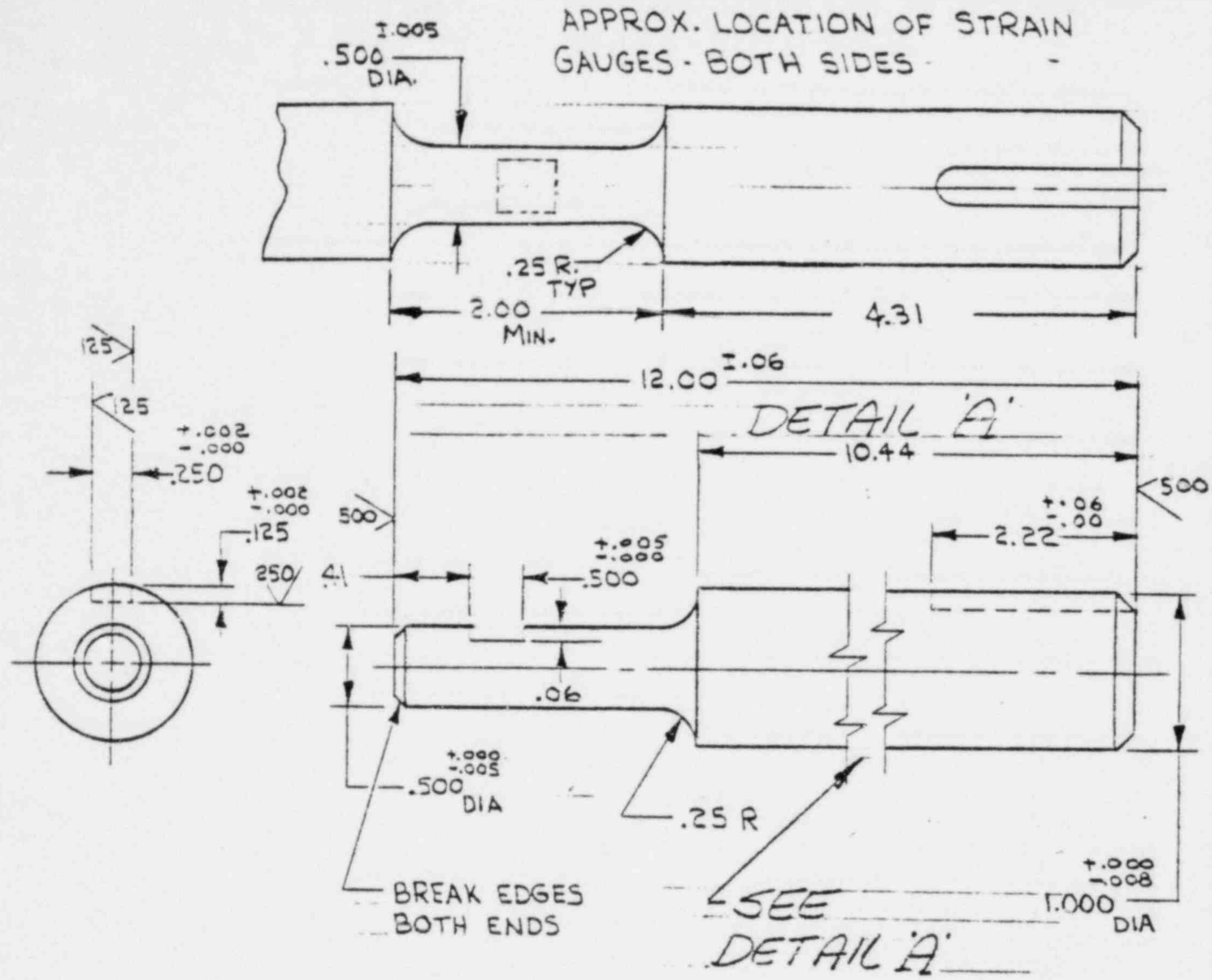



FIG. 12

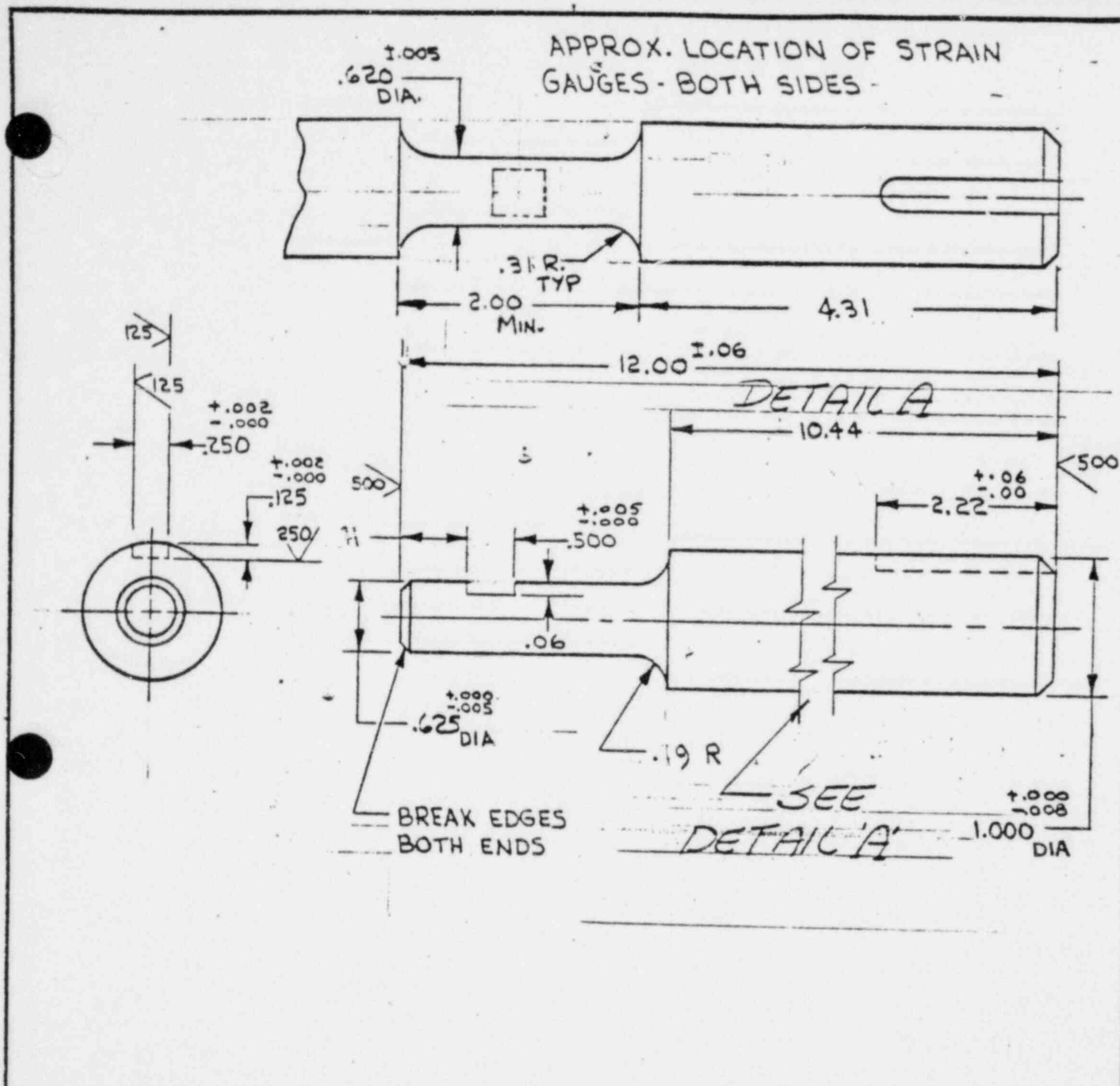



Appendix IV

STOCK NO.-304805

ROUTING CODE

| REVISIONS | UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES AND MACHINING TOL. ARE: 1 PLACE DEC ± .060; 2 PLACE DEC ± .030; 3 PLACE DEC ± .010; BREAK ALL CORNERS – .015 | CONFIDENTIAL – PROPERTY OF ALLIS-CHALMERS CORP. YORK PLANT VALVE DIVISION YORK, PA. |
|---|---|---|
| | DSGN: / DFTG APPD: | SHAFT 01.00-00.50 K |
| | DFTM: AFS / MECH ENG APPD: | WT R F / MATERIAL: SST |
| | CHK: / HYD ENG APPD: | SIMILAR TO: / MATERIAL SPEC: ASTM A479 TYPE 304 |
| | SCALE: [illegible] / DATE: 9-28-79 | SK-092779 / 4 / REV NO 00 |

