

REGULATOR SIZING

DEFINITIONS RELATING TO REGULATOR CAPACITY

The capacities contained in this bulletin are based on a specific level of performance by the regulator. The measure of performance is accuracy of regulation, also known as offset or deviation. Each table is appended with a footnote indicating the accuracy of regulation obtainable at the rated capacities listed.

Pertinent terms involved in the determination of accuracy of regulation and rated capacity are defined as follows:

* **CONTROLLED VARIABLE** is the variable which shall be monitored by the controlling process. This variable is either the outlet pressure or the differential pressure.

* **MINIMUM CONTROLLED FLOW** is the lowest flow rate, at a given set point and temperature, at which a steady regulated condition of the controlled variable can be maintained. For some regulators, minimum controllable flow is essentially zero. It is used to determine turndown or rangeability.

* **SET POINT** is the regulator adjustment corresponding to the desired value of the controlled variable.

* **RATED CAPACITY** is the rate of flow obtainable through a regulator, for specified inlet and outlet conditions and fluid, as a specified offset or accuracy of regulation.

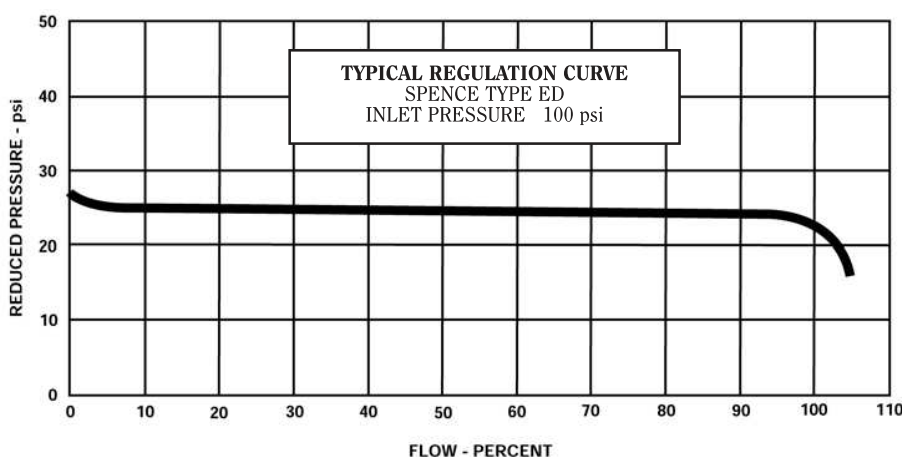
* **ACCURACY OF REGULATION** is the deviation from the set point, expressed as a percentage or as a fixed unit, taken at the test conditions.

* **LOCK-UP** or dead-end shutoff, is the deviation of the controlled variable from set point obtained at a no-flow condition.

* Adapted from "Definitions of Regulator Capacities", Standard No. ANSI/FCI 99-2, published by Fluid Controls Institute, Inc.

TYPICAL REGULATION CURVE

The performance characteristic of a Spence Pressure Regulator is shown above. Using this curve to illustrate several terms of reference, the following facts are evident:



REGULATED VARIABLE REDUCED PRESSURE

Minimum Controlled Flow	4%
Set Point	25.0
Reduced Pressure at Rated (100%) Flow ...	22.5 psi
Accuracy of Regulation, psi	2.5 psi
Accuracy of Regulation, % of set pressure	10%

The slight slope of the curve establishes a definite relationship between flow and regulated pressure. Note that 1 psi accuracy of regulation is obtainable at 95% of rated flow.

For back pressure regulation, or differential where the regulator opens on increasing differential, the characteristic curve would lie opposite to that shown. It would slope upward with flow increase because a positive deviation is required to cancel valve opening.

NOTES ON USE OF TABLES

The lowest reduced pressures are approximate critical pressures. No appreciable increase in flow can be obtained at lower pressures.

Downstream pipe size should be enlarged at regulator outlet to approximately equalize pipe velocities before and after the

reduction. The Steam Capacity Tables are useful for determining steam pipe sizes and regulator size at any desired lower velocity level.

Reduced Seats—Spence Regulators are available with a choice of seat sizes called Full and Normal Ports. There is a capacity table for each port with standard plugs. The Cv Valve Coefficients shown on the back page, indicate where 75% and 50% parabolic plugs are available. For a given pressure drop, rated flows with various ports and plugs in the same size body may be compared. Thus, valve and port size may be selected to limit velocities entering and leaving the regulator. Lower velocities mean a greater proportion of the pressure drop occurs at the valve seat, where it belongs, rather than in the body outlet and connected piping.

Capacity ratings apply to Spence Regulators with Type D, N and Q Pilots which are spring loaded and have 3½ inch diaphragms. Other pilots having greater or lesser sensitivity will provide proportionally greater or less accuracy of regulation.

PLANNING MAIN VALVE INSTALLATION

A. PLANNING THE INSTALLATION

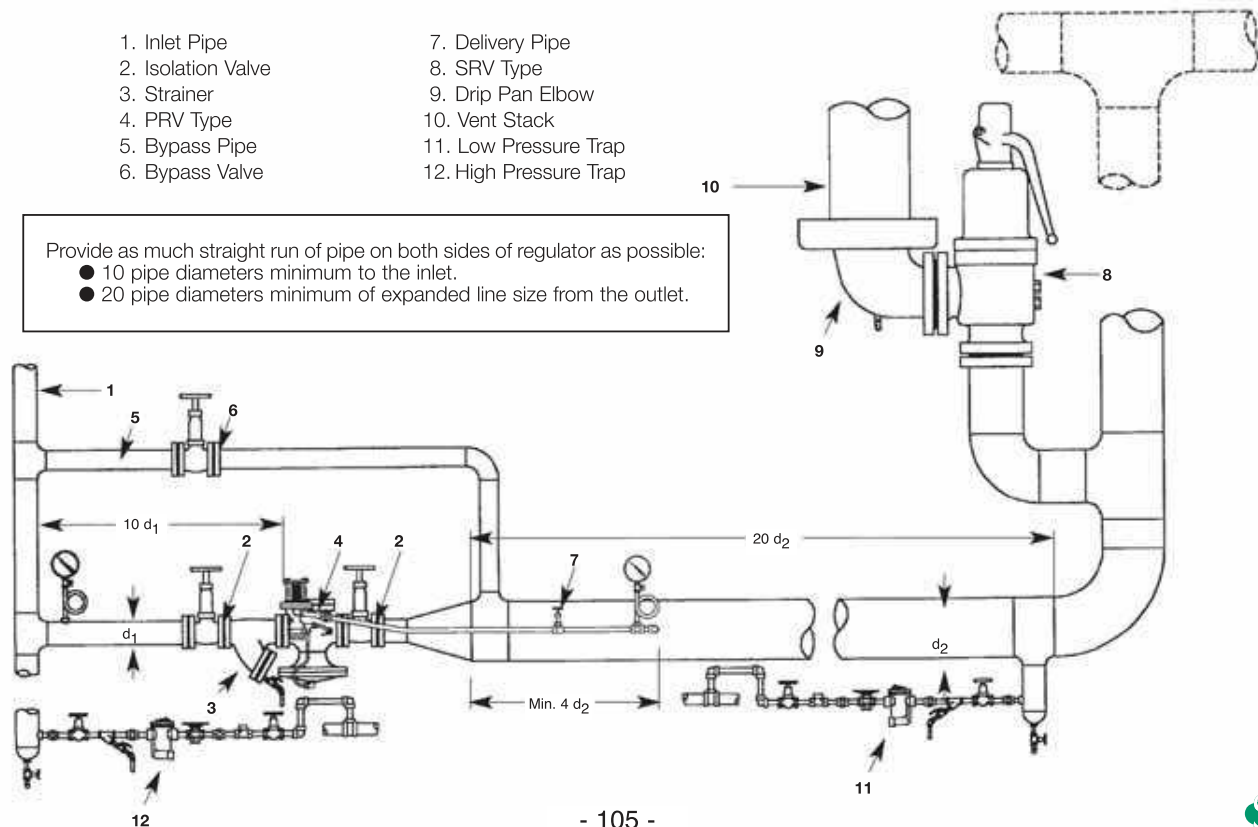
1. Locate the valve in a straight run of horizontal pipe. See Fig. 1.
2. Allow headroom above the valve for access through the blind flange. Provide clearance for stem withdrawal underneath.
3. Prevent water hammer and erratic operation by installing traps to provide proper drainage before and after the valve, and before secondary PRV or control valve.
4. Avoid damaging affects of scale and dirt in pipe lines by using a strainer as shown in Fig. 1.
5. Provide a 3-valve by-pass to facilitate inspection without interrupting service.
6. To eliminate excessive noise and erratic regulation with steam and other compressible fluids enlarge the delivery pipe size to effect a reasonable flow velocity at the reduced pressure. A tapered transition is recommended. If possible, avoid a sharp turn close to the regulator outlet and a bull-headed tee connection to the low pressure main.
7. Install initial and delivery pressure gauges to indicate performance. If the pressure rating of the delivery system or connected equipment is less than the initial steam pressure, provide a safety valve.

B. CONTROL PIPE

1. Use 1/4" pipe for this line which connects the pilot diaphragm chamber to the desired point of pressure control. See Fig. 1.
2. Take the control at a point of minimum turbulence. Avoid control immediately at the valve outlet or after a turn. When the delivery pipe expands in size select a spot at least 4 pipe diameters beyond the point of enlargement.
3. Pitch away from pilot to avoid erratic operation and fouling. Eliminate water pockets.
4. Locate delivery pressure gauge in control pipe to show pressure actually reaching pilot diaphragm.

C. DESIGN GUIDELINES TO MINIMIZE NOISE

1. Size the regulator to provide a maximum inlet velocity of about 10,000 FPM.
2. Determine the regulator outlet velocity, if it would exceed 30,000 FPM, use a Spence muffling orifice or a second stage regulator.
3. Expand regulator outlet piping to limit discharge line velocity to about 10,000 FPM.
4. Avoid abrupt changes in pipe size. Limit pipe diameter changes to two pipe sizes per stage of expansion. Do not use eccentric reducers.
5. Directional changes in downstream piping should be made only after the line size has been increased. Use long radius fittings; avoid bull-head tee connection.
6. Provide as much straight run of pipe on both sides of regulator as possible:
 - a - 10 pipe diameters minimum to the inlet.
 - b - 20 pipe diameters minimum of expanded line size from the outlet.
7. Size all piping components, including strainer and stop valves for a maximum flow velocity of about 10,000 FPM (Exception: An outlet stop valve mounted at the regulator outlet should be equal in size to the regulator). In areas where low sound levels are specified, reduce this limit by 25% to 50%.
8. To limit noise transmission through the building's structure, keep the regulator and piping at least 3 feet away from solid surfaces. Use sound-isolating piping supports.
9. Apply high density insulation to the regulator body, piping and system components. Insulation reduces heat loss significantly and can provide moderate (3-6 dB) local noise attenuation.
10. Use a Spence noise suppressor to reduce the propagation of noise via the downstream piping.



RULES FOR MAIN VALVE SELECTION

When you select a Main Valve, your sizing can be based on one of three methods. They are:

ECONOMICAL MAIN VALVE

Economical Main Valve Selection is choosing a regulator that has the line size and rough capacity to handle the load. No consideration is given to velocities or noise. If you are interested in an economical selection, select a regulator type for your application, then go to the Capacity Tables and select the size that will provide you with the capacity needed.

ENGINEERED MAIN VALVE

Engineered Main Valve Selection takes into consideration the inlet and outlet velocities of the regulator. It will limit these velocities to acceptable standards. See Pressure Reducing Station Design Guidelines on the following pages for details. If you are interested in an engineered selection, select a regulator

type for your application, and then to the Capacity Tables and select the size that will provide you with the capacity needed. Verify that the velocities fall within the guidelines by consulting the Velocity Charts in this Section.

ENGINEERED MAIN VALVE WITH NOISE SUPPRESSION

Engineered Main Valve Selection with Noise Suppression considers both velocity and noise suppression in the selection of the regulator. For this selection, it is recommended that you contact your local Spence Technical Sales Representative who can provide you with a computer generated solution.

SELECTING A REGULATOR TYPE

The following rules should be used to help you to determine the type of regulator that you should use. You should consult the Product Pages, Velocity Tables and Capacity Tables for additional information on your selection.

