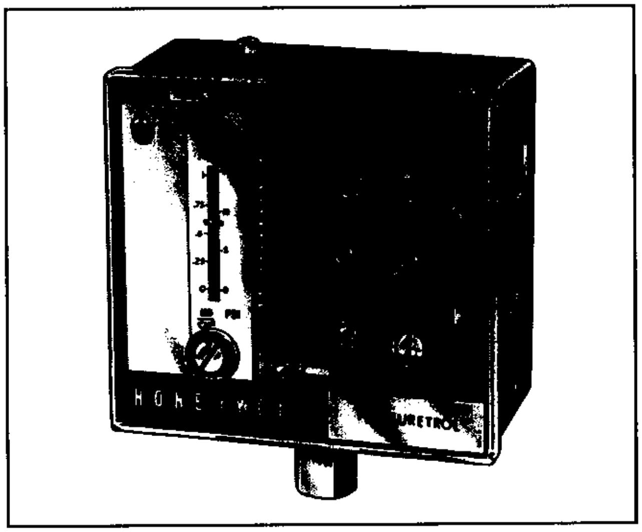
Honeywell

L4079A,B,W PressureTrol® Limit Control

PRODUCT DATA



APPLICATION

The L4079A,B, and W PressureTrol® Limit Controls are high pressure limit switches which break electrical circuits when pressure rises to a preset value.

The L4079A and B can be used with steam, air, noncombustible gases, and fluids noncorrosive to the sensing element.

L4079W is for use on oil burner systems.

FEATURES

- **L4079A has two ganged spst switches; breaks two circuits (may be both sides of the power supply) simultaneously.**
- **L4079B has one spst switch.**
- **L4079W is the same as L4079B, but with seals for oil applications.**
- **MICRO SWITCH® snap-acting switches are visible through transparent cover.**
- **Switches open automatically, but must be reset manually.**
- **Trip-free reset mechanisms do not permit the limiting role of the PressureTrol® Control to be defeated by jamming the reset lever.**
- **Control does not need leveling.**
- **The L4079 is unaffected by moderate vibration.**

Contents

SPECIFICATIONS

Models: See Table 1.
Pressure and Electrical Specifications:

Table 1. Pressure and Electrical Ratings.

Model Number	Range		Maximum Diaphragm Pressure		Ratings in Amperes			
					120 Vac		240 Vac	
	psi	kPa	psi	kPa	Full Load	Locked Rotor	Full Load	Locked Rotor
L4079A[a] and L4079B[b]	2 to 15	15 to 100	25	170	9.8	58.8	4.9	29.4
	5 to 50	35 to 350	85	590	9.8	58.8	4.9	29.4
	10 to 150	70 to 1035	225	1550	9.8	58.8	4.9	29.4
L4079B1066[b]	20 to 300	140 to 2070	350	2410	9.8	58.8	4.9	29.4
L4079W1000[b]	10 to 150	70 to 1035	225	1550	9.8	58.8	4.9	29.4

[a] Ratings apply to each of two separate circuits.
[b] One circuit only.

Switching Action:
L4079A—Snap-switch. Breaks two circuits automatically on pressure rise. Each circuit must be manually reset.
L4079B,W—Snap-switch. Breaks one circuit automatically on pressure rise. Circuit must be manually reset.

Adjustment means: External adjustment screw. Scale is calibrated in psi and kPa.

Maximum Ambient Temperature: 150°F (66°C).

Mounting Means:
Pipe fitting—1/4-18 NPT. Steam trap for mounting furnished on some models. These devices may be either boiler mounted directly to a boiler fitting, or may be surface mounted, such as on a wall, by using the knockouts in the case.

Approvals:
Underwriters Laboratories Inc. (UL) Listed: File No. MP466, Guide No. MBPR. For use in ambient temperatures normally prevailing in occupiable spaces, usually not higher than 77°F (25°C), but may be as high as 104°F (40°C) occasionally and for brief periods.

Accessories:
14026 Steam Trap.
33312B Knurled adjustment knob.

Dimensions: See Fig. 1.

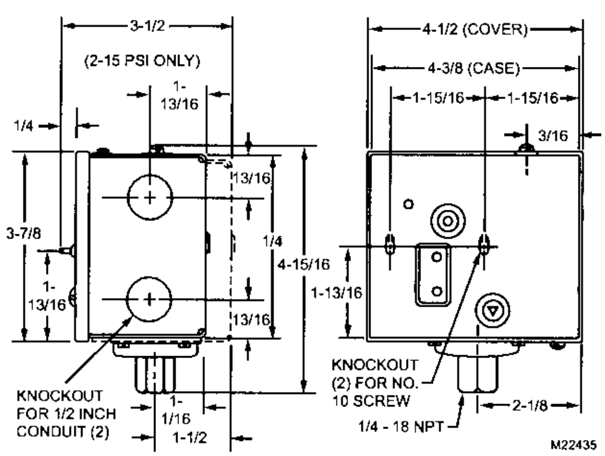


Fig. 1. L4079A,B,W PressureTrol® Limit Control dimensions in in.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

INSTALLATION

When Installing This Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check on the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

Location

PressureTrol® Limit Controllers must be mounted above the water line in steam boilers. They can be mounted alongside the pressure gauge, at a remote location, in a fitting provided by the boiler manufacturer, or in special mountings on low-water cutoffs.

Mounting

See Fig. 1 for mounting dimensions.

A steam trap must always be connected between the PressureTrol® unit and the boiler. The steam trap prevents boiler scale and corrosive vapors from attacking the diaphragm.

Pressure Gauge Mounting:

To mount the limit control beside a pressure gauge, remove the gauge and install in its place a steam trap with a tee on top. Mount the PressureTrol® unit and pressure gauge on the side of the tee by means of nipples and elbows.

Remote Mounting:

If excessive vibration seems likely to affect the operation of the control, it may be located remotely, as long as all piping is suitable and properly pitched to drain all condensation back to the boiler.

Boiler Mounting:

If it is not convenient to mount the control adjacent to the pressure gauge, install a steam trap at a location on the boiler recommended by the boiler manufacturer and screw the unit directly to the steam trap.

WIRING

⚠ WARNING

Electrical Shock Hazard.
Can cause severe injury, death or property damage.
Disconnect the power supply before beginning wiring. More than one power supply disconnect may be required.

All wiring must comply with local codes and ordinances. See Fig. 2 for internal schematics and wiring.

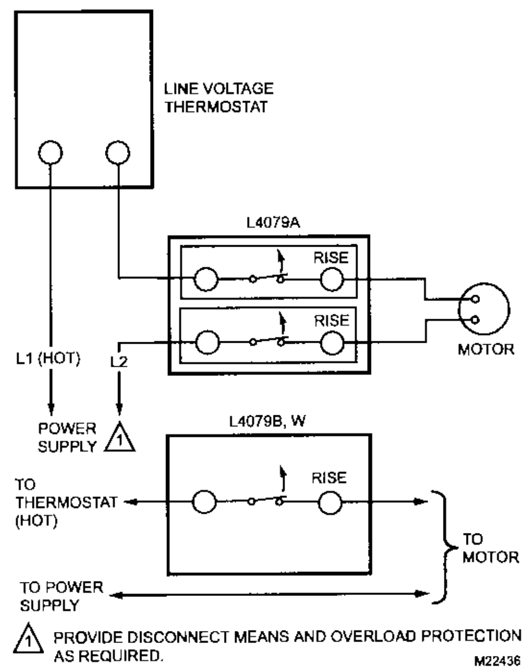


Fig. 2. Schematics and wiring. L4079A breaks both sides of power supply; L4079B,W breaks hot side only.

Setting

To set the control, turn the pressure adjusting screw (see Fig. 3) until the pressure setting indicator on the front of the case is in line with the required control pressure setpoint. The indicator setting is the point at which the switch breaks contact.

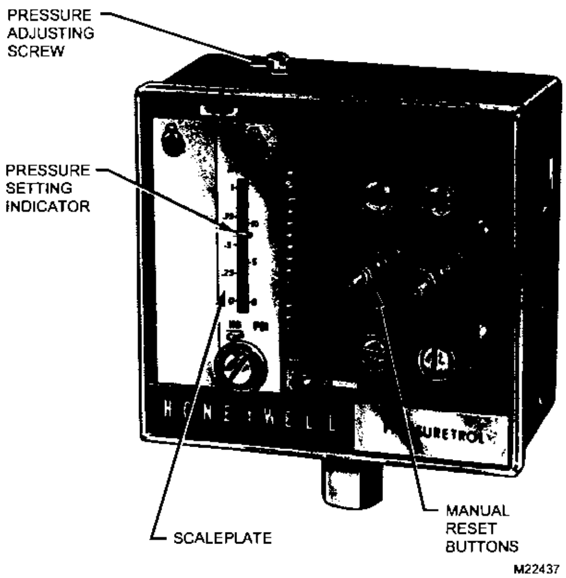


Fig. 3. Controls and indicators on L4079A. L4079B,W is the same except for having only one reset button.

Manual Resetting

When the circuits have broken automatically, they must be manually reset. After the pressure returns to normal, manually reset by depressing the manual reset button(s) firmly and releasing. The circuit is not complete until the reset button is released. The trip-free manual reset mechanism prevents the limit controller from operating as an automatic controller (self-resetting) even if the manual reset button has been tied down.

CHECKOUT

After the control has been installed and wired, test as follows:

Note the boiler pressure by checking the boiler pressure gauge (boiler pressure should be near the middle of the PressureTrol® pressure scale to perform this test properly).

Rotate the PressureTrol® pressure adjusting screw (see FIg. 3) until the pressure setting indicator on the front of the case corresponds to the boiler pressure gauge reading.

The limit control should break the control circuit(s) when the boiler pressure gauge reading equals or slightly exceeds the PressureTrol® pressure setting.

If the limit control is operating properly, manually reset it and adjust the pressure adjusting screw until the pressure setting indicator is in line with the required limit setpoint.

Honeywell

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Honeywell

L6006A Aquastat® Controller

INSTALLATION INSTRUCTIONS

APPLICATION

The Honeywell SUPER TRADELINE® L6006A Controller operates in response to temperature changes in hydronic heating systems. It provides spdt switching for high limit, low limit or circulator control.

The L6006A is designed for horizontal or vertical insertion/mounting using an immersion well (not included). Refer to Wells and Fittings for Temperature Controllers, form 68-0040, for part numbers and ordering information.

A package of heat-conductive compound is included for use when the sensing bulb is inserted into a well designed for a larger bulb.

NOTE: See form 69-0955, 107408, 120650 Heat Conductive Compounds Material Safety Data Sheet (MSDS) when used with this Aquastat® Controller.

A 124904 Well Adapter, for use on old wells that do not fit the L6006A Immersion Well Clamp, can be ordered separately, see form 68-0040. A setting stop is factory-installed to prevent setting above 240°F (116°C) limit. Adjustable differential range is 5°F to 30°F (3°C to 17°C).

Table 1. Electrical Ratings (Amperes):

Type	120 Vac	240 Vac
Full Load	8	5.1
Locked Rotor	48	30.6
Millivoltage	0.25 to 0.25 to 12 Vdc	

INSTALLATION

When Installing this Product...

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

⚠ WARNING

Electrical Shock Hazard.
Can cause serious injury, death or equipment damage.
Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage.

