**REDESIGN OF THE LOW CONDUCTIVITY WATER (LCW)
SYSTEM AT D-ZERO**

D0 Engineering Note: 3823.000-EN-460

October 15,1996

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SUMMARY

Due to the relocation of a magnet power supply, the installation of a buss, and an installation of chokes, and their need for cooling water a redesign of the Low Conductivity Water (LCW) system has been undertaken. This new system required the determination of an optimal pipe diameter for the High Bay pipe as well as the determination of the pressure drop and temperature rise in the buss. Based on numerous calculations it has been determined that the High Bay pipe should be 1 ½ inch (1.90 O.D. x 1.610 I.D.- 40S steel). While the pressure drop in the buss was calculated to be 7.699 psi. Based on such a low pressure drop, no need for any additional pumps has presented itself. Finally, the temperature rise in the buss has been determined to be about 29.39° F for the Assembly Hall (route #1), and 13.93° F for the Collision Hall (route #2).

BACKGROUND AND PURPOSE

The purpose of this engineering note is to explain the redesign of the low conductivity water system (LCW) at D-Zero. The areas to be covered include the sizing of the High Bay, the pressure drop and temperature rise in the buss. In addition, I will try to determine if any more pumps are needed to support this new system.

Originally, the purpose of the LCW was to provide cooling for the EF, CF, SAMUS magnets and the magnet power supply. The water source is composed of two 1 ½ BC, 20 hp, centrifugal pumps (see Table #2) which are located in room 604 of the D-Zero Assembly building.

CURRENT DESIGN

A redesign of this system was necessary because the magnet power supply has been moved to room 511 and a buss has been installed in the High Bay. As a result, a means of cooling these components was needed. The following configuration will be the new LCW system: In room 604, two lines (supply and return) are to be teed into existing LCW lines, where they will follow a path along the existing stairwell into room 603. The piping is then run along the north wall and across the High Bay, following the same path as an existing cable tray. Upon reaching the south wall, the pipes will enter room 511 where they will branch into 3 drops before being terminated. One of these drops will provide the water necessary for the buss, the second will be used for the chokes while the third will provide the cooling for the power supply. Each drop will have a plug valve as well as a flow meter. This setup will be used as a means of balancing the system while using a minimum amount of water.

PROCEDURE AND CALCULATIONS

A flow rate of 15 gallons per minute (GPM) has been determined to be optimal to support the cooling of the chokes, buss and power supply. The individual flow rate requirements for these components are: 2 GPM, 4 GPM and 5 GPM, respectively. The sum of these rates is 11 GPM but to be safe it has been rounded to 15 GPM. Since the pipe size for the High Bay run has not been determined, it must be calculated now. The following criteria have been established for this pipe (note: from this point forward the pipe running through the High Bay to room 511 will be referred to as the High Bay Pipe, while the buss pipe will be simply referred to as the buss):

- 1) Steel pipe - chosen primarily because of the low cost of steel as opposed to brass or copper.

- 2) An equivalent length of 316 +/- 22 feet - this total length is based on the summation of the total of straight pipe plus the equivalent length of straight pipe for the elbows and tees.

[2] lines from room 604 to room 511 $128' \times 2 = 256'$ $18' \times 2 = 36'$

[16] 90 degree ells $3' \times 16 = 48'$ $4' \times 16 = 64'$

[2] tees (flow through side) $6' \times 2 = 12'$ $9' \times 2 = 18'$

TOTAL (1 inch) = 316' (1 1/2 inch) = 338'
(these values are based on friction losses from Table #1)

- 3) Capable of providing 15 GPM of flow - discussed above
- 4) A pressure drop of, at most, 25 psi - This pressure drop has been selected after careful review of the historical data provided by the current LCW system.

This data shows that the supply pressure is consistently around 120 psi while the return is about 20 psi. This gives a pressure drop of 100 psi.

To be conservative, we shall only have a pressure drop of 25 psi. The remaining 75 psi will be absorbed by valve #1 at the beginning of the High Bay supply line (see Figure #1 - valve #1).

In order to calculate the necessary High Bay pipe size, we must sum all the pressure drops along its course remembering that this total shall not exceed 25 psi.

These pressure drops are (refer to Figure #1 for segment representations): ΔP across segment A-B, B-D (either route #1 or #2), valve #2, D-C (return portion of B-D), B-E, valve #3, valve #4, E-F, valve #5.

PRESSURE DROP IN THE BUSS

A drop from the High Bay line connects to the buss which is split into two routes as seen in figure 1. Route #1 drops down through the walk to the pipes running along the wall. There it is angled 90 degrees and runs along the side of the clean room. Route #2 drops down at the end of the walk, past the pump room in the High Bay. Then, it turns and runs into the collision hall through a couple of shielding blocks. The equivalent length for each of these two routes is no more than 300 feet (The 300 feet includes the 150 ft. to the end of each buss route plus 150 ft. for the return trip). The required flow rate for either route is 4 GPM which is to flow through a square edged pipe with a circular inner diameter of 0.75 inches. The pressure drop across the buss is equivalent to the pressure drop across one of the chosen routes, since, at any one time one of the ends of the buss will always be capped.