RULES FOR MAIN VALVE SELECTION—STEAM SERVICE

Together with the following rules, reference should be made to the Main Valve Specification Table or individual Product Pages for maximum initial pressures and temperatures and “minimum differentials” for the several types of Main Valve. For pressure reduction where fast response time is important, but capacity and accuracy are not critical, select **D50 DIRECT OPERATED REGULATOR**.

EITHER DEAD-END OR CONTINUOUS FLOW SERVICE

RULE 1. For Initial Pressures exceeding 15 psi:

- (a) **TYPE E** – Select when the Delivery Pressure is less than 75% of Initial Pressure. For Differential Pressures of 15-50 psi, specify optional LP Spring (10 psi minimum Differential Pressure is attainable by adding optional fittings).

- (b) **TYPE E5** – Select when the Delivery Pressure is 75% to 96% of Initial Pressure.

RULE 2. For Initial Pressures less than 15 psi:

- (a) **TYPE E2** – Select when Initial Pressure is less than 15 psi.

RULES FOR MAIN VALVE SELECTION—AIR SERVICE

Together with the following rules, reference should be made to the Main Valve Specification Table or individual Product Pages for maximum initial pressures and temperatures and “minimum differentials” for the several types of Main Valve. For pressure reduction where fast response time is important, but capacity and accuracy are not critical, select **D50 DIRECT OPERATED REGULATOR**.

EITHER DEAD-END OR CONTINUOUS FLOW SERVICE

RULE 1. For Initial Pressures exceeding 15 psi:

- (a) **TYPE E** – Select when the Delivery Pressure is less than 75% of Initial Pressure. For Differential Pressures of 15-50 psi, specify optional LP Spring (10 psi minimum Differential Pressure is attainable by adding optional fittings).

- (b) **TYPE E6** – Select when the Delivery Pressure is 75% to 93% of Initial Pressure.

- (c) **TYPE E5** – Select when the Delivery Pressure is 93% to 96% of Initial Pressure.

RULE 2. For Initial Pressures less than 15 psi:

- (a) **TYPE E2** – Select when Initial Pressure is less than 15 psi.

RULES FOR MAIN VALVE SELECTION—WATER SERVICE

Pilot Operated Regulators are not uniformly successful in liquid pressure reducing service unless the delivery system has unusual cushioning such as afforded by an elevated tank or large air chamber.

WATER PRESSURE REDUCING VALVES

The **TYPE D34 DIRECT OPERATED VALVE** was developed for application on rapidly changing and intermittent flow to an inflexible system.

RULE 1. Select **TYPE D34 DIRECT OPERATED VALVE** for pressure reducing service.

FOR PILOT OPERATED WATER REGULATORS

When a pilot operated regulator is required the following rules for the selection of a main valve govern:

RULE 2. When pressure drop across valve exceeds 10 psi:

- (a) **TYPE C34** -Select for all normal requirements.

- (b) **TYPE E6** with Dashpot-Select where high lift is desired or special flow requirements encountered.

RULE 3. When pressure drop across valve is between 5 and 10 psi:

- (a) **TYPE E5** - Select for pressure drops not less than 5 psi.
- (b) **TYPE E6** with Dashpot-Select if auxiliary operation is possible.

Together with the above rules, reference should be made to the Main Valve Specification Table for maximum initial pressures and temperatures and “minimum differentials” for the several types of Main Valves.

VALVE SIZING BY COMPUTATION

FORMULA KEY

A = Area of Pipe in (inches)²
 C_v = Valve Coefficient
 EDR = Equivalent Direct Radiation (Sq. Ft.)
 F = Pipe Area Factor (see Pipe Factors Table)
 ft = Feet
 G = Specific Gravity
 ΔP = Pressure Drop, $P_1 - P_2$ psi
 P_1 = Inlet Pressure, psia (psi + 14.7)
 P_2 = Reduced Pressure, psia (psi + 14.7)
 P_c = Pressure at Thermodynamic Critical Point, psia (water = 3206 psia)
 P_v = Vapor Pressure, psia

$\Delta P_s = P_1 - P_v$ when $P_2 > P_v$
 $\Delta P_s = P_1 - (.96 - .28 \sqrt{\frac{P_v}{P_c}}) P_v$ when $P_2 \leq P_v$
 q = Liquid Flow Rate, U.S. gpm
 Q = Flow Rate, SCFH
 T = Absolute T ($T + 460$)°R
 T_{SH} = Steam Superheat (°F) =
 Total Steam Temp. - Saturated Steam Temp.
 \bar{v} = Specific Volume $ft^3/\#$
 V = Velocity, FPM
 W = Steam Flow, #/Hr.
 W_s = Flow, #/Hr. Superheated Steam

To avoid interpolation or solve problems beyond the scope of the table, valve sizes may be determined by calculation as follows:

C_v

SUBCRITICAL

CRITICAL

SATURATED STEAM:

$$C_v = \frac{W}{2.1 \sqrt{\Delta P (P_1 + P_2)}} \quad P_2 > .58 P_1$$

$$C_v = \frac{W}{1.71 P_1} \quad P_2 \leq .58 P_1$$

SUPERHEATED STEAM:

$$C_v = \frac{W (1 + .0007 T_{SH})}{2.1 \sqrt{\Delta P (P_1 + P_2)}} \quad P_2 > .55 P_1$$

$$C_v = \frac{W (1 + .0007 T_{SH})}{1.75 P_1} \quad P_2 \leq .55 P_1$$

GAS:

$$C_v = \frac{Q}{963} \sqrt{\frac{GT}{\Delta P (P_1 + P_2)}} \quad P_2 > .5 P_1$$

$$C_v = \frac{Q \sqrt{GT}}{834 P_1} \quad P_2 \leq .5 P_1$$

LIQUID:

$$C_v = q \sqrt{\frac{G}{\Delta P}} \quad P_2 > P_1 - .85 \Delta P_s$$

$$C_v = .93q \sqrt{\frac{G}{\Delta P_s}} \quad P_2 \leq P_1 - .85 \Delta P_s$$

LOADS

WATER $W = \frac{GPM}{2} \times \text{Temp. Rise (°F)}$

FUEL OIL $W = \frac{GPM}{4} \times \text{Temp. Rise (°F)}$

AIR $W = \frac{CFM}{900} \times \text{Temp. Rise (°F)}$

RADIATION $W = \frac{f^2 EDR}{4}$

ABSORPTION $W = 16-20 \text{ \#/Hr./Ton-Hr.}$

STM. ATOM $W = 0.1 \text{ \#/Hr./\#Oil}$

VELOCITY

STEAM $V = 2.4 \frac{W \bar{v}}{A}$

FLOW

STEAM $W = \frac{.0433 \times V \times F}{v}$

AIR & GASES $Q = \frac{.0259 \times V \times F \times P_1}{T}$

LIQUIDS $q = .0054 \times V \times F$

PIPE FACTORS FOR STANDARD (SCHEDULE 40) PIPE

SIZE	FACTOR	SIZE	FACTOR
1/8	.55	3 1/2	95
1/4	1.0	4	122
3/8	1.8	5	192
1/2	2.9	6	278
3/4	5.1	8	481
1	8.3	10	758
1 1/4	14	12	1076
1 1/2	20	14	1301
2	32	16	1699
2 1/2	46	18	2151
3	71	20	2673

PRESSURE REDUCING STATION DESIGN GUIDELINES

I. SINGLE STAGE PRESSURE REGULATOR

1. When to use single stage regulator:
 - A. When load turndown requirement is generally no greater than 10:1.
 - B. When ratio of specific volume of steam, outlet to inlet, is no greater than 3 to 1.
 - C. When only one reduced steam pressure level is required.

II. PARALLEL PRESSURE REGULATORS

1. When to use parallel pressure regulator stations:
 - A. When maximum specified capacity requires selection of a pressure regulator greater than 12 inch pipe size. (It may be more economical to install two smaller valves than one very large one.)
 - B. When normal conditions require operation at 10% or less of specified maximum capacity for sustained periods.
 - C. When there are two distinct load requirements; i.e., summer/winter operation.
2. When to use a pneumatically operated parallel pressure regulator station:
 - A. When the combined accuracy of regulation of mechanically operated controls is unacceptable.
For Spence mechanically operated regulators normal sizing/selection results in accuracy of regulation of approximately 5% of set pressure. Combined accuracy of regulation of mechanically operated parallel installed regulators is approximately 10% of set pressure.
Pneumatically operated regulators equipped with reset maintain set point within 1% for all sustained flows.

III. TWO STAGE PRESSURE REGULATORS[†]

1. When to use two stage pressure regulator stations:

[†] Primary PRV requires optional base bypass and 1/8" bleedport.

- A. When intermediate steam pressure is required.
- B. When concerned with PRV generated noise, use two stage station when specific volume ratio, outlet to inlet, is greater than 3 to 1, unless manufacturer offers assurance or other means of meeting noise specification.
- C. When complying with Power Piping Code ANSI B31.1-1986, which reads, in part, "in district heating and steam distribution systems where the steam pressure does not exceed 400 psi (2758 kPa) and where the use of relief valves and vent piping are not feasible, two or more pressure reducing valves may be installed in series, each set at or below the safe working pressure of equipment served and no relief valve is required."

IV. TWO STAGE PARALLEL PRESSURE REGULATORS[†]

1. Whenever any condition from II and any condition from III applies.

SPACE CONSIDERATIONS FOR REDUCING STATIONS

1. Following are rules of thumb for approximating space requirements for installing reducing stations:
 - A. Single stage (with or without noise suppressors)
Inlet side: ten (10) diameters of PRV pipe size
Outlet side: twenty (20) diameters of final pipe size, where final pipe size is determined on the basis of 10,000 fpm line velocity.
 - B. Two stage
Inlet side of primary: ten (10) diameters of PRV pipe size.
Intermediate: twenty (20) diameters of secondary PRV pipe size.
Outlet side: twenty (20) diameters of final pipe size, where final pipe size is determined on the basis of 10,000 fpm line velocity.
 - C. Two stage with muffling orifice; same as A above.

PRESSURE REDUCING STATION GENERAL SPECIFICATION

A. Pressure Reducing Station shall consist of:

- pressure regulator
- inlet strainer
- inlet and outlet stop valves (gate type)
- by-pass valve (globe type)
- trap at inlet to pressure regulator
- pressure gauges on inlet and outlet of station
- pressure relief valve downstream of regulator

B. Stop valves and strainer shall be at least pressure regulator size

C. Expand pressure regulator outlet pipe size to obtain discharge line velocity which will not exceed:

Up to and including 2"	15,000 FPM
2 1/2" up to 8"	10,000 FPM
Above 8"	8,000 FPM

Regulator outlet velocity shall be limited to:

Up to and including 2"	45,000 FPM
2 1/2" up to 8"	30,000 FPM
Above 8"	24,000 FPM

D. Unions shall be used on either side of screwed end by-pass valve and pressure regulator to facilitate removal.

E. Pressure regulators 2-1/2" and larger shall have flanged ends and be suitable for pressure and temperature specified.

F. Limit pressure regulator inlet velocity to:

Up to and including 2"	15,000 FPM
2 1/2" thru 8"	10,000 FPM
Above 8"	8,000 FPM

G. Regulator sound pressure level while operating at specified maximum capacity shall not exceed 90 dbA as measured at a point three feet downstream and three feet from uninsulated pipe surface.

H. Pressure regulator capacity shall not be greater than 120 of specified maximum capacity.

I. For details of safety valve sizing and installation, please refer to the latest National Board Inspection Code and ANSI B31.1 Code.