Follow instructions furnished by the system manufacturer, if available. Otherwise, refer to the following procedure.

To install this L6006A as a replacement for other L6006A models:

1. Shut off the power and remove the old control in the existing application. If the old immersion well appears suitable and if the adapter clamp on the L6006A Aquastat Controller fits the old immersion well spud, this immersion well does not need to be replaced.
2. If the immersion well is to be replaced and if the system is filled, drain the system to a point below the boiler tapping.
3. Remove plug (or old immersion well) from boiler tapping.
4. Install new immersion well (not included). When a boiler tapping is greater than 1/2 in. or 3/4 in. NPT, use a reduction fitting to adapt the boiler opening to the 1/2 in. or 3/4 in. NPT threads that are standard with the well or fitting. Use thread seal compound or equivalent on the fitting.

NOTE: Some models have an adjustable tubing length to 3 in. (76 mm). In these models, pull out extra tubing inside the case if needed.

5. Fill the system. Make sure that the well is screwed in tightly enough to prevent leakage. Do not tighten after controller is secured to the well, applying force to the case.
6. Loosen the screw (at the top of the case, above the scale setting), and remove the cover. Loosen the two screws that secure the adapter clamp (See Fig. 1).
7. Determine whether vertical or horizontal mounting method is desired; see Fig. 2 for mounting bracket placement.
8. Insert the sensing element into the immersion well.
9. Fasten the case of the Aquastat Controller to the well with the adapter clamp. Make certain that the clamp is properly positioned over the groove of the well spud. Also be sure the flange at the opening of the well fits snugly into the opening of the case. Be sure the sensing element bulb bottoms in the well.

Wiring

Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage. Make sure all wiring complies with local electrical codes and ordinances. The case has a knockout for 1/2 in. conduit.

Fig. 3 and 4 show typical wiring diagrams of Aquastat Controllers used in heating systems.

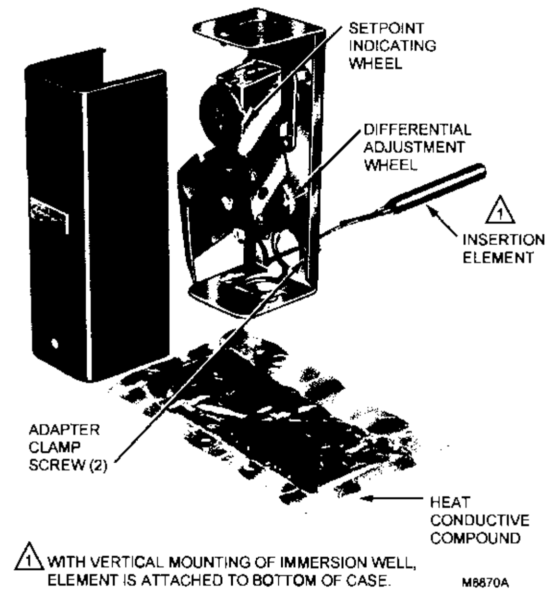

Fig. 1. Internal view of L6006A and accompanying components.

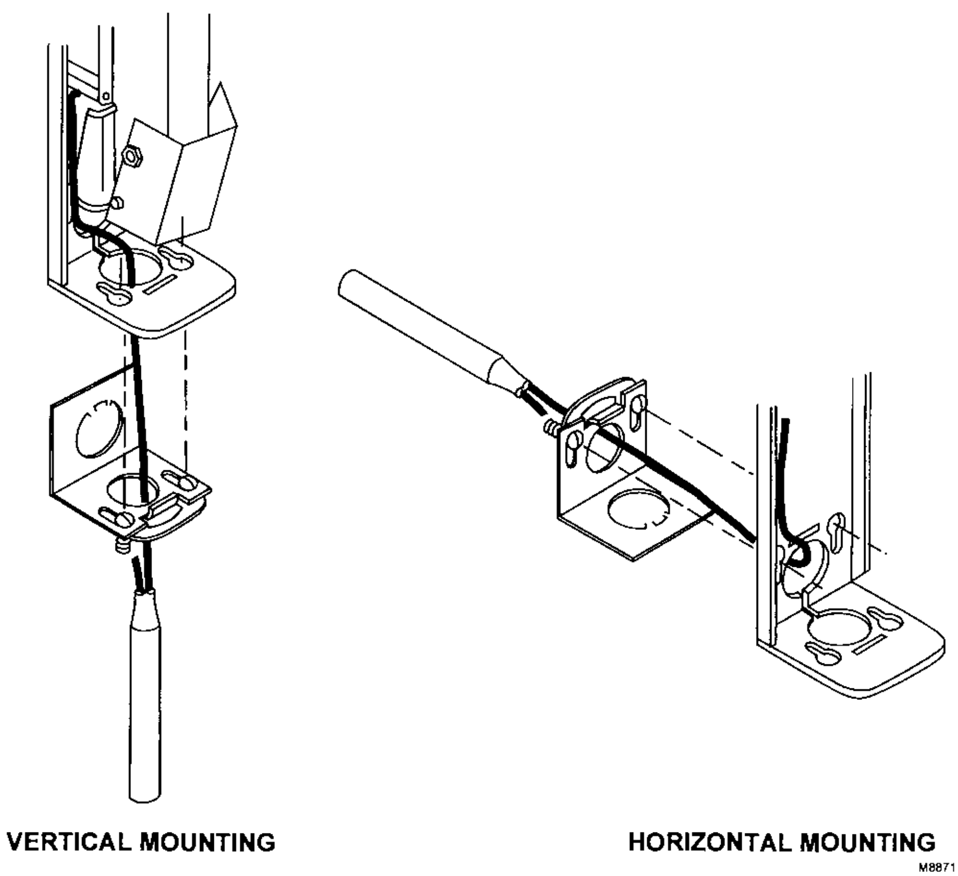

Fig. 2. Mounting bracket placement for vertical or horizontal mounting.

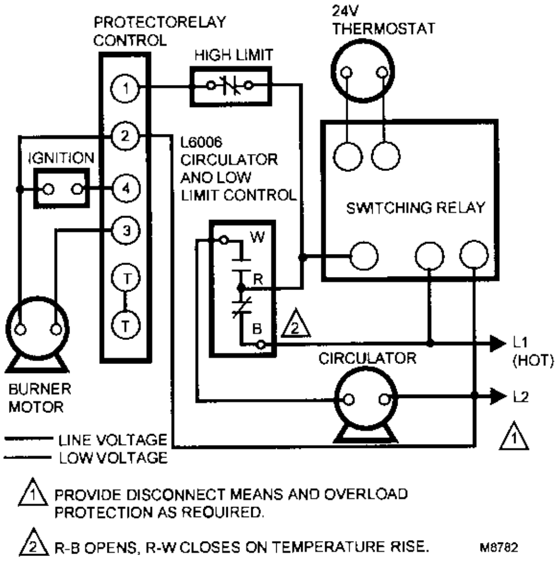

Fig. 3. Typical wiring hookup using L6006 for low limit and circulator control in oil-fired hydronic system.

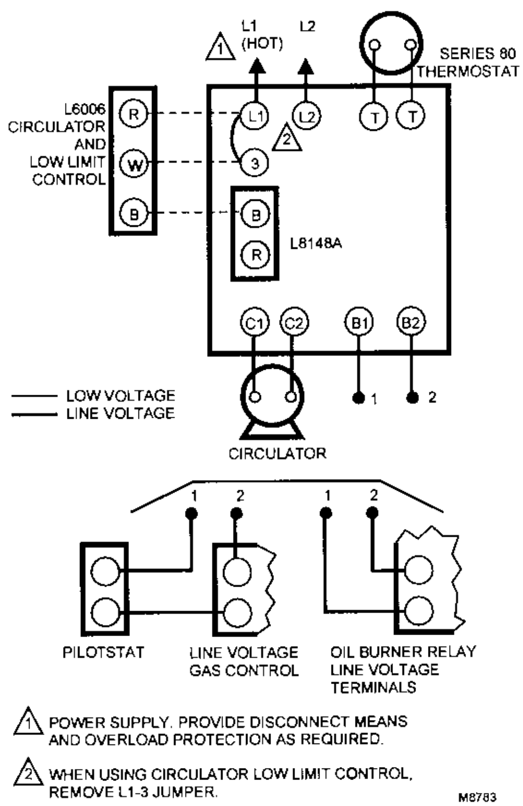

Fig. 4. Typical wiring hookup using L6006 with L8148A Aquastat Relay.

OPERATION

Select control settings according to the heating system manufacturer recommendations.

High-limit Controller—shuts off burner when water temperature exceeds high-limit setting. R-B contacts make, and burner restarts when temperature drops to high-limit setting minus the temperature differential.

Low-limit Controller—maintains minimum water temperature for domestic hot water; e.g., tankless coil in heating boiler. Makes R-B contacts at temperature setting minus differential.

Circulator Controller—prevents circulation of water that is not hot enough. Breaks R-W contacts for circulator circuit at temperature setting minus differential; remakes the R-W contacts for circuit when the temperature setting is reached.

Switching action operates as follows:

> When there is a drop in water temperature (to dial setting, less differential), the R to B contacts make and the R to W contacts break, preventing circulator operation. When there is a rise in water temperature (to dial setting), R to B contacts break and R to W circulator contacts make.

ADJUSTMENT

Set the differential according to the system manufacturer recommendations. Rotate the wheel on the back of the snap switch until the desired reading is aligned with the V notch in the frame. The wheel provides an adjustment from 5°F to 30°F (3°C to 17°C). Replace the cover on the Aquastat Controller.

Adjust the control point according to the system manufacturer recommendations. To adjust, insert a screwdriver in the slotted screw type head located beneath the window in the cover. Turn the scale to the desired control point. Move the factory-set stop if desired, as shown in Fig. 5.

TO CHANGE SETTING, INSERT BENT PAPER CLIP INTO SMALL HOLE IN DIAL AND PUSH ENOUGH TO ALLOW FOR MOVEMENT OF FACTORY-SET STOP.

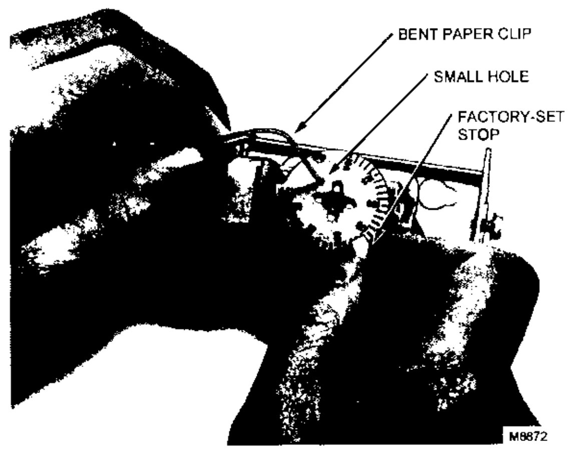

Fig. 5. Moving factory-set stop on L6006A.

CHECKOUT

Check to make certain that the Aquastat Controller was installed and adjusted properly. Put the system into operation and observe the action of the device through several cycles to make certain that it provides proper limit and circulator control.