First determine the Reynold's Number and then the corresponding friction factor for the pipe. Using equation #1 the Reynold's number is:

$$N_{Re} = \frac{50.6W\rho}{d\mu} \quad [1]$$

where: $W = 4 \text{ GPM}$

$L = 300 \text{ feet}$

$\rho = 62.4 \text{ lb/ft}^3 \text{ [ref. A-6]}$

$D = 0.0625 \text{ ft}$

$d = 0.75 \text{ inches}$

$f_T = 0.025 \text{ [ref A-26]}$

$\mu = 1.06 \text{ [ref. A-3]}$

$$N_{Re} = 15,886.49$$

While the friction factor is: (using equation #7)

$$f = 0.0281$$

Thus the resistance coefficient (K) for the pipe is:

$$K = fL / D \quad [2]$$

$$K = 135.1$$

while K for the plug valve is:

$$K = 18 f_T \quad [2b]$$

$$K = 0.45$$

$$K_{total} = 135.55$$

Finally, the pressure drop for the buss pipe and valve #2

$$\Delta P = \frac{18 \times 10^{-6} K \rho W^2}{d^4} \quad [\text{psi}] \quad [3]$$

is determined to be 7.699psi with a contribution of 0.0256 psi from valve #2.

Since our allowable pressure drop is 25 psi and the drop in the bus is 7.699 psi, we are

left with 17.3 psi across the High Bay pipe line. Therefore, summing the individual ΔP 's

across segments: valve #1, A-B, valve #3, valve #4, C-E, E-F and valve #5 we should not surpass the above value. But in order to determine the High Bay pipe diameter we must make the following assumption. Due to the fact that valve #1, #3, #4 and #5 are plug valves, and that the pressure drop across these types of valves is very small, we can assume that the pressure drop for one-half of the High Bay route should be roughly one-half of 17.3 psi or 8.65 psi. With this assumption in hand we can now attempt to calculate the High Bay pipe's inner diameter.

HIGH BAY PIPE SIZING

Two methods were used to calculate the inner diameter of the High Bay Pipe. One method involved the use of an iterative process while the other was based primarily on an assumption.

Method #1

Initially, we must make an educated guess as to what the inner diameter of the pipe might be. We then use this guess in equation #1 and determine the rate of flow per cross-sectional area (G).

$$G = \frac{m}{A} \quad [\text{kg/s-m}^2] \quad [4]$$

where: m = mass flow rate [kg/s]

A = cross-sectional area of the pipe = $\pi D^2/4$ [m²]

D = Inner diameter of pipe [m]

The next step is to determine the Reynold's Number using equation #5.

$$N_{\text{Re}} = \frac{DG}{\mu} \quad [\text{dimensionless}] \quad [5]$$

where: μ = viscosity [kg/m-s]

Having obtained the Reynold's Number, we must decide if the flow is turbulent or laminar so as to determine the corresponding friction factor (f). The following ranges will help in obtaining the correct friction factor.

$$\underline{N_{re} < 2300}$$

$$f = 64 / N_{re} \quad [6]$$

$$\underline{3000 < N_{re} < 50000}$$

$$f = 0.316 N_{re}^{-0.25} \quad [7]$$

$$\underline{50000 < N_{re}}$$

$$f = 0.184 N_{re}^{-0.20} \quad [8]$$

Now, we are able to calculate the value for the inner pipe diameter (D) and compare it to our original guess. Simply solve equation #9 for D_{new} using the necessary values that were obtained previously.

$$D_{new} = \left(\frac{L}{\Delta p} \right) \left(\frac{G^2 f}{2 g \rho} \right) \quad [m] \quad [9]$$

where: L = equivalent length of pipe [m]

Δp = pressure drop [kg/m-s²]

$g = 1$ [kg-m/N-s²]

ρ = density [kg/m³]

f = friction factor [dimensionless]

G = mass flow rate per cross-sectional area [kg/s-m²]

If the value for D (initial guess) is within about 2% of D_{new} then your initial guess

was correct, otherwise you must substitute D_{new} for D and begin the iteration once again.