REGULATOR Cv DATA

Valve Size	E				E2	E5,E6		C34	D	D34	D50	N6	Series 2000
	Normal 50%	Normal 75%	Normal	Full 50%	Full 75%	Full	Full						
1/4	—	—	—	—	—	—	—	—	.42	—	—	—	—
3/8	—	—	.66	—	—	—	—	—	1.05	—	—	—	—
1/2	—	—	1.55	1.7	2.2	2.8	—	—	1.05	—	2.2	—	4-5.22
3/4	—	—	4.8	2.6	4.2	5.4	7.6	5.7	—	—	3.3	7.1	6.85
1	—	—	7.5	6.3	7.2	8.8	11.7	10.0	—	5.5	4.9	13.3	9.15
1 1/4	—	—	10.4	7.4	11.1	14.1	18.9	13.4	—	12.5	5.0	22	14.3
1 1/2	—	—	14.6	11.3	15.9	19.8	27.4	19.8	—	17.3	10.1	32.5	15.1
2	—	—	17.6	17.7	22.9	31	44	25	—	24	10.8	51	17.2
2 1/2	14	18	24	25	27	44	68	35	—	36	—	88	—
3	26	34	43	42	56	74	96	59	—	53	—	—	—
4	46	62	78	65	88	109	143	120	—	86	—	—	—
5	65	89	115	94	136	169	202	176	—	139	—	—	—
6	83	110	151	139	188	248	255	228	—	196	—	—	—
8	139	187	249	252	353	444	462	366	—	—	—	—	—
10	230	294	377	400	558	706	748	525	—	—	—	—	—
12	363	463	631	631	880	1113	1118	952	—	—	—	—	—

75% AND 50% REDUCED TRIM (Parabolic)

The Parabolic Discs given in the above table are designed to:

- Improve performance at minimum flows by improving stability over wide flow ranges.
- Provide easy field conversion to obtain a substantial increase or decrease in regulator Cv to meet system load requirements.
- Facilitate selection of smaller size safety relief valves.
- Size more precisely to the required Cv, thereby eliminating one of the most frequent causes of poor performance.

SATURATED STEAM FLOW TABLE (LB/HR)

Based on Schedule 40 Pipe

SIZES 1/4" THROUGH 2"

VEL., FPM	45000	45000	45000	45000	45000	45000	45000	45000
PRESS. (PSIG)	REGULATOR or PIPE SIZE (inches)							
	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
-10	23	43	68	120	195	337	458	755
-5	51	93	148	260	422	730	994	1638
0	73	134	213	373	605	1046	1424	2348
5	97	178	284	498	807	1396	1900	3132
10	120	220	350	613	994	1720	2342	3860
15	142	260	415	728	1179	2041	2778	4579
20	164	301	479	841	1363	2359	3210	5292
25	186	341	543	953	1545	2673	3639	5998
30	208	381	607	1065	1726	2987	4065	6700
40	251	460	732	1285	2083	3605	4906	8087
50	293	538	857	1504	2437	4217	5740	9461
60	336	616	981	1721	2789	4827	6570	10829
70	377	692	1102	1934	3134	5424	7383	12170
80	420	770	1225	2150	3485	6031	8209	13531
90	461	846	1347	2364	3831	6630	9024	14874
100	503	922	1468	2577	4176	7228	9838	16216
125	607	1113	1771	3108	5037	8718	11866	19558
150	710	1302	2072	3636	5893	10198	13881	22879
175	813	1491	2374	4166	6752	11685	15905	26216
200	916	1680	2675	4694	7608	13166	17921	29539
250	1121	2057	3274	5746	9313	16118	21938	36160
300	1336	2452	3902	6848	11099	19209	26145	43094

SIZES 2 1/2" THROUGH 12"

VEL., FPM	30000	30000	30000	30000	30000	30000	24000	24000
PRESS. (PSIG)	REGULATOR or PIPE SIZE (inches)							
	2 1/2	3	4	5	6	8	10	12
-10	718	1109	1910	3002	4335	7507	9466	13437
-5	1558	2405	4142	6509	9399	16276	20524	29134
0	2233	3448	5938	9331	13475	23334	29424	41767
5	2979	4600	7922	12449	17978	31131	39256	55723
10	3671	5669	9762	15341	22154	38362	48374	68666
15	4356	6725	11581	18200	26283	45512	57390	81464
20	5033	7772	13383	21032	30372	52594	66320	94139
25	5705	8809	15170	23839	34426	59613	75171	106703
30	6373	9841	16947	26632	38459	66596	83977	119203
40	7692	11878	20454	32143	46418	80378	101355	143871
50	9000	13896	23929	37605	54305	94036	118578	168318
60	10301	15905	27389	43042	62156	107631	135722	192653
70	11576	17874	30779	48370	69851	120955	152523	216502
80	12870	19873	34221	53779	77662	134481	169579	240713
90	14148	21846	37619	59119	85373	147834	186417	264614
100	15424	23817	41012	64452	93074	161169	203233	288484
125	18603	28725	49465	77735	112256	194385	245117	347938
150	21763	33603	57865	90936	131319	227395	286743	407024
175	24936	38503	66303	104197	150470	260557	328560	466382
200	28097	43384	74708	117405	169544	293586	370208	525501
250	34395	53108	91453	143720	207545	359389	453186	643286
300	40991	63293	108992	171283	247348	428313	540098	766655

SATURATED STEAM FLOW TABLE (LB/HR)

Based on Schedule 40 Pipe

SATURATED STEAM
FLOW TABLE

SIZES 3/8" THROUGH 4"

VEL., FPM	15000	15000	15000	15000	15000	15000	15000	10000	10000	10000
PRESS. (PSIG)	REGULATOR or PIPE SIZE (inches)									
	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
-10	14	23	40	65	112	153	252	239	370	637
-5	31	49	87	141	243	331	546	519	802	1381
0	45	71	124	202	349	475	783	744	1149	1979
5	59	95	166	269	465	633	1044	993	1533	2641
10	73	117	204	331	573	781	1287	1224	1890	3254
15	87	138	243	393	680	926	1526	1452	2242	3860
20	100	160	280	454	786	1070	1764	1678	2591	4461
25	114	181	318	515	891	1213	1999	1902	2936	5057
30	127	202	355	575	996	1355	2233	2124	3280	5649
40	153	244	428	694	1202	1635	2696	2564	3959	6818
50	179	286	501	812	1406	1913	3154	3000	4632	7976
60	205	327	574	930	1609	2190	3610	3434	5302	9130
70	231	367	645	1045	1808	2461	4057	3859	5958	10260
80	257	408	717	1162	2010	2736	4510	4290	6624	11407
90	282	449	788	1277	2210	3008	4958	4716	7282	12540
100	307	489	859	1392	2409	3279	5405	5141	7939	13671
125	371	590	1036	1679	2906	3955	6519	6201	9575	16488
150	434	691	1212	1964	3399	4627	7626	7254	11201	19288
175	497	791	1389	2251	3895	5302	8739	8312	12834	22101
200	560	892	1565	2536	4389	5974	9846	9366	14461	24903
250	686	1091	1915	3104	5373	7313	12053	11465	17703	30484
300	817	1301	2283	3700	6403	8715	14365	13664	21098	36331
400	1065	1696	2976	4823	8347	11361	18725	17812	27502	47360
500	1326	2110	3703	6002	10387	14138	23303	22166	34225	58936
600	1591	2532	4444	7202	12464	16965	27963	26599	41070	70724

SIZES 5" THROUGH 24"

VEL., FPM	10000	10000	10000	8000	8000	8000	8000	8000	8000	8000
PRESS. (PSIG)	REGULATOR or PIPE SIZE (inches)									
	5	6	8	10	12	14	16	18	20	24
-10	1001	1445	2502	3155	4479	5413	7071	8951	11122	16087
-5	2170	3133	5425	6841	9711	11737	15332	19407	24115	34878
0	3110	4492	7778	9808	13922	16826	21980	27822	34572	50002
5	4150	5993	10377	13085	18574	22448	29325	37119	46124	66710
10	5114	7385	12787	16125	22889	27662	36136	45740	56836	82204
15	6067	8761	15171	19130	27155	32818	42871	54265	67430	97526
20	7011	10124	17531	22107	31380	37924	49542	62708	77921	112700
25	7946	11475	19871	25057	35568	42986	56153	71078	88321	127741
30	8877	12820	22199	27992	39734	48021	62731	79404	98667	142706
40	10714	15473	26793	33785	47957	57959	75713	95836	119086	172238
50	12535	18102	31345	39526	56106	67808	88579	112121	139321	201505
60	14347	20719	35877	45241	64218	77611	101385	128331	159464	230638
70	16123	23284	40318	50841	72167	87219	113936	144217	179204	259189
80	17926	25887	44827	56526	80238	96972	126677	160345	199244	288174
90	19706	28458	49278	62139	88205	106601	139255	176265	219027	316787
100	21484	31025	53723	67744	96161	116217	151817	192166	238785	345363
125	25912	37419	64795	81706	115979	140168	183105	231770	287997	416540
150	30312	43773	75798	95581	135675	163972	214199	271128	336904	487276
175	34732	50157	86852	109520	155461	187884	245437	310668	386036	558337
200	39135	56151	97862	123403	175167	211700	276549	350048	434970	629112
250	47907	69182	119796	151062	214429	259150	338534	428507	532463	770120
300	57094	82449	142771	180033	255552	308850	404358	510687	634579	917814
400	74426	107479	186112	234685	333130	402609	525936	665717	827219	1196436
500	92620	133751	231607	292053	414562	501024	654498	828448	1029428	1488898
600	111143	160501	277928	350464	497474	601229	785398	994137	1235314	1786677

SELECTING PRESSURE PILOTS

Any of the Main Valves described in the Main Valve Section can be combined with any of the Pilots listed below to produce the SPENCE Pressure Regulator. This Regulator will reduce and

regulate a steady or varying initial pressure, within the range specified, so as to maintain a constant, adjustable, predetermined delivery pressure. The table below lists the principal Pressure Pilots.

PRESSURE REGULATOR PILOTS

Type	Service Conditions								Normal Accuracy ±	Diaphragm		Loading	Main Valve
	Cast Iron		Cast Bronze		Cast Steel		Delivery Pressure			Diameter inches	Material		
	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum Initial Pressure psi	Maximum Temperature °F	Minimum psi	Maximum psi					
D	250	450	—	—	600	750	3	150	1 psi	3½	St. Stl.	Spring	E or C Series
D2	250	450	—	—	600	750	100	300	2 psi	3½	St. Stl.	Spring	E or C Series
D5	250	450	—	—	—	—	1	25	½ psi	5¾	St. Stl.	Spring	E or C Series
D120	250	450	—	—	600	750	5	150	1 psi	4½	St. Stl.	Spring	E or C Series
A73	250	450	—	—	600	750	See response curves on A Pilot Product Page 49		½ psi	3½-7¼ ^b	St. Stl.	Air	E or C Series
A53	250	450	—	—	600	750			½ psi	3½-5¾ ^b	St. Stl.	Air	E or C Series
A	250	450	—	—	600	750			½ psi	3½	St. Stl.	Air	E or C Series
A35	250	450	—	—	—	—			⅛ psi	5¾-3½ ^b	St. Stl.	Air	E or C Series
A54	250	450	—	—	600	750			1 psi	4½-5¾ ^b	St. Stl.	Air	E or C Series
A70	250	450	—	—	600	750			2 psi	7¼	St. Stl.	Air	E or C Series
A86	250	450	—	—	600	750			½ psi	4½	St. Stl.	Air	E or C Series
A87	250	450	—	—	600	750			½ psi	7¼	St. Stl.	Air	E or C Series
A85	250	450	—	—	600	750			½ psi	3½-5¾ ^b	St. Stl.	Air	E or C Series
A84	250	450	—	—	600	750			½ psi	3½	St. Stl.	Air	E or C Series
A83	250	450	—	—	600	750			½ psi	3½	St. Stl.	Air	E or C Series
A82	250	450	—	—	—	—			⅛ psi	5¾	St. Stl.	Air	E or C Series
Safety Pilot	—	—	300	500	600	750	5	175	—	3½	St. Stl.	Spring	E or C Series
P125	250	450	—	—	600	750	5	175	1 psi	4½	St. Stl.	Spring	E or C Series

^aThese Pilots have dual diaphragms, the first size being the control diaphragm and the second, the air loading diaphragm.

NOTES ON SELECTION OF PILOTS

D SERIES PILOTS meet the requirements of the majority of all pressure regulator problems. They are spring-loaded. Other Pilots are modifications of the D Series for specific purposes.

A SERIES PILOTS are air-loaded. These Pilots are recommended where frequent changes in setting must be made and the Regulator is not easily accessible.

In any one Series of Pilots a larger Diaphragm will produce closer accuracy of control but with less range in delivery pressure.

Water Service Pilot operated Regulators are not uniformly

satisfactory as water reducing valves unless the delivery system has the ample cushioning afforded by an elevated tank or air chamber. When the flow is intermittent to an inflexible system, the SPENCE Type D34 Direct Operated Pressure Reducing Valve is recommended.