Honeywell

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70-100 SERIES

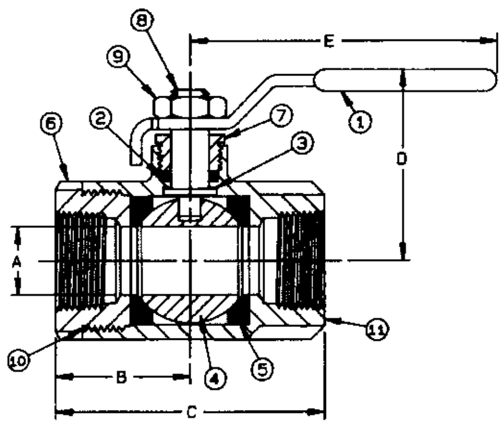
Bronze Ball Valves

Female NPT Thread, 600 CWP (psig), Cold Non-Shock. 150 psig Saturated Steam. (See referenced P/T charts)
Vacuum Service to 29 inches Hg.
MSS SP-110 compliant.

5 YEAR WARRANTY

FEATURES

- Two-piece body
- Reinforced seats
- Blow-out-proof stem design
- Adjustable packing gland



STANDARD MATERIAL LIST

	PART	MATERIAL
1	Lever and grip	Steel, zinc plated w/vinyl
2	Stem packing	MPTFE
3	Stem bearing	RPTFE
4	Ball	B16 Brass, chrome plated
5	Seat (2)	RPTFE (1/4" to 3"); TFM (4")
6	Retainer	B16 Brass (1/4" to 1") B584-C84400 (1.25" to 4")
7	Gland nut	B16 Brass
8	Stem	B16 Brass
9	Lever nut	Steel, zinc plated
10	Body seal	PTFE (1.25" to 4")
11	Body	B584-C84400

PRODUCT NUMBER	SIZE	A	B	C	D	E	WT.
70-101-01	1/4"	0.37	1.03	2.06	1.75	3.87	0.60
70-102-01	3/8"	0.37	1.03	2.06	1.75	3.87	0.56
70-103-01	1/2"	0.50	1.12	2.25	1.75	3.87	0.63
70-104-01	3/4"	0.68	1.50	3.00	2.12	4.87	1.39
70-105-01	1"	0.87	1.68	3.37	2.25	4.87	1.72
70-106-01	1.25"	1.00	2.00	4.00	2.62	5.50	3.26
70-107-01	1.5"	1.25	2.18	4.37	3.06	8.00	4.61
70-108-01	2"	1.50	2.34	4.68	3.25	8.00	6.06
70-109-01A	2.5"	2.00	3.12	6.25	3.72	8.00	17.25
70-100-01	3"	2.50	3.37	6.75	4.12	8.00	18.60
70-10A-01	4"	3.12	3.69	7.37	5.25	9.94	25.50

VARIATIONS AVAILABLE:

70-140 Series	(316 SS Ball & Stem)
70-190 Series	(Locked Retainer)

OPTIONS AVAILABLE: (More information in Section J)

- Minimum quantities apply
- To specify an option, replace the "01" standard suffix with the suffix of the option.
- To specify multiple options, replace the "01" suffix with the desired suffixes in the numerical order shown below. NOTE: Not all suffixes can be combined together.

SUFFIX	OPTION	SIZES
-01	Standard Configuration	All
-P -01-	BSPP (Parallel) Thread Connection	1/4" to 3"
-T -01-	BSPT (Tapered) Thread Connection	1/4" to 3"
-02-	Stem Grounded	1/4" to 4"
-04-	2.25" Stem Extension (Carbon Steel, Zinc Plated)	1/4" to 3"
-05-	Plain Ball	1/4" to 3"
-07-	Steel Tee Handle	1/4" to 2"
-08-	90° Reversed Stem	1/4" to 3"
-10-	SS Lever & Nut	1/4" to 3"
-11-	Therma-Seal™ Insulating Tee Handle	1/4" to 2"
-14-	Side Vented Ball (Uni-Directional)	1/4" to 4"
-15-	Wheel Handle, Steel	1/4" to 2"
-16-	Chain Lever - Vertical	3/4" to 2"
-17-	Rough Chrome Plated - Bronze Valves	1/4" to 3"
-21	UHMWPE Trim (Non-PTFE)	1/4" to 3"
-24-	Graphite Packing	1/4" to 3"
-27-	SS Latch-Lock Lever & Nut	1/4" to 4"
-30-	Cam-Lock and Grounded	1/4" to 2"
-32-	SS Tee Handle & Nut	1/4" to 2"
-35-	PTFE Trim	1/4" to 3"
-36-	SS Hi-Rise Round Handle, SS Nut	1/4" to 2"
-39-	SS Hi-Rise Locking Wheel Handle, SS Nut	1/4" to 2"
-40-	Cyl-Loc and Grounded	1/4" to 2"
-41-	Automatic Drain (Bronze Valves Only)	1/4" to 2"
-45-	Less Lever & Nut	1/4" to 3"
-46-	Latch Lock Lever - Lock in Closed Position Only	1/4" to 3"
-47-	SS Oval Latch-Lock Handle & Nut	1/4" to 2"
-48-	SS Oval Handle (No Latch) & Nut	1/4" to 2"
-49-	No Lubrication. Assembled Dry.	1/4" to 4"
-50-	2.25" CS Locking Stem Extension	1/4" to 3"
-56-	Multifill Seats & Packing	1/4" to 3"
-57-	Oxygen Cleaned	1/4" to 4"
-58-	Chain Lever - Horizontal	3/4" to 2"
-60-	Static Grounded Ball & Stem	1/4" to 3"
-63-	NPT x Solder/Socket Weld	3/8" to 4"
-64-	250# Steam Trim (MPTFE Seats & Packing) *Use with 316 SS Ball & Stem Variation*	1/4" to 3"
-92-	Balancing Stop	1/4" to 3"
-94-	2.25" Stem Extension, Balancing Stop	1/4" to 3"
-HC-	Hose Cap & Chain	1/2" to 1"

FOR PRESSURE/TEMPERATURE RATINGS, REFER TO PAGE M-10, GRAPH NO. 4

FLOW DATA

For Apollo Ball Valves

The listed Cv "factors" are derived from actual flow testing, in the Apollo® Ball Valve Division, Conbraco Industries, Inc., Pageland, South Carolina. These tests were completed using standard "off the shelf" valves with no special preparation and utilizing standard schedule 40 pipe. It should be understood that these factors are for the valve only and also include the connection configuration. The flow testing is done utilizing water as a fluid media and is a direct statement of the gallons of water flowed per minute with a 1 psig pressure differential across the valve/ connection unit. Line pressure is not a factor. Because the Cv is a factor, the formula can be used to estimate flow of most media for valve sizing.

FLOW OF LIQUID

$$Q = C_V \sqrt{\frac{\Delta P}{SpGr}}$$

$$\text{or } \Delta P = \frac{(Q)^2\,(SpGr)}{(Cv)^2}$$

Where:

- Q = flow in US gpm
- ΔP = pressure drop (psig)
- SpGr = specific gravity at flowing temperature
- Cv = valve constant

FLOW OF GAS

$$Q = 1360\, C_V \sqrt{\frac{(\Delta P)\,(P_2)}{(SpGr)\,(T)}}$$

$$\text{or } \Delta P = \frac{5.4 \times 10^{-7}\,(SpGr)\,(T)\,(Q)^2}{(Cv)^2\,(P_2)}$$

Where:

- Q = flow in SCFH
- ΔP = pressure drop (psig)
- SpGr = specific gravity (based on air = 1.0)
- P_2 = outlet pressure–psia (psig + 14.7)
- T = (temp. °F + 460)
- Cv = valve constant

CAUTION: The gas equation shown, is valid at very low pressure drop ratios. The gas equation is NOT valid when the ratio of pressure drop (ΔP) to inlet pressure (P1) exceeds 0.02.

NOTE: Only use the gas equation shown if (P1-P2)/P1 is less than 0.02.

Cv FACTORS FOR APOLLO VALVES

VALVE	Size (in)														
	1/4	3/8	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10	12
70B-140 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
70-100/200 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	---
70-300/400 Series	--	--	15	30	43	48	84	108	--	--	--	--	--	--	--
70-600 Series	2.3	4.5	5.4	12	14	21	34	47	--	--	--	--	--	--	--
70-800 Series	8.4	7.2	15	[illegible]	[illegible]	48	84	--	--	--	--	--	--	--	--
71-AR Series	--	--	--	30	43	48	84	108	190	370	--	--	--	--	--
71-100/200 Series	--	--	[illegible]	30	43	48	84	108	190	370	--	--	--	--	--
72-100/900 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
73A-100 Series	8.4	7.2	15	30	43	48	84	108	--	--	--	--	--	--	--
73-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
74-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
75-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76-AR Series	8.4	7.2	15	30	43	48	84	108	190	370	670	--	--	--	--
76F-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FH-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76FK-100 Series	8.1	15	15	51	68	125	177	389	--	--	--	--	--	--	--
76-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76-300/400 Series	--	--	26	48	65	125	170	216	--	--	--	--	--	--	--
76-600 Series	2.3	[illegible]	[illegible]	[illegible]	14	21	34	47	--	--	--	--	--	--	--
76J-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76J-AR Series	[illegible]	[illegible]	15	30	43	48	84	108	190	370	670	--	--	--	--
76K-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
76K-AR Series	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	48	84	108	190	370	670	--	--	--	--
7K-100 Series	--	--	15	51	68	125	177	389	503	--	--	--	--	--	--
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	68	125	177	389	--	--	--	--	--	--	--
77C-100/200 Series	4.5	7.2	16	36	68	125	177	389	503	--	--	--	--	--	--
77D-100 Series	[illegible]	7.2	16	[illegible]	68	125	177	389	--	--	--	--	--	--	--

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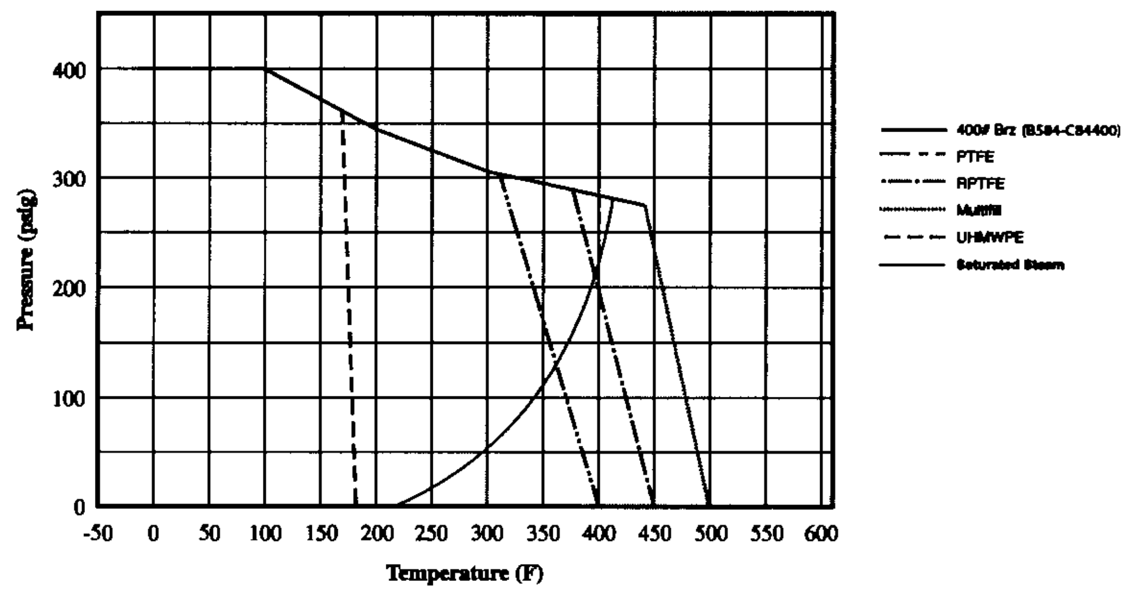
FLOW DATA