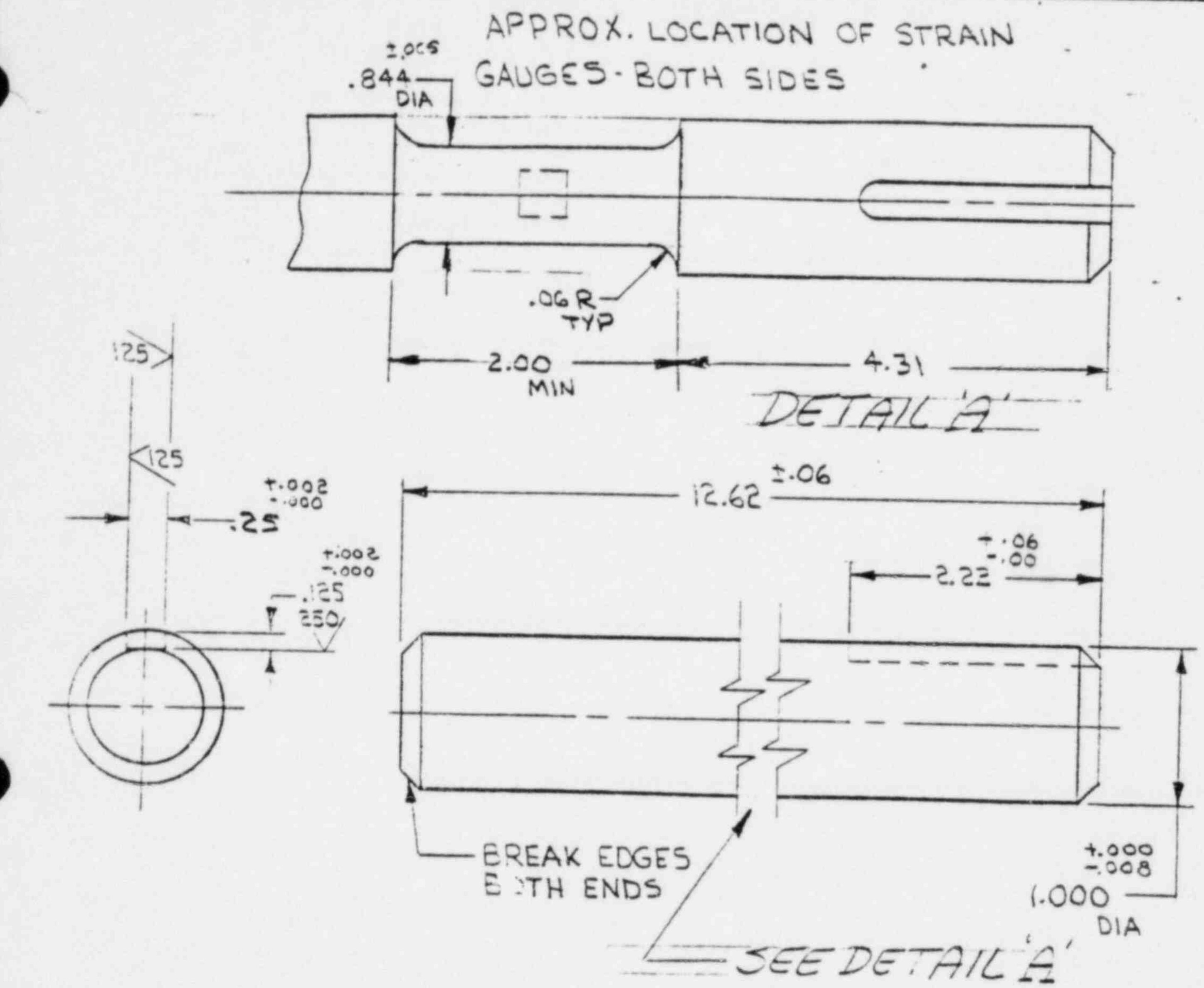



STOCK NO.-304805

ROUTING CODE

| REVISIONS | UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES AND MACHINING TOL. ARE: 1 PLACE DEC ± .060; 2 PLACE DEC ± .030; 3 PLACE DEC ± .010; BREAK ALL CORNERS – .015 | CONFIDENTIAL – PROPERTY OF ALLIS-CHALMERS CORP. YORK PLANT VALVE DIVISION YORK, PA. |
|---|---|---|
| | DSGN / DFTG APPD | SHAFT 01.00-00.62 K |
| | DFTM: AFS / MECH ENG APPD | WT R F / MATERIAL: SST |
| | CHK / HYD ENG APPD | SIMILAR TO / MATERIAL SPEC: ASTM A479 TYPE 304 |
| | SCALE: [illegible] / DATE: 9-28-79 | SK-092780 / 4 / REV NO 00 |

4 3 2 1 A




STOCK NO. 304805

ROUTING CODE

REVISIONS

POOR ORIGINAL

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES AND MACHINING TOL. ARE:
1 PLACE DEC ± .060
2 PLACE DEC ± .030
3 PLACE DEC ± .010
BREAK ALL CORNERS – .015

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**ALLIS - CHALMERS CORP.**
YORK PLANT VALVE DIVISION YORK, PA.

SHAFT 01.00 K

| | | | |
|---|---|---|---|
| DSGN | DFTG APPD | | |
| DFTM AFS | MECH ENG APPD | WT | MATERIAL SST |
| CHK | HYD ENG APPD | SIMILAR TO | MATERIAL SPEC ASTM A479 TYPE 304 |
| SCALE | DATE 9-28-79 | SK-092781 | 4 REV NO 00 |