SIZING PRESSURE REGULATORS

DATA REQUIRED FOR ORDERING

- 1. SERVICE** Fluid flowing through Regulator.
- 2. INITIAL (INLET) PRESSURE**
 - (a) Maximum/Minimum.
 - (b) Superheat, Gravity, etc.
 - (1) Steam Service—Total Temperature or Degrees Superheat, if any.
 - (2) Air, Gases, Water and Liquids—Temperature and Specific Gravity.
- 3. DELIVERY (OUTLET) PRESSURE** Maximum/Minimum.
- 4. CAPACITY** Maximum required flow through Regulator.
- 5. END CONNECTIONS** Screwed or Flanged. (If flanged, state drilling.)

EXAMPLE

Select size and type Regulator to pass 14,600 lb. steam per hour reducing from 175/150 psi saturated to 40/20 psi. Ends to be flanged, pilot spring loaded and pressure controlled within 2 psi.

1. Steam
2.
 - (a) 175/150 psi
 - (b) None (saturated, 378°F total temperature)
3. 40/20 psi
4. 14,600 lb. per hour
5. Flanged, if 2½" size or larger

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. TYPE —See Selection Criteria for Steam, Air, Gases or Water and Liquids in beginning of this Section.	See Selection Criteria and Selection Charts opposite.
B. SIZE —See applicable Valve Capacity Tables in this Section.	
C. MATERIAL — See Main Valve Selection Chart in Technical Reference Section or individual Product Pages.	See Pilot Selection Chart opposite or individual Product Pages.
D. ACCESSORIES —See Accessories in Other Products Section.	

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. Since maximum Delivery Pressure is less than 75% of minimum Initial Pressure and the least pressure drop exceeds required "minimal differential". SELECT TYPE E	Since maximum Initial Pressure 175 psi, Total Temperature 378°F maximum Delivery Pressure 40 psi, Pilot spring loaded and required accuracy 2 psi: SELECT TYPE D
B. For 14,600 lb. per hour and 150 psi minimum Initial Pressure Economical: SELECT 3" FULL PORT Engineered: SELECT 4" NORMAL PORT	
C. For 175 psi, 378°F: SELECT CAST IRON, FLANGED 250 LB.	For 175 psi, 378°F: SELECT CAST IRON
D. None required in this case.	None required in this case.

ECONOMICAL SOLUTION: 3" FULL PORT SPENCE TYPE ED, CAST IRON BODY, 250 LB. FLANGED ENDS
ENGINEERED SOLUTION: 4" NORMAL PORT SPENCE TYPE ED, CAST IRON BODY, 250 LB. FLANGED ENDS.

NOTE: Pressure Regulators should always be protected by properly designed Strainers.

PRESSURE RECOVERY FACTORS FOR REGULATORS

TRIM	F _L (Liquid Service)									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Normal	0.998	0.997	0.996	0.990	0.980	0.968	0.958	0.950	0.944	0.940
Full	0.998	0.996	0.987	0.980	0.970	0.960	0.948	0.936	0.928	0.925
Parabolic	0.957	0.956	0.955	0.954	0.953	0.952	0.95	0.945	0.942	0.938

TRIM	X _T (Gas Service)									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Normal	0.837	0.835	0.833	0.823	0.807	0.787	0.771	0.758	0.749	0.742
Full	0.837	0.833	0.818	0.807	0.790	0.774	0.755	0.736	0.723	0.719
Parabolic	0.769	0.768	0.766	0.764	0.763	0.761	0.758	0.750	0.745	0.739

Note- $X_T = .84 \cdot F_L^2$

SELECTING TEMPERATURE PILOTS

Any of the Main Valves described in the Main Valve Section can be combined with any of the Pilots listed below, to produce the SPENCE Temperature Regulator. This Regulator is designed to control the flow of fluid to a heating or cooling element so as to maintain a constant, adjustable, precise predetermined temperature. Pilots fully stroke valve within 5°F. The table below lists the principal Temperature Pilots.

The Thermostats of these SPENCE Pilots are of the Vapor Tension Type. They are ruggedly constructed and will not be injured by overheating.

These SPENCE Temperature Pilots can be furnished with 150°F range of temperature adjustment on special order. It should be noted that since heavier Adjusting Springs are required for this greater range the regulation will not be quite so accurate.

TEMPERATURE RANGES

20°F to 120°F	150°F to 300°F	Thermostats can be furnished for temperatures higher than 350°F on special order.
50°F to 150°F	170°F to 270°F	
70°F to 170°F	250°F to 350°F	
120°F to 220°F		

TEMPERATURE REGULATOR PILOTS

Type	Service Conditions							Operating Characteristics	Main Valve
	Cast Iron		Cast Bronze ^a		Cast Steel		Delivery Pressure		
	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum psi		
T134	250	450	—	—	600	750	20	Cascade Control—Closes on rise in temperature—controls delivery pressure—decreases delivery pressure as temperature increases & vice versa—spring loaded pressure control.	E or C Series
T124	250	450	—	—	—	—	125		
T14	250	450	—	—	600	750	—	Closes on rise in temperature.	E or C Series
T14D	250	450	—	—	600	750	150	Closes on rise in temperature—controls delivery pressure at predetermined setting—spring loaded pressure control	E or C Series
T14D2	250	450	—	—	600	750	300		
T52	250	450	—	—	—	—	—	Opens on rise in temperature.	E or C Series
Safety Pilot	—	—	300	500	—	—	—	Prevents excessive temperature rise.	E or C Series

^aBronze Body Pilots are recommended for water service.

AIR CONTROLLED TEMPERATURE PILOTS

SPENCE Air Control Pilots, listed below, have been developed to meet special conditions when used in conjunction with A Series Pressure Pilots. The fast bi-metal thermostats have a 200°F adjustable range and protection against damage from

over-heating. By cascading an air signal onto a pressure regulator, the EAT Series temperature control reduces steam pressure to an adjustable limit as well as regulating output temperature.

Type	Bulb Style	Bulb Material	Bulb Mounting	Range °F	Maximum Bulb Temperature °F	Control Mode	Action
T61	No.736	Bronze	½ NPT	50-250	350	Proportional	Reverse*
	No. 737	St. Stl. ¹	½ NPT	50-250	350	Proportional	Reverse*
T64	No. 738	St. Stl. ¹	Sanitary Thermometer Bushing	50-250	350	Proportional	Reverse*
T60	No.745	St. Stl. ²	½ NPT Union Mounted	30-150 100-300***	180 350	Proportional Proportional	Reverse* Reverse*

* Rising output pressure on falling temperature. This action applied to an EA Series Regulator increases steam flow with decreasing temperature. Direct action available for cooling control.

**Rate or reset available on application

***Other ranges on application

¹Type 304

²Type 347 or optional Type 316

NOTES ON SELECTION OF PILOTS

HEATING CONTROL Single Pilot Types T134 and Combination Pilot Type T14D2 reduce the steam pressure as well as regulate the output temperature. A choice should be made according to the maximum required delivery pressure, i.e., the pressure needed in the heater to carry the peak load. Pilot Types T14D and T14D2 in cast steel are designed for initial steam pressures in excess of 500°F.

Of the Air Control Pilots, the Type T61 is the general choice. The Type T60 is used for temperature indication or for remote adjustment. The required heater pressure will determine the choice of the A Series Pilot. See Product Pages.

COOLING CONTROL Pilot Type T52 is employed With Type E or C Series Main Valves to control temperature by regulating the flow of a cooling medium. This Pilot opens the Main Valve on rising temperature and exercises no control over the delivery pressure. The Air Control Pilots can be furnished with increasing air signal on temperature rise for use in cooling control.

TEMPERATURE RANGES Selection of the following ranges of temperature adjustment is recommended for the services noted:

50°F to 150°F	Room or air duct control
120°F to 220°F	Domestic or laundry hot water service.
70°F to 170°F	Fuel oil preheating.
170°F to 270°F	Fuel oil heating.

SIZING TEMPERATURE REGULATORS

DATA REQUIRED FOR ORDERING

1. SERVICE

- (a) Fluid flowing through Regulator.
- (b) Type heater to be controlled.

2. INITIAL (INLET) PRESSURE

- (a) Maximum/Minimum.
- (b) Superheat, Gravity, etc.
 - (1) Steam Service—Total Temperature or Degrees Superheat, if any.
 - (2) Air, Gases, Water and Liquids—Temperature and Specific Gravity.

3. DELIVERY (OUTLET) PRESSURE

Maximum required on heater.

4. CAPACITY

Maximum required flow through Regulator or the following data leading to same:

- (a) Quantity and type of fluid to be heated or cooled.
- (b) Temperature rise or drop, °F.

5. THERMOSTAT CHARACTERISTICS:

- (a) Controlled Temperature, °F—Maximum/Minimum.
- (b) Operation—Open or Close on temperature rise.
- (c) Thermostat Bulb—Style Number and Material.
- (d) Flexible Tubing—Length and Material.

6. END CONNECTIONS

Screwed or Flanged. (If flanged, state drilling)

EXAMPLE

Select size and type Regulator for heating 120 gpm water from 50°F entering temperature to 170°F final temperature in an instantaneous heater. Steam supply at 125 psi pressure to be reduced to 30 psi maximum in heater.

1. (a) Steam
(b) Instantaneous
2. (a) 125 psi
(b) None (saturated, 353°F total temperature)
3. 30 psi
4. See Capacity Tables in this Section.
(a) 120 gpm water.
(b) $170 - 50 = 120^\circ\text{F Rise}$

$$\frac{120}{2} \times 120 = 7200\text{#/Hr.}$$
5. (a) 170°F—Select standard Temperature Range from facing page to include this final temperature.
(b) Close on temperature rise.
(c) Style No. 700 bronze. (See Options Section)
(d) Ten (10) feet, brass—furnished unless otherwise specified.
6. Flanged, if 2½" size or larger.

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. TYPE —See Selection Criteria for Steam, Air, Gases or Water and Liquids in beginning of this Section.	See Selection Criteria and Selection Charts opposite.
B. SIZE —See applicable Valve Capacity Tables in this Section.	
C. MATERIAL — See Main Valve Selection Chart in Technical Reference Section or individual Product Pages.	See Pilot Selection Chart opposite or individual Product Pages.
D. ACCESSORIES —See Accessories in Other Products Section.	

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. Since maximum Delivery Pressure is less than 75% of minimum Initial Pressure and the least pressure drop exceeds required "minimal differential". SELECT TYPE E	Since maximum Initial Pressure 125 psi, Total Temperature 353°F maximum Delivery Pressure 30 psi SELECT TYPE T124
B. Using Capacity Tables in this Section, for 7200#/Hr and 125 psi initial pressure SELECT 2" FULL PORT	
C. For 125 psi, 353°F: SELECT CAST IRON, NPT 250	For 125 psi, 353°F: SELECT CAST IRON
D. None required in this case.	None required in this case.

ECONOMICAL SOLUTION: 3" SPENCE TYPE ET124, CAST IRON BODY, NPT 250 ENDS TEMPERATURE RANGE 120-220°F EQUIPPED WITH 10 FEET OF BRASS FLEXIBLE TUBING AND STYLE NO. 700 BRONZE THERMOSTAT BULB.

Temperature Regulators should always be protected by properly designed Strainers.

SELECTING DIFFERENTIAL PRESSURE PILOTS

SPENCE Differential Pressure Regulators may usually be classified in one or the other of the following groups:

1. Control of the delivery pressure at a constant, adjustable, pre-determined differential above another source of fluid pressure. This case is illustrated by the use of the SPENCE Type EN Differential Pressure Regulator on a boiler feedwater make-up line to control the delivery pressure of the feedwater at a constant differential above the boiler steam pressure. Another example is the use of the Type EN to control the steam pres-

sure on a steam atomizing oil burner at a constant differential above the oil pressure at the nozzle.

2. Control of the differential pressure or pressure drop across the Pressure Regulator itself. This case is illustrated by the use of the SPENCE Type EN24 Differential Pressure Regulator installed in parallel with a heat exchanger to maintain a constant differential across it, thereby limiting the flow rate of fluid through the heater.

The table below lists the principal Differential Pilots.