For Apollo® Ball Valves

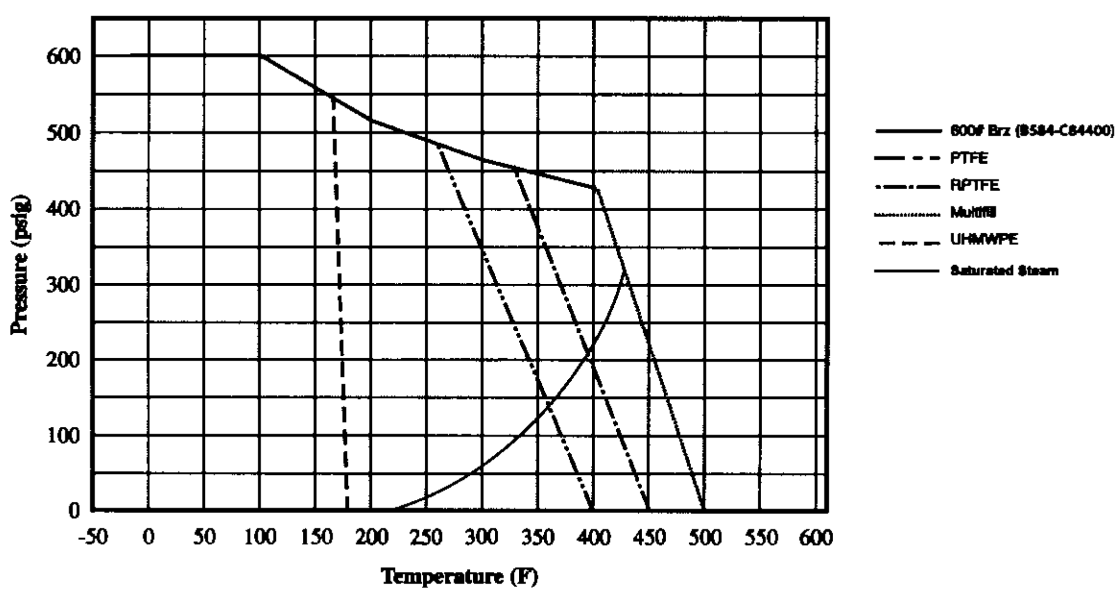
Cv FACTORS FOR APOLLO VALVES (*continued from M-3*)

VALVE	SIZE (IN)														
	1/4	3/8	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10	12
77D-640 Series	--	--	--	11	24	35	--	--	--	--	--	--	--	--	--
77C-100 Series	4.5	7.2	16	[illegible]	[illegible]	125	177	389	505	--	--	--	--	--	--
77W Series	--	--	16	36	68	125	177	389	--	--	--	--	--	--	--
78-100/200 Series	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	177	389	505	--	--	--	--	--	--
79 Series	8.5	8.5	9.8	32	44	66	148	218	440	390	--	--	--	--	--
80 Series	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	370	--	--	--	--	--
82-100/200 Series	8.1	14	26	51	68	120	170	376	510	996	1893	--	--	--	--
83A/83B Series	8.1	14	26	[illegible]	[illegible]	120	170	376	--	--	--	--	--	--	--
83R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
86A/86B Series	8.1	14	26	[illegible]	68	120	170	376	--	--	--	--	--	--	--
86R-100/200 Series	--	--	--	--	--	--	170	376	--	996	1893	--	--	--	--
87A-100 Series	--	--	--	--	--	--	86	104	234	375	673	1099	1902	3890	--
87A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-700 Series	--	--	[illegible]	[illegible]	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
87A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87A-[illegible]00 Series	--	--	[illegible]	[illegible]	75	--	195	410	545	1021	2016	4837	--	--	--
87B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
87J-100 Series	--	--	--	[illegible]	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
87J-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87J-700 Series	--	--	[illegible]	[illegible]	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
87J-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-100 Series	--	--	[illegible]	--	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
87K-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
87K-700 Series	--	--	[illegible]	[illegible]	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
87K-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-100 Series	--	--	[illegible]	[illegible]	[illegible]	--	86	104	234	375	673	1099	1902	3890	--
88A-200 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-700 Series	--	--	[illegible]	[illegible]	--	--	86	104	234	375	673	1099	1902	3890	--
88A-900 Series	--	--	15	19	75	--	195	410	545	1021	2016	4837	9250	15170	22390
88A-[illegible]00 Series	--	--	[illegible]	--	75	--	195	410	545	1021	2016	4837	--	--	--
88B-100 Series	--	--	--	--	--	--	--	--	--	375	673	1099	1902	3890	--
89-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
9A-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
90-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
92-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
93-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
94A-100/200 Series	6	7	19	34	50	104	268	309	629	1018	1622	--	--	--	--
96-100 Series	8.3	6.7	5.7	10	16	25	40	62	--	--	--	--	--	--	--
399-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--
489-100 Series	8.4	7.2	15	30	43	48	84	108	190	370	--	--	--	--	--

PRESSURE TEMPERATURE RATINGS



600 CWP ... Bronze ASTM B584-C84400 ... (GRAPH 4)



BRONZE QUARTER-TURN (TWO-PIECE) BALL VALVE INSTALLATION, OPERATION, & MAINTENANCE GUIDE

INSTALLATION

Special considerations must be taken with respect to pipe line expansions and contractions and the media expansion and contractions within the piping system. Standard Apollo ball valves are bi-directional. They may be installed in either vertical or horizontal pipe runs without regard to flow direction or stem orientation. Lead free (LF) models are available for potable water service.

Threaded End Valves
Pipe connections to be threaded into these valves should be clean and free of foreign material or metal shavings. PTFE pipe tape is recommended for use as the pipe joint sealant. Two wrenches must be used when making up pipe joints to these valves. Apply one wrench on the valve hex closest to the pipe joint being tightened and the other wrench to the pipe to prevent transmitting torque through the valve body joint. Typical wrench make-up is 1-1/2 turns after installing the pipe hand-tight.

Solder End (Sweat) Valves
Refer to ASTM B828 "Standard Practice for Making Capillary Joints by Soldering of Copper Tube and Fittings". Preheat for soldering by concentrating the heat on the pipe or tube first, then the valve solder cup, always directing the heat away from body joint. See figure 1. The extent of this preheating depends on the size of pipe. After preheating direct the heat on the valve cup area (avoiding the body joint) to aid capillary action in drawing the molten filler metal into the cup. See figure 2.

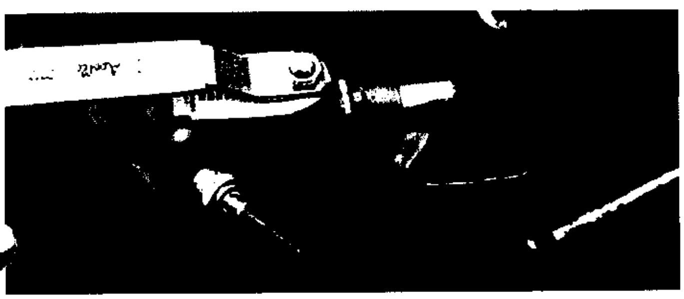


Figure 1 - Preheat tubing

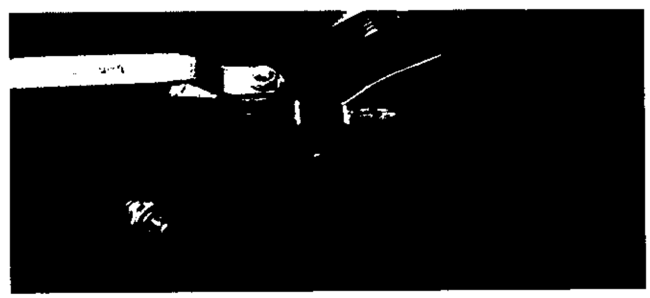


Figure 2 – Heat valve cup area and apply solder

- Horizontal mounting – start applying the filler metal at the bottom of the joint then upward allowing bottoming portion to dam up upper portion.
- Valves should only be soldered in either the fully closed position or fully open position.
- Allow completed joints to cool naturally. Quenching with water will cause unnecessary stress on the joint.
- It is recommended to wrap the valve body with wet rags or employ other heat absorbing techniques to avoid damaging valve seats and thread sealant.
- Tightening stem packing after soldering may be required.

Caution: The Apollo Lead Free alloys do not contain silicon and therefore DO NOT REQUIRE EXTRA HEAT. Excessive heat input will damage the body seal resulting in leaks at the valve body joint. In extreme cases, seats and stem packing may also be damaged.

OPERATION

The valve handle is marked showing proper rotation direction for "ON" and "OFF" positions. Standard rotation is clockwise for "OFF" (closed) and counterclockwise for "ON" (open).

MAINTENANCE

Normal stem packing wear can be compensated for by tightening the packing gland nut. There are two nuts on the stem. The top nut retains the lever. The bottom nut (packing nut or screw) controls the packing gland. The top nut and the lever may need to be removed for easy access to the packing nut. Tighten the packing nut clockwise in 1/8 turn increments until observed leakage stops. (Packing wrench part number H371400 is available to ease this operation.) Reinstall the handle and handle nut after adjustment.

For seat and seal repair please order the appropriate kit shown at http://www.apollovalves.com/products/kits. For repair of seats and seals follow the steps below:

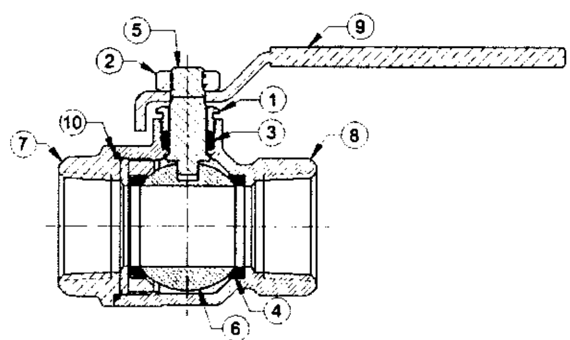
Disassembly

1) Remove valve from service.
2) Operate the valve fully open to fully closed to assure there are no trapped fluids or pressure in the body cavity. Leave the valve in the closed position.
3) Remove the handle nut, handle and packing nut or gland screw. Set aside for reuse.
4) Install pipe plugs in the body and retainer ports of NPT valves to prevent collapsing those areas during disassembly.
5) Remove the retainer from the body and PTFE body seal if applicable. It may be necessary to heat the body joint above 450°F to breakdown the sealant used to secure the valve halves.
6) Remove the ball and stem from the body cavity.
7) Remove the stem packing(s) and seats from the body and retainer then discard.