Method #2

Method #2 requires one to assume that the friction factor is around 0.021 and deviates very little from this value. Using equation #10 we solve for d (inner diameter in inches) to obtain equation #10b.

$$\Delta P = 3.36 \times 10^{-6} \left(\frac{f L W^2}{\rho d^5} \right) \quad [10]$$

$$d = \sqrt[5]{\left(\frac{3.36 \times 10^{-6} f L W^2}{\rho \Delta P} \right)} \quad [10b]$$

where: f = friction factor (assumed to be 0.021)

L = pipe length [ft]

W = mass flow rate [lb/hr]

ρ = density [lb/ft³]

ΔP = pressure drop [psi]

HIGH BAY PIPE DIAMETER

After using methods #1 and #2, I have determined that the inner diameter of the High Bay pipe should be at least 1.315 O.D. x 1.049 I.D. -40S steel in order to provide the necessary 15 GPM flow rate along with a pressure drop of no more than 25 psi. (Table #2 has been provided to show what calculations were involved in calculating this 1 inch diameter.) On the other hand, if we use the entire 100 psi allowable pressure drop we can obtain 37.4 GPM of flow through this 1 inch pipe. Even though we have this extra 20 GPM of flow at our disposal, I recommend that a 1 ½ inch (1.90 O.D. x 1.610 I.D.- 40S steel) pipe be installed instead. This pipe will be capable of providing 55 GPM with $\Delta P=$

25 psi and a max. of 110 GPM with $\Delta P = 100$ psi. Consequently, we will have satisfied our flow requirements along with allowing for any future needs that this LCW system may have to satisfy. As mentioned before, we must use a plug valve on the supply line (see Figure 1 - valve #1) in order to maintain control of the system. Also, a second plug valve (see Figure 1 - valve #5) will be located on the return High Bay line. This second valve is used as a form of redundancy. For instance, if a leak occurs in the system or a new drop is to be installed in the High Bay line, some means of avoiding backwash from the return pipe must be provided. It is recommended that these valves be 1 1/2 inch DeZURIK SERIES 400 ECCENTRIC PLUG VALVES (see attached pamphlet). Also, the plug valves located on the buss, chokes and power supply drops should be 3/4 inch DeZURIK plug valves. In addition, it is recommended that adjustable memory stops be obtained for each valve as a way to manually control each one.

SUMMATION OF PRESSURE DROPS

For this summation of pressure drops please refer to Figure #1 for segment representations. The primary equations that will be used are equations #1 and #3, with K values depending if the segment is a pipe (equation #2) or if it is a valve (equation #2b).

<u>Segments:</u>	<u>1.0 inch (ΔP)</u>	<u>1 1/2 inch (ΔP)</u>
valve #1	0.026 psi	0.014 psi
A-B	7.247 psi	0.947 psi
B-D	3.837 psi	3.837 psi
D-C	3.837 psi	3.837 psi
valve #2	0.026 psi	0.026 psi

B-E	0.211 psi	0.137 psi
valve #3	0.014 psi	0.0003 psi
valve #4	0.014 psi	0.0012 psi
E-F	8.298 psi	1.084 psi
valve #5	0.026 psi	0.014 psi
TOTAL	23.536 psi	9.898 psi

Based on the low pressure drops that have been calculated, an additional pump is not required at this time. Also, because a 1 1/2" pipe has been selected, there is more than enough flow to support the redesigned system and possibly any other additions in the future.

TEMPERATURE RISE IN THE BUSS

Using the First Law of Thermodynamics we are able to determine the temperature rise in the buss. First we must determine the pressure at state #1 which corresponds to the position on the High Bay line where the drop for the buss is located. Using equation #3, for a mass flow rate of 15 GPM, inner diameter = 1.610 in, and length of pipe from room 604 to the buss drop (High Bay pipe) of 138 ft, the pressure drop is 0.947 psi.

{1}<-----300 ft----->	{2}
<u>state #1</u>	<u>state #2</u>
$T_1 = 50^\circ \text{ F} = 10^\circ \text{ C}$	$T_2 = \text{????}$
$P_1 = 119.05 \text{ psi} = 820.84 \text{ kPa}$	$P_2 = 111.32 \text{ psi} = 767.52 \text{ kPa}$
$m_1 = 4 \text{ GPM} = 0.556 \text{ kg/s}$	$m_2 = m_1 = 0.556 \text{ kg/s}$

1st LAW:

$$m_2 h_2 - m_1 h_1 = W + Q \quad \text{where } W = 0$$

$$h_2 = Q / m + h_1 \quad [\text{kJ/kg}] \quad [11]$$

where:

$$Q = 38 \text{ kW} = 38 \text{ kJ/s (Assembly Hall route)} \quad [\text{Table 10.1}]$$

$$18 \text{ kW} = 18 \text{ kJ/s (Collision Hall route)} \quad [\text{Table 10.1}]$$

$$h_1 = h(T_1=10^\circ \text{ C}, P_1=777.40 \text{ kPa})$$

= 41.988 kJ/kg (NOTE: Because the pressure at state one is higher than the saturation pressure, this state is in the sub-cooled region. Thus, using the table of properties of saturated water at 10° C, the enthalpy is 41.988 kJ/kg)

Consequently, h_2 for the Assembly Hall route is:

$$h_2 = 110.33 \text{ kJ/kg}$$

for the Collision Hall route:

$$h_2 = 74.36 \text{ kJ/kg}$$

Finally, using the properties of saturated water table, the final temperature at state # 2

along with the corresponding temperature rise is:

Assembly Hall route:

$$\underline{T_2 = 26.33^\circ \text{ C} = 79.39^\circ \text{ F} \quad \text{Temp. Rise} = 16.33^\circ \text{ C} = 29.39^\circ \text{ F}}$$

Collision Hall route:

$$\underline{T_2 = 17.74^\circ \text{ C} = 63.93^\circ \text{ F} \quad \text{Temp. Rise} = 7.74^\circ \text{ C} = 13.93^\circ \text{ F}}$$

FRICION LOSS TABLES

FRICION LOSSES THROUGH FITTINGS IN TERMS OF EQUIVALENT LENGTHS OF PIPE

TYPE FITTING & APPLICATION	PIPE & FTG. MATERIAL (NOTE 1)	EQUIVALENT LENGTH OF PIPE NOMINAL SIZE FITTING & PIPE						
		1/2	3/4	1	1 1/4	1 1/2	2	2 1/2
INSERT COUPLING	PLASTIC	3	3	3	3	3	3	3
THREADED ADAPTER PLASTIC OR COPPER TO THREAD	COPPER PLASTIC	1 3	1 3	1 3	1 3	1 3	1 3	1 3
90° STANDARD ELBOW	STEEL	2	3	3	4	4	5	8
	COPPER	2	3	3	4	4	5	8
	PLASTIC	4	5	8	7	8	9	10
STANDARD TEE FLOW THRU RUN	STEEL	1	2	2	3	3	4	5
	COPPER	1	2	2	3	3	4	5
	PLASTIC	4	4	4	5	6	7	8
STANDARD TEE FLOW THRU SIDE	STEEL	4	5	6	8	9	11	14
	COPPER	4	5	6	8	9	11	14
	PLASTIC	7	8	9	12	13	17	20
GATE VALVE	NOTE (2)	2	3	4	5	6	7	8
SWING CHECK VALVE	NOTE (2)	4	5	7	9	11	13	18

Table 7. Friction loss tables for fittings. Figures given are friction losses in terms of equivalent length (in feet) of straight pipe. Note: (1) Loss figures are based on equivalent lengths of indicated pipe material and (2) Loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

9-23-96

LCW Pump info

Pump 1531 AB
Model 1 1/2 BC 7 7/8
175 gpm 254 ft head 20 hp 3600 rpm
Ser. 1684523 F19

Motor 20hp 2ph 60hz
RPM 3490
ID C526A/TO8T170R060F
Frame A254JP
Type DI DP SF F15

Readings from historical data.

Supply	Return	GPM
117	18	160
115	18	180
118	16	155
116	16	175
116	18	175
112	17	175

3500 RPM PUMP CURVES

** Limited to 60HP ODP or 50HP TEFC at 3550 RPM FR#326JP.

Table 10.1: Electrical System Parameters		
Parameter	PS Tap 30 V, 5000 A	PS Tap 15 V, 5000 A
Nominal Operating Current	5000 A	Same
Maximum Allowable dI/dt	≤ 720 A/min	Same
Maximum Dump Voltage	250 V	Same
Maximum Insulation Test Voltage to ground (1 min)	1250 V DC	Same
Magnet Stored Energy	5.6 MJ	Same
Circuit Inductance	0.53 H	Same
Circuit Resistance (CH)	2.3×10^{-3}	Same
Circuit Resistance (AH)	1.5×10^{-3}	Same
CH(AH) Slow Dump Time Constant	230 (353) seconds	Same
CH(AH) Fast Dump Time Constant	10.5 (10.7) seconds	Same
Charging Time	7 minutes	Same
CH(AH) Slow Dump Time	20 (25) minutes	Same
Fast Dump Time	50 seconds	Same
DC Current Reversing Time	37 minutes	Same
Power Supply		
Max Voltage	34	17
Current Regulation	≤ 100 ppm at > 1000 A _{dc}	Same
External Reference	≤ 5 ppm/ $^{\circ}$ C, ≥ 16 bit	Same
	0-10 V dc, 500 A/v	Same
CH(AH) Operating DC Voltage	≈ 8 (12) V	Same
Output Ripple P to P	≈ 5.6 V	≈ 2.2 V
AC Input	480 V, 3 ϕ , 240 A, 60 Hz	Same Except 120 A
Input Power Factor	0.3 (0.2)	0.6 (0.4)
Ripple Filter Chokes	$2 \times 230 \mu\text{H}$	Same
	$2 \times 0.38 \times 10^{-3}$	Same
CH (AH) Bus	5000 A, 3.8 cm nom. Cu pipe	Same
	1.5×10^{-3} (0.7×10^{-3})	Same
	91 (43) m	Same
Protection Resistor	48×10^{-3}	Same
	120 kg	
	$\Delta T \approx 100^{\circ}\text{C}$ at 5.6 MJ	
Dump Switch	5000 A Contactor	Same