DIFFERENTIAL PRESSURE REGULATOR PILOTS

Type	Service Conditions											Normal Accuracy ±	Diaphragm		Loading	Operating Characteristics	Main Valve
	Cast Iron			Cast Bronze*			Cast Steel			Differential Pressure							
	Max. Initial Pressure psi	Max. Temperature °F	Max. Diaph. Pressure psi	Max. Initial Pressure psi	Max. Temperature °F	Max. Diaph. Pressure psi	Max. Initial Pressure psi	Max. Temperature °F	Max. Diaph. Pressure psi								
	Min. psi	Max. psi	Diameter inches	Material													
N	250	450	240	300	500	290	600	750	300	3	150	1 psi	3½	St. Stl.	Spring	Closes on increase in differential Delivery pressure controlled at set differential above loading pressure Loading Pressure may be any fluid	E or C Series E or C Series
N33	250	450	240	300	500	290	600	750	300	3	150	1 psi	3½	St. Stl.	Spring		
N20	250	366	250	300	366	300	300	366	300	3	150	1 psi	31/2	St. Stl.	Spring	Opens on increase in differential Initial pressure controlled at set differential above loading pressure Loading pressure may be any fluid	E or C Series

^aBronze Body Pilots are recommended for water service.

NOTES ON SELECTION OF PILOTS

TYPE N AND N33 PILOTS require that the delivery pressure (pressure of fluid discharged from the Regulator) be controlled at a given differential above some separate source of loading pressure.

TYPE N meets the requirements of most boiler feedwater make-up and steam atomizing oil burner differential control problems as described in the first group in the above table.

TYPE N33 is a version of the Type N in which two separated diaphragms are employed to preclude the possibility of contact between the two fluids applied to the pilot.

TYPE N20 is a differential relief pilot which causes the Main Valve to open when its initial pressure exceeds the loading pressure by a set differential.

SIZING DIFFERENTIAL PRESSURE REGULATORS

DATA REQUIRED FOR ORDERING

- 1. SERVICE** Fluid flowing through Regulator.
- 2. INITIAL (INLET) PRESSURE**
 - (a) Maximum/Minimum.
 - (b) Superheat, Gravity, etc.
 - (1) Steam Service—Total Temperature or Degrees Superheat, if any.
 - (2) Air, Gases, Water and Liquids—Temperature and Specific Gravity.
- 3. LOADING PRESSURE**
 - (a) Maximum/Minimum.
 - (b) Fluid
- 4. CONTROLLED PRESSURE**
 - (a) Maximum/Minimum.
 - (b) Fluid
- 5. DELIVERY PRESSURE** Maximum/Minimum.
- 6. CAPACITY** Maximum required flow through Regulator.
- 7. END CONNECTIONS** Screwed or Flanged. (If flanged, state drilling.)

EXAMPLE

Select size and type Regulator to control the flow of water from a Motor-Driven Centrifugal Boiler Feed Pump maintaining an Excess or Differential pressure of 50 psi between the boiler feedwater and the boiler steam pressure. The feedwater temperature is 240°F. The boiler steam pressure is 150 psi. Flow 90 gpm at 220 psi pump discharge pressure.

- 1.** Water
- 2.** (a) 220 psi
(b) 240°F
- 3.** (a) 150 psi Boiler Pressure
(b) Steam
- 4.** (a) 200 psi (Loading plus Excess Pressure)
(b) Water
- 5.** Identical with Controlled Pressure, Item 4
- 6.** 90 gpm
- 7.** Flanged, if 2½" size or larger

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. TYPE —See Selection Criteria for Steam, Air, Gases or Water and Liquids in beginning of this Section.	See Selection Criteria and Selection Charts opposite.
B. SIZE —See applicable Valve Capacity Tables in this Section.	
C. MATERIAL — See Main Valve Selection Chart in Technical Reference Section or individual Product Pages.	See Pilot Selection Chart opposite or individual Product Pages.
D. ACCESSORIES —See Accessories in Other Products Section.	

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. Since pressure drop across valve (Initial Pressure minus Delivery Pressure) is greater than 10 psi: SELECT TYPE E	Since Initial Pressure 220 psi, 240°F, Differential (Excess) Pressure 50 psi and the Delivery and Controlled Pressures are the same: SELECT TYPE N
B. For 90 gpm: SELECT 3"	
C. For 220 psi, 240°F: SELECT CAST IRON, FLANGED 250 LB.	For 220 psi, 240°F: SELECT BRONZE
D. For Water Service: Dashpot required.	None required in this case.

ANSWER: 3" SPENCE TYPE EN, CAST IRON BODY, 250 LB FLANGED ENDS, EQUIPPED WITH BRONZE DASHPOT AND BRONZE PILOT BODY.

NOTE: Differential Regulators should always be protected by properly designed Strainers.

WATER CAPACITY TABLE—FLOW IN GALLONS PER MINUTE

These flow rates provide a simple method for sizing regulators or water pipes with inlet velocities in the range of 240 to 600 fpm. Spence Regulators have variable seat sizes. The factory will select the proper seat for particular flow and pressure drop. Additional capacity data is available on request.

VALVE OR PIPE SIZE															
1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Velocity, fpm															
247	251	255	262	270	277	285	300	315	330	360	390	420	480	540	600
1.3	2.5	4.0	7.3	12	22	30	52	78	127	238	405	630	1250	2210	3490

SELECTING BACK PRESSURE PILOTS

Any of the Main Valves described in the Main Valve Section can be combined with any of the Pilots listed below to produce the SPENCE Back Pressure Regulator. Provided the delivery (discharge) pressure is sufficiently below the desired back pressure to operate the Regulator, it will maintain a steady back pressure regardless of fluctuations in the load. The Pilot is guaranteed to shut tight when the back pressure falls below a predetermined

setting. The table below lists the principal Back Pressure Pilots. **THE SPENCE BACK PRESSURE REGULATOR IS NOT A SAFETY VALVE AND SHOULD NEVER BE USED AS SUCH.** The discharge pressure must always be low enough in relation to the back pressure to provide the required minimum differential listed in the Main Valve Selection Chart in the Technical Reference Section.

BACK PRESSURE REGULATOR PILOTS

Type	Service Conditions							Diaphragm		Main Valve
	Cast Iron		Cast Steel		Delivery Pressure					
	Maximum Initial Pressure psi	Maximum Temper- ature °F	Maximum Initial Pressure psi	Maximum Temper- ature °F	Minimum psi	Maximum psi	Normal Accuracy ±	Diameter inches	Material	
Q	150	366	150	366	3	150	1 psi	3½	St. Stl.	E or C Series
Q2	250	450	600	750	100	400	2 psi	3½	St. Stl.	E or C Series
Q73 ^b	150	366	150	366	3	150	½ psi	3½-7¼ ^c	St. Stl.	E or C Series
F14	250	450	600	750	3	150	1 psi	4½	St. Stl.	E or C Series
F13	250	450	600	750	100	300	2 psi	3½	St. Stl.	E or C Series
F15	250	450	600	750	2	25	1/2 psi	5¾	St. Stl.	E or C Series
F32	250	450	600	750	200	2000	10 psi	¾ piston	St. Stl.	E or C Series

^bType Q73 is air adjusted, all others are spring loaded.

^cThese Pilots have dual diaphragms, the first size being the control diaphragm and the second, the air loading diaphragm.

NOTES ON SELECTION OF PILOTS

TYPE Q SERIES meet the requirements of the majority of all back pressure problems. They are packless and spring or air loaded. The Type Q Pilot can be furnished for service on refrigerants on special order.

TYPE F SERIES have bellows stem seals and separate diaphragm chambers. They are designed for applications where a regulator is required to open on rise in pressure of a fluid other

than that flowing through the regulator. Type F Series Pilots are also recommended for usual back pressure service in the event that long control pipes are unavoidable.

In either series of back pressure pilots, a larger Diaphragm will produce closer accuracy of control but with less range in back pressure.

SIZING BACK PRESSURE REGULATORS

DATA REQUIRED FOR ORDERING

- 1. SERVICE** Fluid flowing through Regulator.
- 2. INITIAL (INLET) PRESSURE**
 - (a) Maximum/Minimum.
 - (b) Superheat, Gravity, etc.
 - (1) Steam Service—Total Temperature or Degrees Superheat, if any.
 - (2) Air, Gases, Water and Liquids—Temperature and Specific Gravity.
- 3. DISCHARGE (OUTLET) PRESSURE** Maximum/Minimum.
- 4. CAPACITY** Maximum required flow through Regulator.
- 5. END CONNECTIONS** Screwed or Flanged. (If flanged, state drilling.)

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. TYPE —See Selection Criteria for Steam, Air, Gases or Water and Liquids in beginning of this Section.	See Selection Criteria and Selection Charts opposite.
B. SIZE —See applicable Valve Capacity Tables in this Section.	
C. MATERIAL — See Main Valve Selection Chart in Technical Reference Section or individual Product Pages.	See Pilot Selection Chart opposite or individual Product Pages.
D. ACCESSORIES —See Accessories in Other Products Section.	

EXAMPLE

Select size and type Regulator to pass 9000 lb steam per hour retaining a back pressure of 5 psi and exhausting into a condenser at 6" Hg vacuum. Pilot to be packless, spring loaded and to control the pressure within $\pm 1/2$ psi.

1. Steam
2. (a) 5 psi
(b) None (saturated, 228°F total temperature)
3. 6" Hg vacuum
4. 9000lb. per hour
5. Flanged, if 2 1/2" size or larger

SELECTION OF TYPE AND SIZE OF REGULATOR

MAIN VALVE	PILOT
A. Since Initial Pressure is less than 15 psi and the least pressure drop exceeds "minimum differential": SELECT TYPE E2	Since maximum Initial Pressure 5 psi, Total Temperature 228°F, accuracy of control $\pm 1/2$ psi and Pilot spring loaded: SELECT TYPE F15
B. For 9000 lb. per hour and 5 psi Initial Pressure: SELECT 8" SIZE.	
C. For 5 psi, 228°F: SELECT CAST IRON, FLANGED 125 LB.	For 5 psi, 228°F: SELECT CAST IRON
D. For discharge into vacuum: Condensation Chamber required.	None required in this case.

ANSWER: 8" SPENCE TYPE E2F15, CAST IRON BODY, 125 LB. FLANGED ENDS, EQUIPPED WITH CONDENSATION CHAMBER.

NOTE: Back Pressure Regulators should always be protected by properly designed Strainers.

SELECTING PUMP GOVERNOR PILOTS

SPENCE Pump Governors are classified in four groups as follows:

1. Constant Pressure Pump Governor which is illustrated by the SPENCE Type EP14 Pump Governor. This Regulator governs the steam supply to a pump, either reciprocating or turbine-driven, and maintains a constant, adjustable pump discharge pressure.
2. Excess Pressure Pump Governor which is illustrated by the SPENCE Type EN Differential Pressure Regulator. Although this Regulator is not a Pump Governor, it is recommended to govern the steam supply to boiler feed pump where it is desired to maintain the pump discharge pressure at a constant, adjustable differential pressure in excess of the boiler steam pressure.

3. Vacuum Pump Governor which is illustrated by the SPENCE Type EF46 Pump Governor. This Regulator governs the steam supply to a vacuum pump and maintains a constant, adjustable vacuum on the pump suction.

4. Differential Control for electric motor-driven centrifugal pumps which is illustrated by the SPENCE Type EN Differential Pressure Regulator. Although this Regulator is not a Pump Governor, it is recommended to maintain a constant, adjustable differential between the feedwater pressure and the boiler steam pressure; i.e., a constant pressure drop across the feedwater regulator.

The table below lists the principal Pump Governor Pilots.

PUMP GOVERNOR PILOTS

Type	Service Conditions						Diaphragm		Main Valve	Type of Control
	Cast Iron		Cast Steel		Pump Discharge Pressure					
	Maximum Initial Pressure psi	Maximum Temperature °F	Maximum Initial Pressure psi	Maximum Temperature °F	Minimum psi	Maximum psi	Diameter inches	Material		
P13	250	450	600	750	100	300	3½	St. Stl.	E or C Series	Constant Pressure
P14	250	450	600	750	5	150	4½	St. Stl.	E or C Series	Constant Pressure
P15	250	450	600	750	3	25	5¾	St. Stl.	E or C Series	Constant Pressure
P32	250	450	600	750	200	2000	7⁄8 Piston	St. Stl.	E or C Series	Constant Pressure
F46	250	450	600	750	0	30" Hg vac	4½	St. Stl.	E or C Series	Vacuum
N	250	450	600	500	3 ^b	300 ^b	3½	St. Stl.	E or C Series	Differential ^c

^aRegulator discharge pressure

^cFor electric motor driven centrifugal pump applications only, differential pressure range 3 to 150 psi

NOTES ON SELECTION OF PILOTS

P SERIES PILOTS are used for constant pressure control. In this Series a larger Diaphragm will produce closer accuracy of control but with less range in pump discharge pressure.