Re-Assembly

1) Make sure internal portion of the valve is clean before installing new components.
2) Fit stem into body from the retainer end and position the stem with the handle flats perpendicular to the flow axis.
3) Install packing over stem and fit into body recess.
4) Install packing gland and nut or gland screw over stem and onto packing.
5) Secure the stem, thread packing nut/screw on stem hand tight, then wrench tight 1 turn.
6) Install the handle and handle retaining hardware.
7) Apply NSF approved lubricant to body seat and fit into the seat pocket of the body.
8) Install the ball in the closed position.
9) Apply NSF approved lubricant to retainer seat and fit into the seat pocket of the retainer.
10) Install body seal on retainer, if applicable.
11) Apply an adequate amount of thread locking compound (Loctite® 680 or equal) to the retainer threads so that it covers no less than two complete threads opposite of the retainer shoulder.
12) With the ball in the closed position, thread the retainer into the body and tighten securely.
13) Cycle the valve to the open position and verify proper operation and alignment of handle.
14) Final adjustment of packing nut/screw may be required after applying pressure.

Parts Illustration



No.	Description
1	PACKING GLAND
2	STEM NUT
3	PACKING
4	SEAT
5	STEM
6	BALL
7	RETAINER
8	BODY
9	HANDLE
10	BODY SEAL

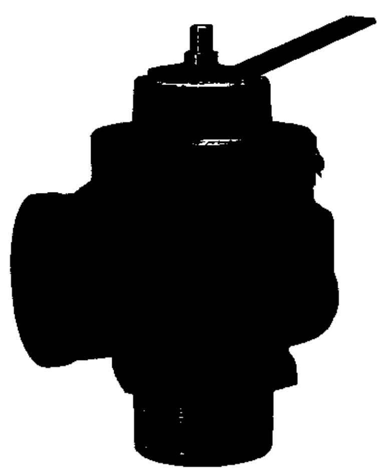
***Warning:* (Required by California) This product contains a chemical known to the state of California to cause Cancer and Birth Defects or other Reproductive Harm.**
***For Non-Lead Free Valves*, it is illegal to use this product in the United States for potable water services (water intended for human consumption).**

EMERSON.

KUNKLE MODEL 930 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

High capacity cast iron safety valve that meets ASME section IV steam standard 'HV' and is National Board certified



FEATURES

- Extra high capacity for industrial, commercial and residential low pressure steam heating boilers.
- Cast iron body with bronze nozzle, disc and guide.
- Large seat area/guide area ratio and disc pivot design ensures optimum performance.
- Seats are lapped for optimum performance.
- Reversible lift lever for 'pull-up' or 'pull-down' manual testing.
- All adjustments factory sealed to prevent tampering or disassembly.
- Tested and inspected for pressure setting and leakage.

GENERAL APPLICATION

Model 930 is suitable for use on low pressure steam heating boilers to ASME code section IV at 15 psig set pressure.

TECHNICAL DATA

Sizes:	2", 2½", 3"
Connections:	Threaded NPT
Temperature:	250°F (121°C)
Pressure:	15 psig (1 barg) only
Code:	ASME IV

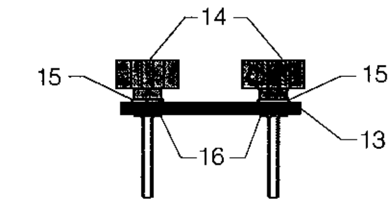
ASME HV

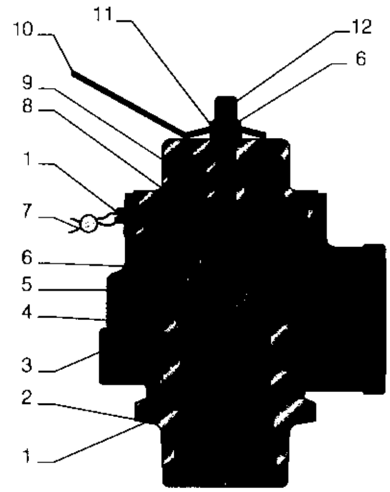
KUNKLE MODEL 930 SAFETY VALVES

SAFETY AND RELIEF PRODUCTS

PARTS AND MATERIALS

No.	Part name	Materials
1	Set screw	SS
2	Nozzle	BRZ B584-C84400 or BRS B283-C48500
3	Disc	BRZ B584-C84400
4	Body	Cast Iron, A126 class A or B1
5	Step spring	Brass B16
6	Snap ring	SS, A151
7	Wire and seal	SS wire and lead seal
8	Spring	Steel, A231 aluminum coated
9[3]	Compression screw guide	BRZ B584-C84400
10	Lever	Steel
11	Lift washer	Brass, B16
12	Stem	SS, A582-303
13[2]	Gag bracket	Aluminum, SB211-6061-T6/anodized
14[2]	Threaded knob	Phenolic/stl, A108-1018 ZN PL
15[2]	Washer	Stl, A108-1018 ZN PL
16[2]	Retaining washer	Nylon



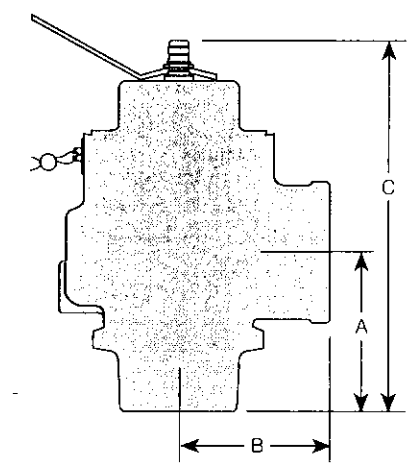


NOTES

1. Finish heat resistant gray primer paint.
2. Gag assembly ships with valve, not installed. Applies only to gag option.
3. Modified with 2 threaded holes for gag assembly. Applies only to gag option.

SPECIFICATIONS[1]

Valve	[redacted]			Weight	Orifice area	Capacity
size[2]	A	B	C	lb	in²	lb/h
2"	3⅞	3	7¼	8	2.16	3164
2½"	3¾	3½	8¼	12	3.08	4501
3"	4¼	4	8¾	19	4.75	6949



NOTES

Dimensions are for reference only.

1. ASME section IV steam (U.S., lb/h): set pressure = 15 psig, flow coefficient = 0.818
2. Inlet and outlet are the same size.

SELECTION GUIDE

Model

0930

Inlet size

H 2"

J 2½"

K 3"

Variation

01 Catalog standard

02 With gag

Contents

Kunkle Technical Reference Catalog
Revised July 1999
Catalog: KTR-US.98

A tyco INTERNATIONAL LTD. COMPANY

I. Definitions and Commonly Used Terms

A.S.M.E.
American Society of Mechanical Engineers.

A.P.I.
American Petroleum Institute

PRV
Relief Valve, Safety Valve, Safety Relief Valve.

Back Pressure
The pressure that exists at the outlet of a pressure relief device as a result of the pressure in the discharge system. It is the sum of the superimposed and built-up back pressures.

Built-up Back Pressure
The increase in pressure in the discharge header that develops as a result of flow after the pressure relief device opens.

Blowdown
The difference in pressure between the opening pressure and reclose pressure. May be expressed in percent of set pressure or 'psig'.

Body/Nozzle/Seat
The stationary seating surface, the inlet.

Cap
The pressure screw cover and/or lever housing. May be screwed, bolted, packed, or plain lever.

Chatter
Abnormal, rapid reciprocating movement of the disc on the seat of a pressure relief valve.

Coefficient of Discharge
The ratio of the measured relieving capacity to the theoretical relieving capacity.

Disc
The moveable seating surface.

Gag
A device attached to a safety or safety relief valve that prevents it from opening at the set pressure.

Guide
That portion of the valve used to guide the disc.

Lift
The distance between the seat and disc seating surfaces when the valve is in the full open position.

MAWP
Maximum allowable working pressure. This data is found on the pressure vessel nameplate and is the maximum pressure at which the lowest set safety valve must be set (stamped).

N.B.
National Board of Boiler and Pressure Vessel Inspectors.

Operating Pressure
The gauge pressure at which a pressure vessel is maintained in normal operation. The operating pressure should not be in excess of 90 percent of the PRV set pressure.

Accumulation
The permitted increase in pressure developed after the valve has opened. Usually expressed in percentage, maximum allowable accumulations are established by applicable codes for operating and fire contingencies.

Pre-open/Warn
An audible or visual discharge at a pressure slightly lower than the set pressure. Warns the operator that the valve is about to operate.

Pressure Relief Device
A device actuated by inlet static pressure and designed to open during an emergency or abnormal condition to prevent a rise of internal fluid pressure in excess of a specified value. The device may also be designed to prevent excessive internal vacuum. The device may be a pressure relief valve, a non-reclosing pressure relief device, or a vacuum relief valve.

PSIA
Pounds per square inch absolute or absolute pressure. Absolute pressure is equal to gauge pressure plus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

PSIG
Pounds per square inch gauge or gauge pressure. Differential pressure across the valve, equal to absolute pressure inside the pressure vessel minus atmospheric pressure (14.7 psi [1.01 barg] at sea level).

Relief Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve. The valve opens normally in proportion to the pressure increase over the opening pressure. A relief valve is used primarily with incompressible fluids (liquids).

Safety Relief Valve
A spring-loaded pressure relief valve that may be used as either a safety or relief valve depending on the application.

Safety Valve
A spring-loaded pressure relief valve actuated by the static pressure upstream of the valve and characterized by rapid opening or pop action. A safety valve is normally used with compressible fluids.

Set Pressure
The gauge pressure at which a safety valve visibly and audibly opens or at which a relief valve discharges a 1-inch long unbroken stream of liquid.

Spindle/Stem
The rod connecting to the disc.

Stamped Capacity
The rated relieving capacity that appears on the device nameplate. The stamped capacity is based on the set pressure or burst pressure plus the allowable overpressure for compressible fluids and the differential pressure for incompressible fluids.

Superimposed Back Pressure
The static pressure that exists at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system coming from other sources and may be constant or variable.

Warn Ring or Regulator Ring
The control ring which surrounds the seat, used to control preopen and blowdown.

Yoke/Bonnet
The portion of a safety/relief valve that surrounds the spring; the spring housing.

II. ASME Codes

The ASME (American Society of Mechanical Engineers) boiler and pressure vessels code requirements for overpressure protection as they relate to Kunkle products is as follows:

ASME Section I

This code applies to boilers where steam or other vapor is generated at a pressure greater than 15 psig [1.03 barg] and high temperature water boilers intended for operation at pressures exceeding 160 psig [11.03 barg] and/or temperatures exceeding 250°F [121°C].

Boiler Pressure Accumulation

No more than 6 percent above the highest pressure at which any valve is set, or no more than 6 percent above MAWP.

Set Pressure

The set pressure of a one valve installation cannot be higher than the MAWP. The set pressure of the second or other valves in a multiple valve installation can be up to 3 percent above the MAWP. The complete range of valve settings for multiple valve installations cannot be greater than 10 percent of the highest set pressure. For high temperature water boilers, this 10 percent range may be exceeded.

ASME Section IV

This code applies to steam boilers operating at pressures not greater than 15 psig [1.03 barg] and hot water heating boilers operating at pressures not greater than 160 psig [11.03 barg] and/or temperatures not exceeding 250°F [121°C].

Steam Boilers

Valve capacity must be selected to prevent the boiler pressure from rising more than 5 psig [0.35 barg] above the MAWP.