Table 10.1: Electrical System Parameters, cont.		
Parameter	PS Tap 30 V, 5000 A	PS Tap 15 V, 5000 A
Reversing Switch	5000 A Mechanical	Same
Overvoltage Crowbar	300 V, 5000 A peak	Same
Cooling Water		Same
Resistivity	$\geq 3 \text{ M}\Omega\text{cm}$, LCW	
Power Supply	19 l/s, $\Delta P = 690 \text{ kPa}$	
Chokes Each	4 l/s, $\Delta P = 690 \text{ kPa}$	
Bus at 40°C Rise	15 (8) l/s	
Over Temperature Protection	80°C	Same
Losses	69 kW Total	Same
Power Supply	12 kW	Same
Chokes	19 kW	Same
Bus	38 (18) kW	Same

Viscosity of Water and Liquid Petroleum Products^{8, 12, 23}

1. Ethane (C_2H_6)
2. Propane (C_3H_8)
3. Butane (C_4H_{10})
4. Natural Gasoline
5. Gasoline
6. Water
7. Kerosene
8. Distillate
9. 48 Deg. API Crude
10. 40 Deg. API Crude
11. 35.6 Deg. API Crude
12. 32.6 Deg. API Crude
13. Salt Creek Crude
14. Fuel 3 (Max.)
15. Fuel 5 (Min.)
16. SAE 10 Lube (100 V.I.)
17. SAE 30 Lube (100 V.I.)
18. Fuel 5 (Max.) or Fuel 6 (Min.)
19. SAE 70 Lube (100 V.I.)
20. Bunker C Fuel (Max.) and M.C. Residuum
21. Asphalt

Data extracted in part
by permission from the
Oil and Gas Journal.

Physical Properties of Water

Temperature of Water <i>t</i> Degrees Fahrenheit	Saturation Pressure <i>P'</i> Pounds per Square Inch Absolute	Specific Volume <i>V</i> Cubic Feet Per Pound	Weight Density <i>ρ</i> Pounds per Cubic Foot	Weight Pounds Per Gallon
32	0.08859	0.016022	62.414	8.3436
40	0.12163	0.016019	62.426	8.3451
50	0.17796	0.016023	62.410	8.3430
60	0.25611	0.016033	62.371	8.3378
70	0.36292	0.016050	62.305	8.3290
80	0.50683	0.016072	62.220	8.3176
90	0.69813	0.016099	62.116	8.3037
100	0.94924	0.016130	61.996	8.2877
110	1.2750	0.016165	61.862	8.2698
120	1.6927	0.016204	61.7132	8.2498
130	2.2230	0.016247	61.550	8.2280
140	2.8892	0.016293	61.376	8.2048
150	3.7184	0.016343	61.188	8.1797
160	4.7414	0.016395	60.994	8.1537
170	5.9926	0.016451	60.787	8.1260
180	7.5110	0.016510	60.569	8.0969
190	9.340	0.016572	60.343	8.0667
200	11.526	0.016637	60.107	8.0351
210	14.123	0.016705	59.862	8.0024
212	14.696	0.016719	59.812	7.9957
220	17.186	0.016775	59.613	7.9690
240	24.968	0.016926	59.081	7.8979
260	35.427	0.017089	58.517	7.8226
280	49.200	0.017264	57.924	7.7433
300	67.005	0.01745	57.307	7.6608
350	134.604	0.01799	55.586	7.4308
400	247.259	0.01864	53.648	7.1717
450	422.55	0.01943	51.467	6.8801
500	680.86	0.02043	48.948	6.5433
550	1045.43	0.02176	45.956	6.1434
600	1543.2	0.02364	42.301	5.6548
650	2208.4	0.02674	37.397	4.9993
700	3094.3	0.03662	27.307	3.6505

Specific gravity of water at 60°F = 1.00

Weight per gallon is based on 7.48052 gallons per cubic foot.

All data on volume and pressure are abstracted from ASME Steam Tables (1967), with permission of publisher, The American Society of Mechanical Engineers, New York, N. Y.

C₂H₆ = Et
C₃H₈ = Pr
C₄H₁₀ = B

Exempl
of an oi
specific

Aceton
Ammon
Benzene
Brine
Brine
Bunk
Carbon
Distill
Fuel 3
Fuel 5
Fuel 5
Fuel 5
Fuel 6
Gas
Ga
Ker
M. C.

f_T - flow in the zone of turbulence

"K" FACTOR TABLE—SHEET 1 of 4

Representative Resistance Coefficients (K) for Valves and Fittings

("K" is based on use of schedule pipe as listed on page 2-10)

**PIPE FRICTION DATA FOR CLEAN COMMERCIAL STEEL PIPE
WITH FLOW IN ZONE OF COMPLETE TURBULENCE**

Nominal Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2, 3"	4"	5"	6"	8-10"	12-16"	18-24"
Friction Factor (<i>f_T</i>)	.027	.025	.023	.022	.021	.019	.018	.017	.016	.015	.014	.013	.012

DeZURIK® SERIES 400 ECCENTRIC VALVES

design and construction

DeZURIK Series 400 Eccentric Valves combine proven design and quality construction to provide dependable long life for a variety of applications.