TYPE F46 is a vacuum pump governor Pilot.

TYPE N is a differential pressure Pilot which is applied to the discharge of a constant speed centrifugal pump to effect

excess pressure control. The design of the Pilot requires that the delivery pressure (pressure of fluid discharged from Regulator) be controlled at a given differential above some separate source of loading pressure. In typical service, boiler feedwater flows through the Regulator and is delivered at constant excess pressure above the boiler steam pressure.

RATED STEAM CAPACITY TABLE

TYPE E MAIN VALVE — FULL PORT

VALVE INFO
PAGE 26

Pounds of Saturated Steam per Hour

PRESSURE-PSIG		VALVE SIZE (Inches)														
INLET	REDUCED	3/8	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	10	12
20	0	86	160	309	504	808	1134	1776	2521	4239	6244	9682	14208	25436	40446	63762
	10	90	168	325	529	848	1190	1864	2645	4449	6553	10161	14911	26695	42447	66917
	25	98	184	354	577	925	1299	2033	2886	4853	7148	11083	16264	29118	46301	72993
30	15	98	182	352	573	919	1290	2019	2866	4821	7101	11009	16156	28924	45992	72505
	0	110	206	398	648	1038	1458	2282	3239	5448	8024	12441	18257	32685	51972	81934
	25	111	207	400	652	1044	1466	2296	3259	5481	8073	12517	18368	32884	52289	82432
40	20	121	227	437	713	1142	1604	2511	3564	5994	8829	13688	20087	35963	57184	90149
	3-0	134	250	482	786	1259	1768	2768	3929	6608	9733	15091	22146	39648	63043	99387
	35	123	229	442	721	1155	1622	2540	3605	6062	8930	13845	20317	36374	57838	91181
50	30	136	253	489	796	1276	1791	2805	3981	6695	9861	15289	22436	40168	63870	100691
	25	145	270	521	849	1361	1911	2992	4247	7143	10522	16313	23939	42859	68150	107437
	6-0	157	294	566	923	1478	2076	3250	4614	7759	11429	17720	26003	46554	74026	116701
60	45	134	249	481	784	1256	1763	2760	3918	6589	9706	15048	22083	39535	62865	99106
	40	148	277	535	871	1396	1960	3069	4356	7326	10791	16731	24552	43955	69893	110185
	35	160	298	575	936	1500	2107	3299	4682	7874	11599	17984	26390	47247	75127	118436
75	10-0	181	337	650	1059	1697	2383	3731	5295	8906	13118	20338	29846	53434	84964	133945
	55	166	309	596	971	1556	2185	3421	4856	8166	12028	18650	27367	48997	77909	122822
	50	179	335	645	1052	1685	2366	3705	5259	8844	13027	20198	29639	53064	84376	133017
100	45	190	355	684	1115	1786	2508	3927	5574	9375	13809	21410	31418	56248	89440	141000
	15-0	215	401	774	1261	2021	2837	4442	6305	10604	15620	24218	35539	63626	101172	159496
	75	207	387	747	1217	1950	2739	4288	6086	10236	15077	23376	34304	61415	97655	153951
125	60	243	454	876	1427	2286	3210	5026	7134	11998	17673	27402	40211	71990	114741	180482
	23-0	272	507	978	1594	2554	3587	5616	7971	13406	19747	30617	44929	80437	127901	201635
	100	232	433	835	1360	2179	3060	4791	6800	11436	16845	26118	38327	68618	109108	172008
150	75	296	552	1064	1735	2779	3903	6110	8673	14586	21485	33311	48882	87515	139157	219379
	31-0	328	612	1180	1924	3082	4328	6777	9619	16177	23828	36944	54214	97061	154335	243307
	125	253	473	912	1487	2382	3345	5238	7434	12503	18416	28554	41902	75018	119285	188051
175	100	329	614	1184	1930	3093	4343	6800	9651	16231	23908	37069	54397	97388	154856	244128
	40-0	384	716	1381	2250	3605	5063	7926	11250	18921	27870	43211	63411	113526	180516	284582
	150	273	510	983	1602	2567	3605	5645	8012	13474	19847	30772	45156	80844	128549	202656
200	125	359	670	1293	2106	3375	4739	7420	10532	17712	26090	40451	59361	106275	168986	266405
	100	406	759	1463	2384	3820	5364	8399	11921	20049	29531	45787	67191	120293	191277	301546
	48-0	439	819	1580	2575	4125	5793	9069	12873	21649	31889	49442	72555	129896	206546	325618
225	150	386	721	1390	2266	3630	5098	7981	11328	19051	28062	43509	63848	114308	181760	286542
	125	442	825	1591	2592	4153	5832	9131	12961	21797	32107	49781	73051	130784	207959	327845
	56-0	493	921	1776	2895	4638	6513	10198	14474	24343	35857	55594	81582	146058	232245	366132
250	175	411	768	1481	2414	3868	5431	8504	12070	20299	29900	46358	68029	121793	193662	305306
	150	475	886	1709	2785	4462	6265	9809	13923	23415	34490	53475	78473	140492	223395	352179
	65-0	548	1023	1973	3215	5151	7234	11325	16075	27034	39821	61741	90602	162207	257923	406613
250	200	435	812	1566	2551	4088	5740	8987	12756	21453	31600	48994	71897	128719	204675	322667
	175	505	942	1817	2962	4746	6664	10434	14809	24906	36686	56880	83469	149437	237618	374601
	150	551	1028	1983	3232	5179	7272	11386	16160	27179	40034	62071	91086	163073	259301	408784
73-0	602	1124	2167	3532	5659	7946	12441	17659	29699	43745	67825	99530	178191	283340	446682	

Based on 10% (2 psi minimum) accuracy of regulation.

TYPE E FULL PORT
CAPACITY TABLE

RATED STEAM CAPACITY TABLE

TYPE E MAIN VALVE — NORMAL PORT

Pounds of Saturated Steam per Hour

PRESSURE-PSIG INLET REDUCED		VALVE SIZE (inches)													
		3/8	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	12
20	0	38	87	279	435	603	847	1021	1393	2495	4526	6672	8761	14447	36612
25	10	39	91	291	454	630	884	1066	1454	2604	4724	6965	9145	15081	38217
	0	43	100	319	499	692	971	1171	1597	2861	5190	7652	10047	16567	41983
30	15	43	98	315	492	682	957	1154	1573	2819	5114	7539	9899	16324	41368
	0	49	112	359	561	777	1091	1316	1794	3214	5831	8597	11288	18613	47169
	25	48	112	357	558	774	1087	1310	1786	3201	5806	8560	11240	18534	46969
40	20	51	122	392	612	848	1191	1436	1958	3507	6362	9381	12317	20311	51470
	3-0	59	136	436	681	944	1325	1597	2178	3902	7078	10436	13702	22595	57260
	35	53	123	395	617	856	1201	1448	1974	3537	6417	9460	12422	20484	51908
50	30	59	136	437	682	946	1328	1601	2184	3913	7097	10464	13740	22657	57415
	25	63	146	467	729	1012	1420	1712	2334	4182	7586	11185	14686	24218	61371
	5-0	69	160	511	799	1108	1556	1875	2557	4582	8311	12254	16089	26532	67235
	45	58	134	429	670	929	1305	1573	2145	3842	6970	10276	13493	22250	56385
60	40	65	149	478	746	1035	1452	1751	2388	4278	7760	11440	15022	24771	62773
	35	70	161	514	803	1114	1563	1885	2570	4605	8353	12315	16170	26665	67573
	8-0	79	183	587	917	1272	1786	2152	2935	5259	9539	14064	18467	30452	77170
	55	72	166	532	831	1152	1618	1950	2659	4764	8642	12741	16729	27587	69909
75	50	78	180	577	901	1249	1754	2114	2883	5165	9370	13814	18139	29911	75798
	45	83	191	612	956	1326	1861	2244	3060	5482	9944	14661	19251	31745	80446
	13-0	95	218	699	1092	1515	2126	2563	3495	6262	11359	16747	21990	36261	91890
100	75	90	208	667	1041	1444	2027	2444	3333	5971	10831	15968	20967	34575	87618
	60	106	245	783	1224	1698	2383	2873	3917	7019	12731	18771	24647	40642	102993
	20-0	120	276	884	1381	1915	2688	3240	4418	7916	14360	21172	27799	45841	116168
	100	101	233	744	1163	1612	2263	2728	3721	6666	12092	17828	23409	38601	97821
125	75	129	298	953	1488	2064	2898	3493	4763	8534	15480	22823	29968	49418	125231
	28-0	144	333	1066	1666	2310	3243	3910	5332	9552	17328	25547	33545	55315	140176
	125	110	254	813	1270	1762	2473	2981	4066	7284	13213	19481	25579	42180	106890
150	100	143	331	1059	1654	2294	3221	3882	5294	9485	17205	25367	33308	54925	139188
	36-0	169	390	1247	1949	2702	3794	4573	6236	11173	20267	29881	39235	64699	163956
	150	119	274	876	1369	1898	2664	3212	4380	7847	14234	20986	27556	45439	115149
175	125	156	361	1154	1804	2501	3511	4233	5772	10342	18759	27658	36316	59886	151759
	100	177	410	1311	2048	2840	3986	4806	6553	11741	21297	31400	41229	67987	172289
	44-0	193	446	1427	2230	3092	4341	5233	7135	12784	23190	34190	44893	74028	187598
200	150	168	388	1241	1939	2689	3774	4550	6205	11117	20165	29730	39037	64372	163128
	125	193	445	1423	2224	3084	4329	5219	7117	12751	23129	34101	44776	73836	187111
	52-0	217	501	1605	2507	3477	4881	5884	8023	14375	26075	38444	50478	83239	210940
225	175	179	413	1322	2065	2863	4020	4846	6608	11839	21475	31662	41573	68555	173727
	150	207	477	1528	2387	3310	4647	5602	7639	13686	24826	36602	48060	79251	200834
	59-0	241	557	1782	2784	3861	5420	6534	8910	15964	28958	42694	56059	92442	234262
	200	189	436	1396	2181	3025	4247	5119	6981	12507	22687	33449	43920	72425	183535
250	175	220	507	1624	2537	3519	4940	5955	8120	14548	26389	38907	51087	84243	213483
	150	240	555	1776	2775	3848	5402	6512	8880	15909	28859	42548	55868	92126	233461
	67-0	265	611	1956	3056	4238	5949	7172	9780	17522	31785	46862	61532	101467	257132

Based on 10% (2 psi minimum) accuracy of regulation.

RATED STEAM CAPACITY TABLE

TYPE E2 MAIN VALVE

Based on 1 psi accuracy of regulation.
K-Factor is included in the above tabulations.

Size	E2 Cv Valve Coefficient	ΔP Nominal	K Factor
3/4	7.6		
1	11.7		
1 1/4	18.9	3	0.635
1 1/2	27.4	4	0.785
2	44	5	0.855
2 1/2	68	6	0.895
3	96	7	0.915
4	143	8	0.928
5	202	9	0.935
6	255	10	0.937
8	465	11	0.938
10	748	12	0.940
12	1118	15	0.940

TYPE E2 MAIN VALVE ONLY

Used at such low pressure drops, a 1 psi deviation of reduced pressure at rated capacity is a significant portion of the total drop. It must be accounted for in calculations dealing with a subcritical flow condition.