Hot Water Boilers

Safety valve must be set to relieve at a pressure not greater than the MAWP of the boiler. If more than one safety valve is used, the secondary valve(s) may be set up to 6 psig [0.41 barg] above the MAWP for boilers with MAWP's up to and including 60 psig [4.13 barg], and 5 percent for boilers with MAWP's greater than 60 psig [4.13 barg]. Capacity must be selected to prevent the pressure from rising more than 10 percent above the set pressure of the highest set valve if more than one valve is used.

Tanks/Heat Exchangers High Temperature Water-to-Water Heat Exchangers

Valve(s) must be set at a pressure not greater than the MAWP and with sufficient capacity to prevent the pressure from increasing more than 10 percent above the MAWP.

Steam to Hot Water Supply

Valve(s) must be a least 1-inch [25 mm] diameter with set pressure not greater than MAWP of the tank.

High Temperature Water to Steam Heat Exchanger

Valve(s) must be set at a pressure not greater than 15 psig [1.03 barg] and with sufficient capacity to prevent the pressure from rising more than 5 psig [0.35 barg] above the MAWP.

ASME Section VIII

This code applies to unfired pressure vessels with an inside diameter larger than 6 inches [130 mm] and designed for use above 15 psig [1.03 barg]. Valve(s) must prevent the pressure from rising more than 10 percent or 3 psig [0.21 barg], whichever is greater, above the MAWP. For a single valve installation, the set pressure may not be greater than the MAWP. For multiple valve installations, the first valve cannot be set higher than the MAWP, but the other valves can be set up to 5 percent above the MAWP. The pressure rise for multiple valve installations can be 16 percent or 4 psig [0.27 barg], whichever is greater. When the vessel is exposed to an external heat source, such as fire, the pressure rise can be 21 percent above the MAWP.

Notes

1. MAWP - Maximum allowable working pressure.
2. Information stated above is based on latest code at time of publication.

II. ASME Codes – Requirements

National Board

Kunkle valves are manufactured at facilities that meet the manufacturing requirements of the ASME Sections I, IV, and VIII codes for pressure relief valves. Valves that have the relief capacity certified by the National Board of Boiler and Pressure Vessel Inspectors bear the following code symbol stamp on the name-plate and the letters NB. Most Kunkle Valves have NB certified capacities.

Code Stamps

'V' - applies to all ASME Section I valves

'HV' - applies to all ASME Section IV valves

'UV' - applies to all ASME Section VIII valves

Notes

1. Information stated above is based on latest code at time of publication.
2. Non-code liquid valves are capacity rated at 25 percent overpressure.
3. Non-code air/gas/vapor and steam valves are capacity rated at 10 percent overpressure.

Power Boiler - Section I - Code 'V'

Set Pressure psig	[barg]	Set Pressure Tolerance		Blowdown	
15 – 66	[1.03 – 4.55]			2 – 4 psig	[0.14 – 0.28 barg]
67 – 250	[4.62 – 17.24]			6%	
251 – 374	[17.31 – 25.79]			15 psig	[1.03 barg]
375 – 1000	[25.86 – 68.96]			4%	
15 – 69	[1.03 – 4.75]	±2 psig	[±0.14 barg]		
70 – 300	[4.83 – 20.69]	±3%			
301 – 1000	[20.95 – 68.96]	±10% psig	[±0.69 barg]		
1001 and up	[69.03 and up]	±1%			

Overpressure would be 2 psig [0.14 barg] for pressures between 15 psig [1.03 barg] and 70 psig [4.83 barg]. Pressures above 70 psig [4.83 barg] would have an overpressure of 3%.

Heating Boiler - Section IV - Code 'HV'

	Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 psig Steam	15	[1.03]	±2 psig [±0.14 barg]	2 – 4 psig [0.14 – 0.28 barg]	5 psig [0.34 barg]
Hot Water	15 – 60	[1.03 – 4.14]	±3 psig [±0.21 barg]	N/A	10%
Hot Water	61 – 160	[4.20 – 11.0]	±5%	N/A	10%

Unfired Pressure Vessel - Section VIII - Code 'UV'

Set Pressure psig	[barg]	Set Pressure Tolerance	Blowdown	Overpressure
15 – 30	[1.03 – 2.07 barg]	±2 psig [±0.14 barg]	N/A	3 psig [0.21 barg]
31 – 70	[2.14 – 4.83 barg]	±2 psig [±0.14 barg]	N/A	10%
71 and up	[4.90 barg and up]	±3%	N/A	10%

Non-code Set Pressure Tolerance

Set Pressure, psig [barg]	Set Pressure Tolerance, psig [barg]
Below 15 psig [1.03 barg] to 10 psig [0.69 barg]	+/- 2.0 psig [±0.14 barg]
Below 10 psig [0.69 barg] to 5.0 psig [0.34 barg]	+/- 1.0 psig [±0.07 barg]
Below 5.0 psig [0.34 barg] to 0.0 psig [0.0 barg]	+/- 0.5 psig [±0.003 barg]
Below 0.0-inch Hg [0.0 mb] to 10-inch Hg [337 mb]	+/- 1.0-inch Hg [±33.7 mb]
Below 10-inch Hg [337 mb] to 20-inch Hg [674 mb]	+/- 2.0-inch Hg [±67.4 mb]
Below 20-inch Hg [674 mb]	+/- 4.0-inch Hg [±134.8 mb]

III. General Safety and Relief Valve Information

The terms 'safety valve' and 'relief valve' are frequently used interchangeably. This is satisfactory to the extent that both safety and relief valves of the spring-loaded type are similar in external appearance and both serve the broad general purpose of limiting media (liquid or gaseous) pressures by discharging some of the pressurized liquid or gas. Some authorities restrict 'safety valves' to those installed on boilers, superheaters, and fired vessels - all others being classified as relief valves. We prefer, however, to define them briefly as follows:

Safety valves are used on gaseous service (which include air and steam). Their design always includes a huddling chamber which utilizes the expansion forces of these gases to effect quick opening (popping) and closing actions. The difference between the opening and closing pressures is termed 'blowdown', and for Section I and IV steam safety valves blowdown limitations are carefully stated in the ASME Power Boiler Code. Relief valves are normally used for liquid service, although safety valves may be so used. Ordinarily, relief valves do not have an accentuated huddling chamber nor a regulator ring for varying or adjusting blowdown. They therefore operate with a semi-modulating action in proportion to the system pressure. Such relieving action is desirable to protect piping systems from water hammer.

Seat Tightness Performance Standards (optional)

Model	Code Section	Service	Performance Standard
300/600	I and VIII	Steam	API 527 - No visible leakage for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
6010 (O-ring seat) **916/917 (soft seat)** **918/919 (soft seat)**	**VIII**	**Air/Gas**	**API 527 - Bubble-tight for 1 minute at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.**
910/912 911/913	VIII	Air/Gas	API 527 - D and E orifice: 40 bubbles/min, F thru J orifice: 20 bubbles/min at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
916/917 (soft seat) **918/919 (soft seat)**	**VIII**	**Liquid**	**API 527 - No leakage for 1 minute at 10% below nameplate set pressure, or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.**
910/912 911/913	VIII	Liquid	API 527 - 10 cc/h for inlet sizes less than 1-inch or 10 cc/h/in of inlet valve size for inlet sizes 1-inch and larger at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.

Seat Tightness Performance Standards *(default standard)*

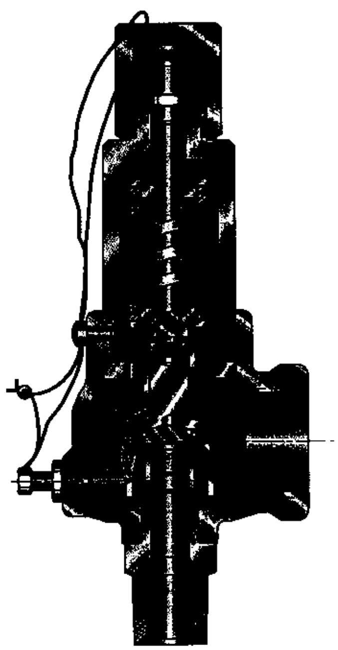
Code Section	Service	Performance Standard
I and VIII	Steam	No visible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
VIII	**Air/Gas**	**No audible leakage for 15 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.**
IV and VIII	Liquid	No visible leakage for 30 seconds at 20% below nameplate set pressure or at 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.
IV	**Steam**	**No visible leakage for 30 seconds at 12 psig [0.83 barg].**

IV. Safety and Relief Valve Pointers

1. ASME Codes require that steam and air safety valves have test levers, although levers may be omitted on valves used in hazardous or toxic gas service.
2. Steam safety valves may be used for air service but not vice versa. Liquid valves should be used on liquid only.
3. Safety/relief valves should be installed vertically with the drain holes open or piped to a convenient location.
4. The inlet to and outlet from a safety/relief valve must be at least as large as the valve connections.
5. Every safety/relief valve is individually tested and set by Kunkle. Steam, air, and gas valves are sealed to prevent tampering. Liquid valves are adjustable plus or minus 20 percent.
6. In the event you have safety/relief valve problems, first check the accuracy and cleanliness of pressure gauges and then refer to "Recommended Installation" for help in determining the cause of your problem. Feel free to consult us in these matters; we would like to help.
7. When ordering, we need to know size, type of connections, model number, pressure setting, required relieving capacity, and service media, or advise your complete requirements so that we can make a selection for you.
8. Following are procedures on the operation and testing of safety/ relief valves:
   a. Avoid excessive operation of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
   b. Test the valve by raising the operating pressure to the set pressure of the safety/relief valve, allowing it to open and reset as it would in normal service.
   c. Do not hand operate the valve with less than 75 percent of the stamped set pressure exerted on the underside of the disc. When hand operating, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

V. Safety and Relief Valve Principles of Operation

Kunkle direct spring operated pressure relief valves consist of a nozzle threaded into a cast body housing which is flanged to a pressurized system. A disc is held against the nozzle by a spring, which is contained in a bonnet. The spring is adjusted by a compression screw to permit the calibration of opening or set

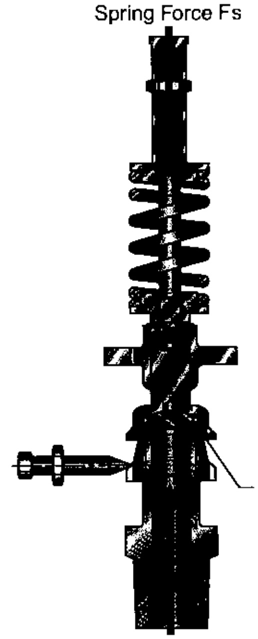


pressure. An adjustable nozzle ring, threaded onto the nozzle, controls the geometry of the fluid exit control chamber (huddling chamber). The huddling chamber geometry is very important in controlling valve opening and closing pressures, and stability of operation. The nozzle ring is locked into position by a ring pin assembly. A cap attached to the top of the bonnet seals the internal calibration adjustments. Refer to the illustration above for the location of these important components.

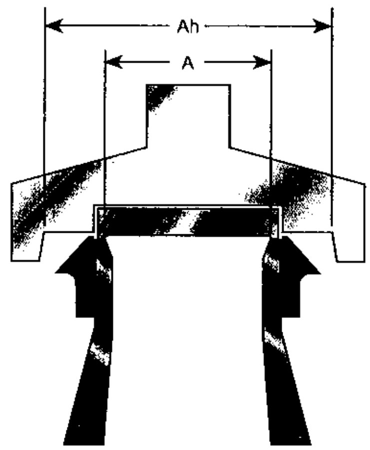
Under normal system operation the valve remains in the closed position because the spring force (Fs) is greater than the system pressure acting on the internal nozzle seating area (PA). If system pressure increases to a point when these forces are equal, the valve begins to simmer. The disc lifts and fluid flows through the valve. When pressure in the system returns to a safe level, the valve closes.