1. Corrosion resistant plug

1. Plug materials resist corrosion and prolong seat life. Available materials are as follows:

Bronze (½"-2" only)

Electroless nickel plated cast iron (2½"-4" valves only).

2. Double-seal for tight shutoff and safety A resilient seal molded into a groove in the plug face assures dead-tight shutoff on liquids and gases without the use of sealing lubricants. When the plug is closed, the resilient seal is compressed against the seat. The metal on the plug face also makes contact with the metal seat to provide a second seal for safety. Gas industry fire tests showed that this second metal seal provides nearly bubble-tight shutoff with the resilient seal burned away.

3. O-Ring stem seal

3. A variety of stem seal materials provides maintenance-free sealing that matches valve performance and assures long life and reliability.

4. Corrosion resistant bearings

4. Permanently lubricated bearings in the upper and lower plug journals resist corrosion and assure easy operation without lubrication. And, operation is just as easy whether the valve is operated once a day or once a year.

5. Corrosion resistant seal

5. A plastic seat coating provides extra corrosion resistance to minimize plug wear.

6. Meets ANSI 125 lb. standard

6. Body walls and end connections conform to all applicable ANSI 125 pound standards. Valves meet MSS standards in ½" and ¾" sizes where ANSI standards are not available.

7. Choice of end connections

7. A complete choice of end connections includes screwed, flanged, Dresser and Victaulic. A complete listing of availability for each valve size and FIG number is shown in the ordering section.

valve sizing and ratings

Sizes ½"-4" — DeZURIK Series 400 Eccentric Valves are available in 9 sizes from ½"-4". Other DeZURIK lines, including ½"-72" Series 100 Eccentric and 2"-36" Butterfly Valves, are available to meet your larger valve requirements.

Compact Size, Light in Weight — Small body size makes this valve ideal for applications where space is limited. Dimensions of this compact line are shown on the back page. Light weight minimizes the need for pipe supports. Weights are shown in the dimension table.

Single Valve Balancing and Shutoff for Air Conditioning Applications — The optional FIG 487 Adjustable Memory Stop provides both balancing and shutoff in one valve. With the memory stop locked in place, except when equipped with an attached lever actuator, the valve can be closed and then reopened to the same balanced position. Included with the memory stop, as shown on page 4, is a drip cap to reduce dripping from sweating valves on chilled water applications.

Ideal for Combined Hot and Chilled Water Service — DeZURIK High Temp (Isobutene-Isoprene) plug seals make the Series 400 Eccentric ideal for combined hot and chilled water heating and cooling systems. This compound is suitable for water service at temperatures up to 250 degrees F.

U.L. Listed—DeZURIK FIG 425 valves with RS 49 and RS 51 plug seals are listed by Underwriters Laboratories, Inc., for a variety of applications including: manual burner shutoff of city gas supplied by public utilities; fuel oils; compressed gas line shutoff; and miscellaneous valves for general use in air and water piping for fire protection equipment. Write DeZURIK for a copy of the complete U.L. listing.

High Flow Capacity — Large port areas and straight through flow provide high flow capacity. Cv values are shown below. Figures are based on discharge into conduit rather than atmosphere and are an average between valves with screwed and flanged ends. CV's are slightly higher for flanged valves and slightly lower for screwed valves.

VALVE SIZE	Cv VALUES—WIDE OPEN (Flow in GPM of Water at 1 psi pressure drop)
½"	9
¾"	22
1"	35
1¼"	54
1½"	78
2"	135
2½"	180
3"	270
4"	500

Pressure Ratings — DeZURIK Series 400 Eccentric Valves with standard cast iron bodies have a W.O.G. non-shock working pressure rating of 175 psi.

Series 400 Eccentric Valves provide dead-tight shutoff on liquids or gasses at pressure differentials up to the maximums shown below:

Valve Size	Maximum Shutoff Differential		
	Actuator	Forward*	Reverse**
½"-3"	All Actuators	175 psi	75 psi
4"	Lever	175 psi	75 psi
	FIG 600 Cylinder	175 psi	175 psi

*Pressure against the back of the plug tending to push the plug into the seat.

**Pressure against the face of the plug tending to push the plug away from the seat.

OPEN

DeZURIK eccentric action and resilient seating assure lasting dead-tight shutoff. As the eccentric plug rotates 90 degrees from open to closed, it moves into a raised eccentric seat.

In the open position, flow is straight through and flow capacity is high.

CLOSING

As the plug closes, it moves toward the seat without scraping the seat or body walls so there is no plug binding or wear. Flow is still straight through making the throttling characteristic of this valve ideal for manual throttling of gases and liquids.