Also, because E2 valve opening, for 1 psi accuracy of regulation, varies with the pressure drop, a regulation factor K is inserted in the formula.

$$Cv = \frac{W}{2.1 K \sqrt{\Delta P'(P_1 + P_2)}}$$

Where K = Factor from accompanying table

Cv = Valve coefficient

W = Flow, #/Hr. (saturated steam)

ΔP' = ΔP nominal plus 1 psi

P₁ = Inlet pressure, psia (psi + 14.7)

P₂ = Reduced pressure, psia (psi + 14.7)

P'₂ = P₂ nominal (set point value) minus 1 psi

ΔP = Pressure drop, psi

NOTE: When computing W for safety valve sizing, use K = 1.0

Pounds of Saturated Steam per Hour

VALVE INFO
PAGE 28

PRESSURE-psig		VALVE SIZE (inches)												
INLET	REDUCED	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	10	12
15	12	209	322	521	755	1212	1873	2644	3939	5564	7024	12808	20603	30794
	10	261	401	648	940	1509	2332	3293	4905	6928	8746	15949	25656	38346
	8	297	457	739	1071	1720	2658	3753	5590	7897	9969	18178	29242	43706
	5	335	515	833	1207	1938	2996	4229	6300	8899	11234	20485	32952	49252
	9" HG VAC	378	581	939	1361	2186	3378	4769	7103	10034	12667	23099	37157	55536
12	9	198	305	493	714	1147	1773	2503	3728	5266	6648	12123	19500	29146
	7	246	378	611	886	1422	2198	3103	4622	6529	8242	15030	24177	36136
	5	279	429	693	1005	1613	2493	3520	5243	7406	9350	17050	27426	40992
	11" HG VAC	341	525	848	1229	1974	3051	4308	6417	9064	11442	20865	33563	50166
10	7	190	293	473	686	1101	1702	2402	3579	5055	6381	11637	18719	27978
	5	235	362	584	847	1360	2102	2968	4421	6245	7884	14376	23125	34564
	2	277	427	689	999	1605	2480	3501	5215	7366	9299	16957	27277	40770
	12" HG VAC	316	487	787	1140	1831	2830	3995	5952	8407	10613	19353	31131	46531
9	6	186	287	463	671	1078	1665	2351	3502	4947	6245	11388	18319	27380
	4	229	353	571	827	1329	2053	2899	4318	6099	7700	14040	22585	33757
	2	259	398	643	933	1498	2315	3268	4868	6877	8681	15830	25464	38060
	13" HG VAC	304	468	756	1096	1761	2721	3841	5722	8083	10203	18606	29930	44735
8	5	182	280	452	656	1053	1628	2298	3423	4836	6105	11132	17907	26765
	3	224	345	557	807	1296	2003	2827	4211	5949	7510	13694	22028	32925
	14" HG VAC	292	449	726	1052	1690	2611	3686	5491	7756	9791	17855	28722	42929
7	4	178	273	442	640	1028	1589	2243	3341	4719	5958	10864	17476	26121
	2	218	335	542	786	1262	1950	2752	4100	5792	7311	13332	21446	32054
	15" HG VAC	280	430	695	1008	1618	2501	3531	5259	7429	9379	17102	27511	41119
6	3	173	267	431	624	1003	1549	2188	3259	4603	5811	10596	17044	25476
	1	212	326	527	764	1227	1896	2677	3988	5633	7111	12968	20860	31178
	15" HG VAC	267	411	664	963	1546	2389	3373	5024	7097	8960	16338	26282	39282
5	2	169	260	419	608	976	1508	2129	3172	4481	5656	10314	16592	24799
	0	206	317	512	742	1191	1840	2598	3870	5467	6902	12585	20245	30259
	16" HG VAC	255	392	633	918	1474	2278	3216	4791	6768	8544	15580	25061	37458

RATED STEAM CAPACITY TABLE

TYPE E5 MAIN VALVE — FULL PORT

Pounds of Saturated Steam per Hour

VALVE INFO
PAGE 30

PRESSURE- INLET		VALVE SIZE (inches)													
REDUCED		3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	10	12	
20	15	284	437	706	1023	1605	2501	3546	5935	9631	13065	24824	38001	60136	
	10	370	570	920	1334	2094	3263	4626	7743	12564	17044	32383	49573	78450	
	0	435	670	1083	1570	2463	3838	5442	9109	14780	20051	38097	58320	92292	
	10	305	469	758	1099	1724	2686	3809	6375	10345	14033	26663	40817	64593	
25	15	402	619	1000	1449	2275	3544	5025	8411	13647	18514	35176	53849	85217	
	10	457	703	1136	1647	2585	4028	5712	9560	15512	21043	39982	61205	96858	
	0	498	767	1240	1797	2820	4394	6230	10428	16920	22954	43612	66763	105653	
	25	324	499	806	1169	1834	2858	4053	6783	11006	14931	28369	43427	68725	
30	20	431	664	1073	1555	2441	3803	5392	9025	14644	19866	37745	57782	91440	
	15	495	762	1231	1785	2801	4365	6189	10358	16807	22800	43321	66317	104947	
	0	559	861	1391	2017	3165	4932	6993	11705	18993	25765	48954	74940	118594	
	35	359	553	894	1296	2033	3168	4492	7518	12199	16550	31444	48135	76175	
40	30	484	745	1203	1745	2738	4266	6049	10124	16427	22285	42341	64817	102574	
	25	563	867	1400	2029	3185	4962	7036	11776	19108	25922	49252	75396	119316	
	3-0	679	1045	1688	2447	3840	5983	8483	14198	23039	31254	59382	90904	143857	
	45	391	602	972	1409	2211	3446	4886	8177	13268	18000	34200	52354	82851	
50	40	531	817	1319	1913	3002	4677	6632	11100	18011	24434	46424	71067	112465	
	35	623	959	1548	2245	3523	5489	7783	13026	21136	28673	54479	83398	131979	
	6-0	797	1227	1982	2873	4509	7025	9961	16672	27052	36698	69727	106740	168917	
	70	459	706	1141	1654	2596	4044	5734	9598	15573	21127	40141	61449	97243	
75	65	630	970	1567	2272	3566	5556	7877	13184	21393	29022	55142	84413	133585	
	60	749	1153	1863	2701	4238	6604	9363	15671	25429	34497	65544	100336	158784	
	15-0	1089	1677	2708	3926	6162	9601	13614	22785	36972	50156	95296	145882	230860	
	95	516	794	1283	1861	2920	4550	6451	10797	17519	23767	45157	69127	109394	
100	90	714	1099	1775	2573	4037	6291	8920	14929	24225	32863	62440	95584	151263	
	85	854	1315	2124	3079	4832	7529	10676	17868	28994	39333	74732	114401	181042	
	23-0	1377	2120	3424	4964	7790	12138	17211	28805	46740	63407	120474	184424	291854	
	120	567	872	1409	2042	3205	4994	7081	11852	19232	26090	49570	75883	120086	
125	115	787	1211	1956	2836	4450	6934	9832	16456	26703	36225	68827	105362	166736	
	110	946	1456	2351	3409	5350	8335	11819	19781	32098	43543	82732	126849	200424	
	90	1335	2055	3320	4814	7554	11771	16690	27933	45325	61488	116827	178842	283021	
	31-0	1661	2556	4130	5987	9395	14639	20757	34741	56372	76473	145299	222428	351995	
150	145	612	942	1522	2206	3462	5395	7649	12803	20774	28182	53545	81969	129717	
	140	852	1312	2119	3072	4821	7512	10651	17827	28927	39241	74559	114136	180623	
	135	1027	1581	2555	3704	5812	9056	12841	21492	34874	47309	89887	137602	217757	
	110	1544	2377	3840	5568	8738	13614	19304	32309	52425	71119	135127	206856	327352	
175	40-0	1943	2992	4833	7006	10995	17131	24290	40655	65968	89491	170033	260291	411915	
	170	654	1006	1626	2357	3699	5763	8172	13677	22193	30107	57203	87567	138577	
	165	912	1404	2268	3289	5161	8042	11403	19084	30967	42009	79818	122187	193363	
	160	1102	1697	2741	3973	6236	9716	13776	23057	37414	50755	96434	147624	233618	
200	125	1819	2800	4524	6558	10292	16037	22739	38058	61754	83775	159173	243666	385605	
	48-0	2223	3423	5529	8016	12580	19601	27793	46517	75480	102396	194552	297825	471312	
	195	692	1065	1721	2495	3915	6101	8650	14478	23493	31870	60553	92696	146694	
	185	1170	1802	2911	4220	6622	10318	14630	24487	39733	53901	102413	156776	248100	
250	150	1957	3012	4866	7054	11070	17249	24458	40935	66422	90108	171205	262085	414753	
	56-0	2500	3849	6217	9013	14145	22040	31251	52305	84872	115136	218758	334881	529954	
	245	762	1173	1895	2747	4312	6718	9526	15943	25870	35095	66681	102077	161538	
	235	1295	1993	3220	4668	7326	11415	16185	27089	43955	59629	113295	173435	274463	
250	200	2203	3392	5479	7943	12466	19424	27541	46095	74796	101468	192789	295126	467041	
	73-0	3050	4696	7585	10996	17257	26889	38127	63812	103544	140466	266886	408556	646545	

Based on 10% (2 psi minimum) accuracy of regulation.

RATED STEAM CAPACITY TABLE

TYPE E5 MAIN VALVE — NORMAL PORT

VALVE INFO
PAGE 30

Pounds of Saturated Steam per Hour

INLET	REDUCED	VALVE SIZE (inches)												
		3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6	8	10	12
20	15	213	374	501	741	936	1310	2208	4490	6586	8532	13696	19646	35624
	10	279	490	656	969	1224	1713	2888	5875	8616	11162	17918	25702	46606
	0	331	580	777	1149	1451	2031	3423	6963	10212	13229	21236	30461	55237
	10	229	402	538	796	1005	1406	2371	4822	7072	9161	14706	21095	38252
25	15	303	531	712	1052	1328	1860	3135	6377	9352	12115	19448	27897	50587
	10	345	606	812	1199	1514	2120	3573	7268	10660	13809	22167	31797	57659
	0	379	665	892	1317	1663	2329	3926	7984	11710	15170	24352	34931	63341
	25	244	427	573	846	1068	1496	2522	5129	7522	9745	15643	22438	40688
30	20	325	570	764	1128	1425	1995	3362	6838	10030	12993	20857	29918	54251
	15	374	656	878	1298	1639	2295	3868	7867	11538	14948	23995	34419	62413
	0	426	748	1002	1480	1869	2616	4410	8970	13156	17044	27359	39245	71164
	35	270	474	635	938	1184	1657	2794	5683	8335	10797	17332	24862	45083
40	30	364	639	856	1265	1597	2236	3769	7665	11242	14563	23378	33534	60808
	25	424	744	997	1474	1861	2605	4392	8932	13101	16971	27243	39078	70862
	2-0	517	907	1215	1796	2267	3174	5351	10883	15961	20677	33192	47611	86335
	45	294	515	690	1020	1287	1802	3038	6179	9063	11741	18847	27034	49022
50	40	399	700	938	1386	1750	2450	4130	8399	12319	15959	25618	36748	66636
	35	469	823	1102	1629	2057	2879	4854	9872	14478	18756	30108	43188	78315
	5-0	607	1065	1427	2109	2662	3727	6283	12779	18743	24280	38976	55908	101381
	70	344	604	810	1196	1510	2115	3565	7250	10633	13775	22113	31719	57517
75	65	474	831	1113	1645	2077	2908	4901	9969	14621	18941	30406	43614	79088
	60	563	988	1325	1957	2471	3460	5832	11862	17397	22537	36178	51894	94102
	13-0	829	1455	1950	2881	3638	5093	8585	17461	25609	33175	53255	76390	138521
	95	387	680	911	1345	1699	2378	4009	8154	11960	15493	24871	35675	64691
100	90	536	940	1260	1862	2351	3291	5548	11284	16549	21439	34415	49365	89516
	85	642	1126	1509	2230	2816	3942	6645	13515	19822	25679	41222	59129	107221
	20-0	1049	1840	2465	3642	4599	6439	10854	22075	32377	41943	67330	96580	175132
	120	425	746	999	1477	1865	2610	4400	8950	13127	17005	27298	39157	71004
125	115	591	1036	1389	2052	2591	3627	6114	12434	18237	23625	37925	54401	98646
	110	710	1246	1670	2468	3116	4362	7353	14956	21935	28416	45616	65432	118650
	90	1006	1765	2365	3494	4412	6177	10412	21177	31060	40236	64590	92650	168005
	28-0	1265	2219	2974	4394	5549	7768	13095	26633	39062	50602	81230	116519	211288
150	145	459	806	1079	1595	2014	2820	4753	9667	14178	18367	29484	42293	76692
	140	640	1122	1504	2222	2806	3928	6622	13468	19752	25588	41076	58920	106842
	135	772	1354	1814	2680	3384	4738	7987	16245	23826	30865	49547	71071	128875
	110	1163	2041	2735	4041	5102	7143	12041	24490	35919	46532	74696	107145	194290
175	36-0	1480	2596	3479	5140	6490	9086	15317	31153	45692	59191	95018	136296	247150
	170	491	861	1153	1704	2151	3012	5077	10327	15146	19621	31496	45179	81925
	165	685	1201	1610	2379	3003	4205	7088	14415	21143	27389	43967	63068	114363
	160	828	1452	1946	2875	3630	5082	8567	17424	25556	33106	53144	76232	138233
200	125	1371	2405	3223	4762	6013	8418	14190	28861	42329	54835	88025	126266	228962
	44-0	1693	2971	3981	5882	7427	10397	17527	35647	52283	67309	108725	155958	282803
	195	519	911	1221	1804	2277	3188	5374	10931	16032	20769	33339	47823	86719
	185	879	1542	2066	3053	3855	5396	9097	18502	27136	35153	56430	80945	146780
250	150	1474	2585	3464	5119	6463	9048	15253	31023	45500	58943	94620	135725	246114
	52-0	1904	3340	4476	6614	8351	11691	19708	40084	58790	76160	122257	175369	318002
	245	572	1003	1344	1986	2508	3511	5918	12036	17653	22869	36711	52659	95488
	235	972	1705	2285	3376	4263	5968	10061	20463	30012	38880	62412	89526	162340
250	200	1658	2909	3898	5759	7272	10180	17161	34904	51192	66317	106456	152703	276902
	67-0	2323	4075	5460	8068	10187	14262	24042	48900	71720	92910	149145	213937	387939

Based on 10% (2 psi minimum) accuracy of regulation.