Just prior to reaching set point, the pressure relief valve leaks system fluid into the huddling chamber. The fluid now acts on a larger area of the disc inside the huddling chamber (PAh), causing the valve to experience an instantaneous increase in the opening force. Refer to the Figure on page 7 to see relationship between Nozzle Area (A) and the Huddling Chamber Area (Ah). System pressure acting on the larger area will suddenly open the pressure relief valve at a rapid rate.

Although the opening is rapid and dramatic, the valve does not open fully at set point. The system pressure must increase above the set point to open the valve to its full lift and full capacity position. Maximum lift and certified flow rates will be achieved within the allowable limits (overpressure) established by various codes and standards. All pressure relief valves are allowed an overpressure allowance to reach full rated flow.

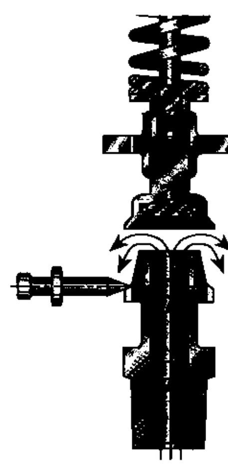


V. Safety and Relief Valve Principles of Operation



Relationship of Nozzle Area to Huddling Chamber Area

Once the valve has controlled the pressure excursion, system pressure will start to reduce. Since the huddling chamber area is now controlling the exit fluid flow, system pressure must reduce below the set point before the spring force is able to close the valve. The difference between the set pressure and the closing pressure is called blowdown, and is usually expressed as a percentage of set pressure. Refer to code for appropriate blowdown.



Valve Opens, Force P_{Ah} Acting on Disc

The nozzle ring adjustment changes the shape and volume of the huddling chamber, and its position will affect both the opening and closing characteristics of the valve. When the nozzle ring is adjusted to its top position, the huddling chamber is restricted to its maximum. This ring position will usually make the valve pop very distinctly with a minimum simmer (leakage before opening), but the blowdown will increase. When the nozzle ring is lowered to its lowest position, minimal restriction to the huddling chamber occurs. At this position, simmer increases and the blowdown decreases. The final ring position is somewhere between these two extremes to provide acceptable performance.

Liquid Service Operation

On liquid service, a different dynamic situation exists. Liquids do not expand when flowing across orifices, and a small amount of fluid flow across the nozzle will produce a large local pressure drop at the nozzle orifice. This local pressure drop causes the spring to reclose the valve if the fluid flow is minimal. Liquids leaking into the huddling chamber can quickly drain out by gravity and prevent fluid pressure from building up on the secondary area of the huddling chamber. Liquid relief valves are thus susceptible to a phenomenon called chatter, especially at low fluid flow rates. Chatter is the rapid opening and closing of the pressure relief valve and is often destructive in nature.

Since no visible or audible pop is heard at set point, liquid set pressure is defined as the pressure when the first heavy flow occurs (a stream of water falls off the outlet flange and remains unbroken for about one-inch).

VI. Ordering Information

Purchase orders must show the Size, Model Number, Set Pressure, and Service. (Include flange rating with size when applicable.)

1. To make a proper catalog selection, the following information will be needed:

   A. Connection sizes (in and out), and types (male, female, flanged; 125#, 150#, 250#, 300#, etc.)

   B. Material of construction

      a. Bronze

      b. Iron

      c. Steel

      d. Stainless Steel or other

   C. Pressure setting

   D. Service (steam, air, gas, etc., including any applicable codes or standards)

   E. Capacity required, if available

   F. Unusual conditions (temperature, location, etc.)

      Be sure to use the capacity correction factors for superheated steam, liquid overpressure (10 percent), air-gas temperature and density correction.

   G. If valve is to be 'equal to' another brand, provide nameplate information or specification data from brand being replaced.

2. Ordering data for replacement valves may be obtained from the valve nameplate or stamping.

VII. Valve Selection

The most critical consideration when selecting a pressure relief valve is that the valve will be capable of passing the maximum expected flow capacity. To properly select a relief valve the user must first determine the following:

1. The set pressure at which the valve is to operate. This pressure is based on the pressure limits of the system and the applicable codes. The set pressure of the primary pressure relief valve must not exceed the maximum allowable pressure of the system, but should be at least 10 percent above the maximum operating pressure.
2. The physical properties of the fluid media to be relieved. Capacity values are given in the Kunkle catalogs based on air, saturated steam, and water. Kunkle valves will relieve many other fluids, but information such as molecular weight, specific gravity, viscosity, ratio of specific heats, compressibility factor, and process temperature may be necessary to insure accurate valve selection.
3. The required relieving capacity. The ASME Boiler and Pressure Vessel Code, American Petroleum Institute Recommended Practices, and other applicable standards have many rules for obtaining the required relieving capacity and should be referenced when making this determination. The user must consider all sources of pressure generation in the system that will be protected by the pressure relief valve. Examples of pressure generation sources are pumps, heat input that may cause the system fluid to boil or expand, etc. The pressure relief valve(s) selected must exceed the worst case source of flow generation in order to prevent the system pressure from exceeding acceptable limits.

Once the previous information has been collected, the pressure relief valve may be sized by using the capacity charts (included in each model's catalog sheet) or by performing sizing calculations (see Valve Sizing, pages 13 - 24). The user will also want to consider other important factors such as:

- **Connection size and type.** This information is given in the Valve Selection Guide and in each of the Model Catalog sheets. Please note that the inlet to and outlet from a pressure relief valve must be at least as large as the valve connections to prevent valve malfunction.
- **Pipe Size.** Connection pipe sizes should not be determined by equipment connections, but rather by the relieving capacity of the PRV.
- **Applicable code compliance.** The ASME Code Summary section gives important information about pressure relief valves from the code. Pressure relief valve users are strongly encouraged to reference the full version of the code for important rules that may not be included in this manual.
- **Maximum allowable seat leakage.** The General Safety and Relief Valve Information (page 4) section of this manual shows the leakage acceptance criteria applied to each Kunkle valve. Pressure relief valve users should keep in mind that if 'zero leakage' is a requirement, a soft seated valve must be selected.
- **Environmental conditions.** Environmental conditions play a significant role in how pressure relief valves operate. Extremely high ambient temperatures may affect the set pressure of the valve, extremely low temperatures combined with moisture can cause valves to 'freeze up' and prevent proper operation, and vibration may severely shorten the service life of the valve. The Valve Selection Guide (pages 10 -12) in this manual has general information on the pressure and temperature limits for each valve series. For specific model limitations refer to the individual model catalog. For vibration service, please contact your local Kunkle representative for assistance.
- **Valve options.** Each Kunkle model is offered with useful options such as pressure tight caps, lift lever options, or vibration dampening preparation. When selecting valve options, keep in mind that there are code requirements that may dictate what options may be used. For instance the ASME code dictates that all air, steam and hot water (140°F+ [60°C+]) pressure relief valves must be equipped with a lift lever. Refer to the individual model catalogs for listings of available options.
- **Installation space.** The individual model catalogs show envelope dimensions for each configuration and size.

For assistance on valve sizing and selection, please contact your local Kunkle representative.

VIII. Valve Selection Guide

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range, in	[mm]	Min/Max[1] Press. psig	[barg]	Min/Max Temp. °F	[°C]
Steam (ASME Section I - Power Boilers)										
300, 600	CS	SS		X	1 1/4 - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-29/427]
920, 921, 927 (special use – 10% blowdown)	CS	SS	X		1/2 - 2"	[12.7 - 50.8]	15/800	[1.0/55.2]	-20/800	[-29/427]
6010, 6021, 6121, 6182 6186, 6221, 6283	Bronze	Brass	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/250	[0.69/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/300	[0.69/20.7]	-60/425	[-51/219]
6252	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]
6253	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]
Steam (ASME Section VIII - Unfired Steam Equipment)										
1 and 2	Bronze	Brass	X		1/2 - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS		X	1 1/4 - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/750	[-29/399]
910	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-20/800	[-29/427]
911	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/800	[-51/427]
912	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/250	[0.21/17.2]	-60/406	[-51/208]
913	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-60/425	[-51/219]
6010, 6021, 6121, 6182, 6186, 6221, 6283	Bronze	Brass	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6230	Bronze	SS	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]
6253	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]
Steam (ASME Section IV - Low Pressure Steam Heating Boilers)										
930	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	15 only	[1.03]	250 only	[122]
6933, 6934	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	15 only	[1.03]	250 only	[122]
6935	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	15 only	[1.03]	250 only	[122]
6254	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	15 only	[1.03]	250 only	[122]
Steam (Non-code)[2]										
40R, 40RL	SS	SS	X		1/2 - 3/4"	[12.7 - 19.05]	1/400	[0.07/27.6]	-60/850	[-51/454]

X = Standard O = Optional

Notes

1. Set pressures less than 15 psig [1.03 barg] are non-code only.
2. See also ASME Section VIII steam valves for non-code steam applications.

VIII. Valve Selection Guide

Air/Gas (ASME Section VIII)

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range, in	[mm]	Min/Max Press. psig	[barg][1]	Min/Max Temp. °F	[°C]
1 and 2	Brass	Brass	X		1/2 - 1"	[12.7 - 25.4]	5/250	[0.34/17.2]	-60/406	[-51/208]
30	Brass	Brass	X		1/4"	[6.35]	60/4000	[4.1/275.8]	20/300	[-6.6/150]
189	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	1000/2500	[69/344.8]	-320/350	[-195/177]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
300, 600	CS	SS	X		1 1/4 - 6"	[31.75 - 152.4]	15/1000	[1.0/69]	-20/800	[-29/427]
330 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	1000/5500	[69/379.3]	-20/185	[-29/85]
330S, 333S (Kynar® seat)	Aluminum	SS			1/4"	[6.35]	2000/6500	[138/448.3]	-20/185	[-29/85]
337	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	1/60	[0.07/4.14]	-20/406	[-29/208]
363	Bronze	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/1000	[3.4/69]	-320/350	[-195/177]
389	SS	SS	X		1/2 - 3/4"	[12.7 - 19.05]	50/2500	[3.4/344.8]	-320/350	[-195/177]
541 (Buna disc), 542 (Viton® disc), 548 (SS disc)	Brass	Brass	X		1/4 - 1/2"	[6.35 - 12.7]	3/400	[0.21/27.6]	-20/400	[-29/204]
910, 916 (soft seat)	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-20/800	[-29/427]
911, 917 (soft seat)	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/800	[-51/427]
912, 918 (soft seat)	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-60/406	[-51/208]
913, 919 (soft seat)	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/425	[-51/219]
6010, 6021, 6121, 6182 6186, 6221, 6283[1]	Bronze	Brass	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/250	[0.21/17.2]	-60/406	[-51/208]
6030, 6130, 6320	Bronze	SS	X		1/2 - 2 1/2"	[12.7 - 63.5]	3/300	[0.21/20.7]	-60/425	[-51/219]
6252	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]
6253	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	10/250	[0.69/17.2]	-20/406	[-29/208]

Air/Gas[2] (Non-code)

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range, in	[mm]	Min/Max Press. psig	[barg]	Min/Max Temp. °F	[°C]
230 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	300/1500	[20.7/103.4]	-20/185	[-29/85]
803 (Kynar® seat)	Aluminum	SS	X		1/4"	[6.35]	1000/6000	[69/413.8]	-20/185	[-29/85]
818 (Teflon® seat)	CS	SS/Brass	X		2"	[50.8]	120/150	[8.3/10.3]	-20/300	[-29/150]

Air/Gas (Vacuum) in Hg [mm Hg]

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range, in	[mm]	Min/Max in Hg	[mm Hg]	Min/Max Temp. °F	[°C]
215V	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	2/29	[50/736]	-20/406	[-29/208]
910, 916 (soft seat)	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-20/800	[-29/427]
911, 917 (soft seat)	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-60/800	[-51/427]
912, 918 (soft seat)	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-60/406	[-51/208]
913, 919 (soft seat)	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-60/425	[-51/219]

X = Standard   O = Optional

Notes

1. Soft seat available on some models.
2. See also Section VIII air valves for non-code steam applications.
3. Set pressures below 15 psig [0.105 barg] are non-code only.