CLOSED

In the closed position, the plug makes contact with the seat. The resilient plug seal is pressed firmly into the seat for dead-tight shutoff. Eccentric plug and seat design assure lasting shutoff because the plug continues to move into the seat until firm contact and seal is made.

materials and ordering

To order, give the complete valve identification by specifying the ordering code for each item as shown below. An ordering example is shown at the bottom of the page.

VALVE SIZE

Give Size Code as follows:

0050 = 1/2"
0075 = 3/4"
0100 = 1"
0125 = 1 1/4"
0150 = 1 1/2"
0200 = 2"
0250 = 2 1/2"
0300 = 3"
0400 = 4"

FIGURE NUMBER (Material)

Give "FIG" and number that follows:

FIG 425 = Cast Iron Body
Bronze Plug (1/2"-2")
Electroless Nickel Plated
Cast Iron Plug (2 1/2"-4")
Bronze Bearings
FIG 499 = Air Conditioning
Balancing Valve
Cast Iron Body
Bronze Plug (1/2"-2")
Electroless Nickel Plated
Cast Iron Plug (2 1/2"-4")
Bronze Bearings
Same as FIG 425 except
with FIG 487 stop ring,
drip cap and 1/4" tap on
seat end of valve.

END STYLE

Give end style code as shown below. Description gives availability by FIG number and size.

S = SCREWED. Both FIG numbers — All Sizes.
F = FLANGES. Both FIG numbers — 2" - 4" only.
D = DRESSER - STANDARD AND LOCKING.
FIG 425 only in sizes 3/4"-4". 3/4"-2" valves are machined for Dresser style 90 ends. 2 1/2"-4" are machined for Dresser style 38 ends. Dresser fittings are not included with the valve and must be ordered separately as shown on page 5.
DI = DRESSER INSULATING. FIG 425 only in sizes 3/4"-4". Insulating end prevents electric flow along pipe. Dresser insulating valves have the end opposite the seat only machined for Dresser insulating fittings. The seat end of the valve is machined for Dresser standard fittings. Dresser fittings are not included with the valve and must be ordered separately as shown on page 5.
V = VICTAULIC. FIG 425 only in sizes 3/4"-4". Victaulic fittings are not included with the valve and must be ordered separately. To order fittings, specify requirements.

STEM SEAL

Give stem seal code as shown below:

- 1 = Nitrile-Butadiene (BUNA) Use with RS49, RS50 and RS51 resilient plug seals.
- 2 = Fluorinated Hydrocarbon (VITON) Use with RS54 resilient plug seal.
- 3 = Isobutene Isoprene (HIGH TEMP) Use with RS55 resilient plug seal.

RESILIENT PLUG SEAL

Give "RS" and number that follows. The service recommendations below are general classifications only. For specific recommendations, see DeZURIK Rubber Recommendations 60.00-2 or contact DeZURIK.

RS49 = Carboxylic-Nitrile-Butadiene (HYCAR)—A general service compound recommended for chemicals, natural gas, dry service and non-alkaline applications to 180°F.

RS50 = Chloroprene (NEOPRENE)—A general service compound recommended for alkaline applications to 180°F.

RS51 = Nitrile-Butadiene (PETROLEUM HYCAR)—For manufactured gas and for petroleum applications at temperatures to 180°F. Can also be used for natural gas.

RS54 = Fluorinated Hydrocarbon (Fluoroelastomer)—For high temperature chemicals to 300°F.

RS55 = Isobutene-Isoprene (HIGH TEMP)—For high temperature water to 250°F.

ACTUATORS AND ACCESSORIES

All valves are furnished for lever actuation as standard. Levers are not mounted on the valve and must be ordered separately. To order, see FIG 483 on page 5. All valves can be furnished with on-off cylinder actuators as shown on page 5.

Accessories are also shown on page 5.

RS55,

FIG 487.

actuators and accessories

1. FIG 483 lever—Order as a separate item by giving "FIG 483" followed by valve size code (0100 = 1", 0200 = 2", etc.). Note: FIG 487 Memory Stop cannot be used with the FIG 483 lever.

ORDERING EXAMPLE: FIG 483, 0200.

2. FIG 600 on-off pneumatic cylinder actuator—Double-acting cylinder requires 60 psi supply. Order as a separate item by giving "FIG 600" followed by valve size code (0100 = 1", 0200 = 2", etc.).

ORDERING EXAMPLE: FIG 600, 0200.

FIG 601 solenoid actuator

actuator—Order as a separate item by giving "FIG 601" followed by valve size code (0100 = 1", 0200 = 2", etc.), and solenoid identification number shown below.

SOLENOID NUMBER	SOLENOID SIZE	CURRENT
FIG 601, 450 =	1"	110 volts, 60 Hz
FIG 601, 451 =	2"	220 volts, 60 Hz

ORDERING EXAMPLE: FIG 601, 0200, 450.

3. FIG 487 adjustable memory stop and plastic drip cap—if ordered with valve, add "FIG 487" to valve description.

ORDERING EXAMPLE: 0200, FIG 425, S, 3, RS55, FIG 487.