TYPE E5 NORMAL
PORT CAPACITY TABLE

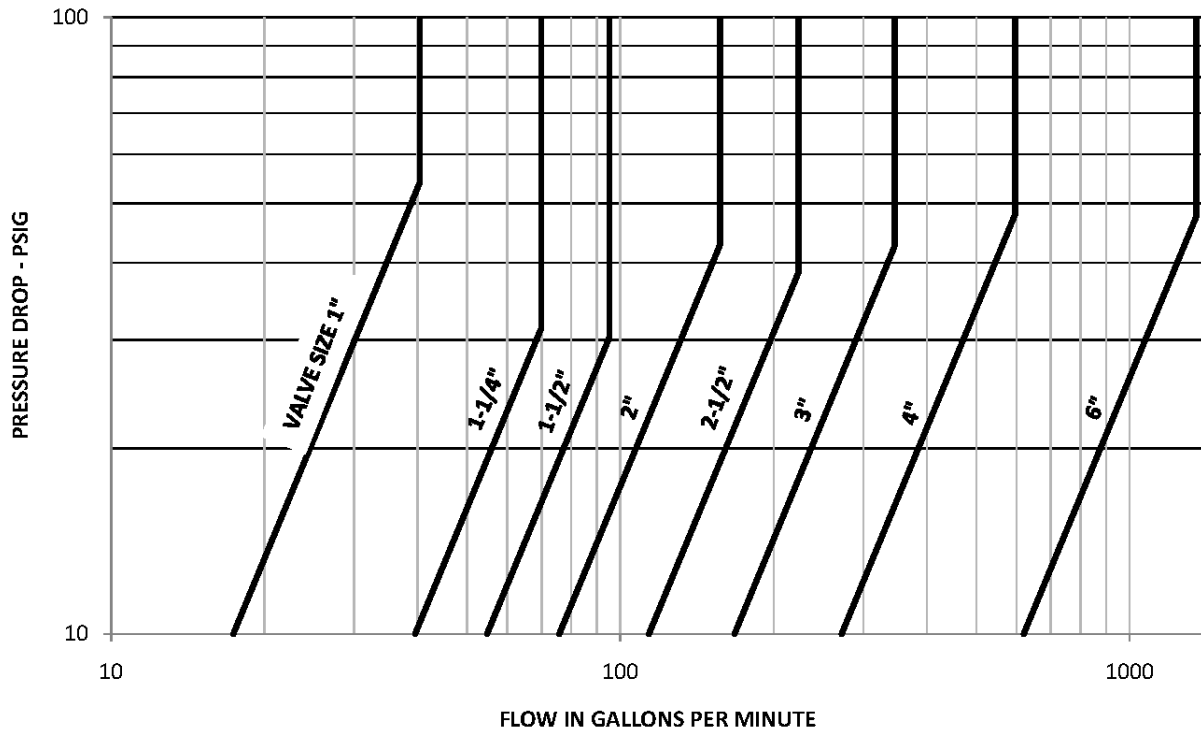
RATED WATER CAPACITY CHART

TYPE C34 PILOT OPERATED MAIN VALVE

(Specific Gravity of 1)

VALVE INFO
PAGE 36

C34 WATER CAPACITY (Assumes Subcritical Flow)



VALVE SIZE SELECTION

Prior to selecting valve size, the maximum required flow and the pressure drop across the valve must be determined. Enter the Capacity Chart at the maximum required flow GPM and follow vertically to the intersection of the horizontal pressure drop line. The valve size nearest to, but to the right of this intersection is the smallest valve that will satisfy the flow requirements.

The vertical portion of the curves indicate the flow at which 15 feet per second velocity is reached. By selecting the next larger size valve, a lower velocity may be maintained. For general service, 8 to 10 feet per second is recommended.

EXAMPLE

Required maximum flow is 100 GPM, Inlet Pressure is 60 psi, Delivery Pressure is 35 psi (Pressure drop is 25 psi). Enter the Capacity Chart at the 100 GPM line and follow up to 25 psi pressure drop. It falls to the right of the 1 1/2" valve size line, therefore 2" is the minimum valve size required.

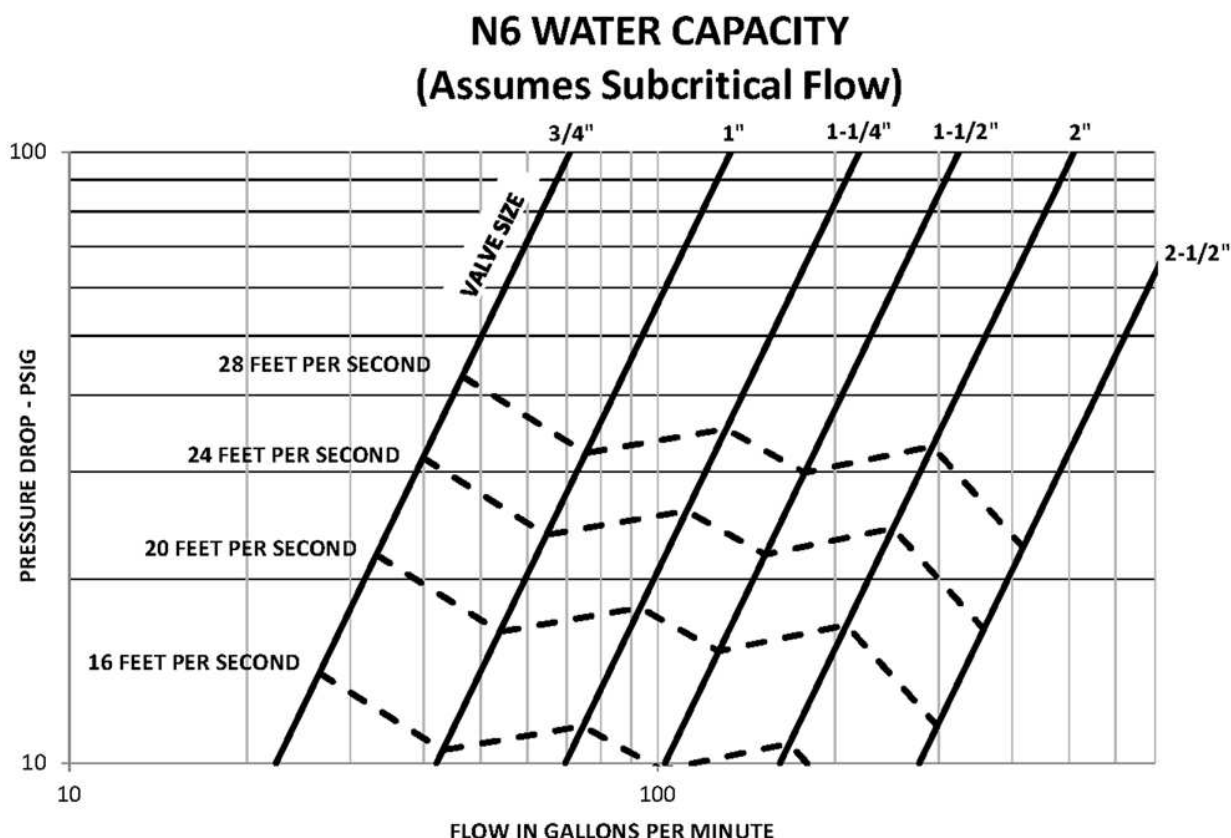
RATED WATER CAPACITY CHART

TYPE N6 DIFFERENTIAL PRESSURE VALVE

(Specific Gravity of 1)

VALVE INFO
PAGE 94

TYPE N6 & D34 WATER
CAPACITY TABLES



RATED WATER CAPACITY TABLE

TYPE D34 VALVE

Water in GPM

PRESSURE DROP-psig	VALVE SIZE (inches)								
	1	1¼	1½	2	2½	3	4	5	6
5	7.4	17	23	32	48	71	116	188	263
10	10	24	33	45	68	101	164	266	373
15	13	29	40	55	84	124	201	325	457
20	15	33	47	64	97	143	233	376	528
30	18	41	51	79	118	175	285	460	646
50	23	53	74	102	153	226	368	594	834
75	29	65	90	125	187	277	450	727	1022
100	33	75	104	144	216	320	520	840	1180
125	37	84	116	161	241	358	581	939	1320
150	40	92	127	176	265	392	637	1029	1445
175	44	100	138	190	285	423	688	1111	1560

SIZING D36 WATER PRESSURE REDUCING VALVE

GENERAL CONSIDERATIONS

When sizing a water valve, the following points should be considered:

- (a) The recommended velocity in the pipe (8-10 ft./sec.)
- (b) The droop which is the fall-off pressure below the no flow pressure setting.

EXAMPLE

SPECIFIED CONDITIONS

Initial Pressure	=	100 PSIG
Reduced No Flow Pressure	=	50 PSIG (lock-up pressure)
Capacity Required	=	30 GPM
Allowable Droop	=	10-15 PSIG

1. Enter Capacities vs. Droop Chart, below, at 30 GPM. Move up until you intersect a curve line (possibly more than one curve). e.g. points (a), (b)...etc.

The lowest point indicates the minimum size valve required (3/4") at a droop of approximately 16 psi.

2. Enter Flow vs. Velocity Chart (left) at 30 GPM and move up until you reach the 3/4" pipe size curve. Move downward and note that the velocity is approximately 18.5 ft./sec., which is unacceptably high.

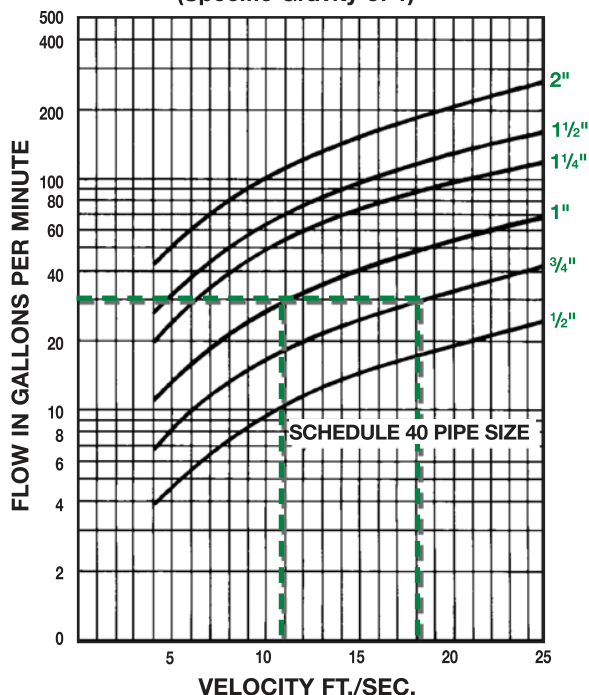
At the point of intersection of 30 GPM with the next valve curve (1"), the velocity will be approximately 11 ft./sec., which is closer to the recommended value.

Referring back to the Capacities vs. Droop Chart, you will find that the droop for a 1" valve is only 11 psig, which is also more acceptable.

SELECT A 1" TYPE D36

NOTE: The capacities shown in the Capacities vs. Droop Chart are based on a difference of 50 psig or more between the initial pressure and the regulator lock-up pressure. Where this difference is less than 50 psig, deduct 20% from the capacity obtained.

FLOW VS. VELOCITY CHART
(Specific Gravity of 1)



VALVE INFO
PAGE 100

CAPACITIES VS. DROOP CHART