If ordered separately, give "FIG 487" followed by valve size code (0100 = 1", 0200 = 2", etc.).

ORDERING EXAMPLE: FIG 487, 0200.

1/8" Gage tap—In upstream or seat end of valve. To order, add description and tap location to valve identification

ORDERING EXAMPLE: 0200, FIG 425, S, 3, RS55, with 1/8" tap on seat end of valve.

FIG 630 dresser and accessories—

Order as a separate item by giving "FIG 630" followed by valve size code (0100 = 1", 0200 = 2", etc.) and Dresser End Code shown below.

Accessories for 3/4"-2" are Dresser Style 90 with bonderized follower nuts. Accessories for 2 1/2"-4" are Dresser Style 38 with bolted couplings.

1 = Standard. With armored grade 27 gaskets. Brass coil in the gasket protects rubber and makes a positive electrical contact between valve and pipe.

2 = Locking. With steel balls in gaskets to prevent pipe from pulling out of valve.

3 = Insulating. Prevents electric current flow along pipe. Valves with Dresser Insulating ends have the end opposite the seat only machined for Dresser Insulating accessories. The seat end is machined for Dresser Standard accessories.

ORDERING EXAMPLE: FIG 630, 0200, 1.

dimensions

VALVE SIZE Inches (mm)	DIMENSIONS (Inches/mm)															VALVE WEIGHTS*		LEVER WEIGHTS (lbs/kg)
	A	B	F	G	H	J	K	L	N	P	Q	R	V	SCREWED	FLANGED			
1/2 (13)	4.00	3.50	.50	.81	2.03	1.25	3.25	.38	4.25	—	4.56	1.25	2.13	1.75	4.00	75		
	101.6	88.9	12.7	20.6	51.6	31.8	82.6	9.7	108.0	—	115.8	31.8	35.8	79	1.81	34		
3/4 (19)	4.00	3.63	.50	.81	2.16	1.44	3.75	.41	4.63	4.31	4.81	1.41	2.28	2.50	4.50	75		
	101.6	92.2	12.7	20.6	54.9	36.6	95.3	10.4	117.6	109.5	122.3	35.8	57.9	1.13	2.04	34		
1 (25)	5.00	4.00	.50	1.13	2.47	1.69	4.25	.44	5.00	4.63	5.25	1.63	2.81	3.75	6.75	100		
	127.0	101.6	12.7	28.7	62.7	42.9	108.0	11.2	127.0	117.6	133.4	41.4	71.4	1.70	3.06	45		
1 1/4 (32)	5.00	4.25	.50	1.13	2.72	1.88	4.75	.50	5.50	5.00	6.00	1.88	3.00	5.25	8.25	100		
	127.0	108.0	12.7	28.7	69.1	47.8	120.7	12.7	139.7	127.0	152.4	47.8	76.2	2.38	3.74	45		
1 1/2 (38)	6.00	4.38	.50	1.13	2.81	2.00	5.00	.56	6.50	5.25	6.50	2.00	3.19	6.25	11.00	100		
	152.4	111.3	12.7	28.7	71.4	50.8	127.0	14.2	165.1	133.4	165.1	50.8	81.0	2.83	4.99	45		
2 (50)	6.00	4.75	.50	1.13	3.16	2.31	5.50	.63	7.00	6.63	7.38	2.25	3.47	9.00	15.25	100		
	152.4	120.7	12.7	28.7	80.3	58.7	139.7	16.0	177.8	168.4	187.5	57.2	88.1	4.05	6.92	45		
2 1/4 (64)	8.00	5.50	.50	1.63	3.94	2.88	6.88	.69	7.50	6.50	8.75	2.50	4.19	15.00	24.00	200		
	203.2	139.7	12.7	41.4	100.1	73.2	174.8	17.5	190.5	165.1	222.3	63.5	106.4	6.80	10.89	90		
3 (75)	10.00	5.75	1.44	1.44	4.66	3.25	7.50	.75	8.00	7.13	9.50	2.50	4.69	22.00	32.00	225		
	254.0	146.1	36.6	36.6	118.4	82.3	190.5	19.1	203.2	181.1	241.3	63.5	119.1	9.98	14.51	102		
4 (100)	12.00	6.88	1.59	1.59	5.94	4.25	9.25	.94	9.00	8.81	10.00	2.50	6.00	47.00	61.00	400		
	304.8	174.8	40.4	40.4	150.9	108.0	235.0	23.9	228.6	223.8	254.0	63.5	152.4	21.32	27.67	181		

L—cast iron flanges

F—width of plug operating nut

V—dimension from valve centerline to top of optional drip cap

Q—length of dresser end valve body only (extra length for dresser accessories not included)

R—slab depth of pipe into dresser and valve body

P—length of victaulic and valve body only (extra length for victaulic accessories not included)

*weights are for FIG 425 only

†—on 3" and 4" valves, this plug square is rotated 45° from the open position as shown

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