VIII. Valve Selection Guide

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range, in [mm]		Min/Max[1] Press. psig	[barg]	Min/Max[2] Temp. °F	[°C]
Liquid (ASME Section IV - Hot Water Boilers)										
537 (soft seat)	Iron/Bronze	Brass	X		3/4 - 2"	[19.05 - 50.8]	15/160	[1.0/11]	-20/250	[-29/208]
Liquid (ASME Section VIII)										
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/800	[-51/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-60/406	[-51/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/425	[-51/219]
Liquid (Non-code)										
19, 20	Bronze	Bronze	X	O	1/2 - 3"	[12.7 - 76.2]	1/300	[0.07/20.7]	-60/406	[-51/208]
19M, 20M	Bronze	SS	X	O	2 1/2 - 3"	[63.5 - 76.2]	1/500	[0.07/34.5]	-60/406	[-51/208]
71S	Iron	SS	X		1/2 - 2"	[12.7 - 50.8]	1/250	[0.07/17.2]	-20/406	[-29/208]
171, 171P	CS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/406	[-29/208]
171S	SS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/406	[-29/208]
91	Iron	Bronze	X	X	1 1/2 - 6"	[38.1 - 152.4]	5/400	[0.34/27.6]	-20/406	[-29/208]
218,228	Iron	Bronze	X		3, 4, and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
140	SS	SS	X		3/8 - 1/2"	[9.5 - 12.7]	10/300	[0.69/20.7]	-60/406	[-51/208]
264, 265	CS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
266, 267	SS	SS	X		1/2 - 1"	[12.7 - 25.4]	4/3300	[0.28/227.6]	-20/750	[-29/399]
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/800	[-51/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-60/406	[-51/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/900	[0.21/62.1]	-60/425	[-51/219]
Liquid - Underwriters Laboratories (UL) For Oil Services										
200A	Bronze	Brass	X		3/4 - 1 1/2"	[19.05 - 38.1]	10/200	[0.69/13.8]	-60/406	[-51/208]
200H	Bronze	SS	X	O	3/4 - 2"	[19.05 - 50.8]	1/200	[0.07/13.8]	-60/406	[-51/208]
Liquid - Underwriters Laboratories (UL) and Factory Mutual Research (FM) For Fire Pump Water Relief										
218, 228	Iron	Bronze	X	X	3, 4 and 6"	[76.2 - 152.4]	60/200	[4.1/13.8]	-20/406	[-29/208]
Other - Drip Pan Elbow										
299	Iron	N/A	X	X	2 - 8"	[50.80 - 203.2]	N/A	N/A	-20/406	[-29/208]

X = Standard O = Optional

Note

1. Set pressures below 15 psig [.105 barg] are non-code only.
2. Temperature limits of soft seats determine operating limit of valve.

IX. Valve Sizing

After the required relieving capacity has been determined, the pressure relief valve may be sized by using the capacity charts that are included in each model's catalog sheet. The capacities given in those charts may be adjusted for special conditions such as fluid density and temperature by using the correction factors given in Tables B through D (pages 17 - 19). Valves may also be sized by performing sizing calculations per the formulas (pages 14 and 15) in this section.

Most Kunkle valves may be sized by using the 'Coefficient Method' (listed below). These valves typically are high lift valves where the nozzle bore is the flow controlling orifice. This calculation method involves selecting the valve model and corresponding flow coefficient and orifice area from Table A (page 16) and then using the capacity formula (page 14) for the service in which the valve will function.

Kunkle Models 30, 541, 542, and 548 use the 'Slope Method' for sizing calculations. These valves are typically low lift valves, where the annular orifice between the disc and the nozzle seat is the flow controlling orifice. These models are characterized by having a linear increase in capacity with respect to inlet pressure. The 'slope' defines this direct relationship of inlet pressure to capacity. Consult the factory for sizing assistance.

Kunkle Models 1, 2, 19, 20, 200, 71S, 171, 171S, 91, 218, 228, and 140 use the 'KA Method' for sizing calculations. This method is similar to the slope method, in that it is used for low lift valves and is empirically derived. The major difference is that the relationship between inlet pressure and capacity is not linear. These valves are characterized by having low lift that varies with inlet pressure, which makes the flow controlling orifice area indeterminate. Consult the factory for sizing assistance.

IV-A Coefficient Method

Follow these steps for calculating what orifice size is necessary to flow the required capacity:

1. Select the Model Family that you are interested in from the Valve Selection Guide (pages 10 - 12).
2. From Table A (page 16), record the Flow Coefficient (K_d) corresponding to the service in which the valve will operate.
3. Select the proper formula(s) for the service in which the valve will operate. Calculate the minimum required orifice area.
4. Select the Orifice/Size Designation from Table A (page 16) that has a Flow Area closest to, but not less than the minimum required orifice area calculated in step 3.

IX. Valve Sizing

English Units — **Metric Units**

Steam - Sections I, IV and VIII (15 psig and above)

English Units:

$$A = \frac{W}{51.5\,K_d\,P_1\,K_{sh}}$$

Metric Units:

$$A = \frac{W}{52.5\,K_d\,P_1\,K_{sh}}$$

Steam - Non Code (less than 15 psig)

English Units:

$$A = \frac{W}{735\,F_2\,K_d}\sqrt{\frac{TZ}{M\,P_1\,(P_1 - P_2)}}$$

Metric Units:

$$A = \frac{W}{558\,F_2\,K_d}\sqrt{\frac{TZ}{M\,P_1\,(P_1 - P_2)}}$$

Air - Section VIII (15 psig and above)

English Units:

$$A = \frac{V\sqrt{MTZ}}{6.32\,C\,K_d\,P_1}$$

Volumetric Flow

$$A = \frac{W}{C\,K_d\,P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

Metric Units:

$$A = \frac{V\sqrt{MTZ}}{17.02\,C\,K_d\,P_1}$$

Volumetric Flow

$$A = \frac{1.316W}{C\,K_d\,P_1}\sqrt{\frac{TZ}{M}}$$

Mass Flow

Air - Non-Code (less than 15 psig)

English Units:

$$A = \frac{V}{4645.2\,F_2\,K_d}\sqrt{\frac{MTZ}{P_1\,(P_1 - P_2)}}$$

Metric Units:

$$A = \frac{V}{12503\,F_2\,K_d}\sqrt{\frac{MTZ}{P_1\,(P_1 - P_2)}}$$

Liquid - Section VIII (15 psig and above)

English Units:

$$A = \frac{Q}{38\,K_d}\sqrt{\frac{G}{(p_1 - p_2)}}$$

Metric Units:

$$A = \frac{Q}{5.094\,K_d}\sqrt{\frac{G}{(p_1 - p_2)}}$$

Liquid - Non-Code

English Units:

$$A = \frac{Q}{38\,K_d}\sqrt{\frac{G}{(1.25\,p_1 - p_2)}}$$

Metric Units:

$$A = \frac{Q}{5.094\,K_d}\sqrt{\frac{G}{(1.25\,p_1 - p_2)}}$$

F_2 - Coefficient of Subcritical Flow

$$F_2 = \sqrt{\left(\frac{k}{k-1}\right)(r)^{2/k}\left[\frac{1 - r^{(k-1)/k}}{1 - r}\right]}$$

Note

1. Consult factory for sizing assistance for product groups: Fig. 1 and 2; Fig. 19, 20, 200; Fig. 30; Fig. 71S, 171, 171S; Fig. 91, 218, 228; Fig. 140; and Fig. 541, 542 and 548.

IX. Valve Sizing

Sizing Coefficient Method

A	=	Required effective discharge area of the valve, in^2 [cm^2]
W	=	Mass Flow Rate, lb/hr [kg/hr]
V	=	Volumetric Flow Rate (gases, vapors) in SCFM [Nm^3/hr] at standard atmospheric conditions of 14.7 psia and 60°F [1.013 bara/0°C]
Q	=	Volumetric Flow Rate (liquids) in GPM [m^3/hr] at standard atmospheric conditions of 14.7 psia and 70°F [1.013 bara/21°C]
K_d	=	ASME Flow Coefficient of Discharge
P_1	=	See chart below
P_2	=	Atmospheric Pressure = 14.7 psia
p_1	=	Set Pressure (psig)
p_2	=	Back Pressure (psig)
F_2	=	Coefficient of Subcritical Flow
k	=	Ratio of Specific Heat - 1.31 for Steam, 1.4 for Air
r	=	Ratio of Back Pressure to Upstream Relieving Pressure = P_2/P_1
M	=	Molecular Weight of Process Medium
T	=	Relieving Temperature, °R = °F + 460 [°K = °C + 273]
Z	=	Compressibility Factor (assume Z = 1 if unknown)
C	=	Gas Constant based on k (if unknown, use C = 315)
G	=	Specific Gravity of process fluid at 70°F [21°C]
K_{sh}	=	Superheat Steam Correction Factor

Allowable Overpressure

Designation	Section	Allowable Dverpressure
P_1	Section I Steam (15 psig and above)	Set pressure + 3% or 2 psi overpressure (whichever is greater) + 14.7 psia
P_1	**Section IV Steam (15 psig and above)**	**Set pressure + 5 psi overpressure + 14.7 psia for Low Pressure Steam Boilers**
P_1	Section IV Hot Water (15 psig and above)	Set pressure + 10% overpressure + 14.7 psia for Hot Water Boilers
P_1	**Non-Code Steam (below 15 psig)**	**Set pressure + 10% overpressure + 14.7 psia**
P_1	Section VIII Steam (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	**Non-Code Air (below 15 psig)**	**Set pressure + 10% overpressure + 14.7 psia**
P_1	Section VIII Air (15 psig and above)	Set pressure + 10% or 3 psi overpressure (whichever is greater) + 14.7 psia
P_1	**Non-Code Liquid (below 15 psig)**	**Set pressure (psig)**
P_1	Section VIII Liquid (15 psig and above)	Set pressure (psig)

IX. Valve Sizing

Table A

Model Family	Orifice/Size Designation	Flow Area in²	[cm²]	Flow Coefficient (K_d): Non-Code and ASME Section VIII Air/Gas and Steam	ASME Section I Steam	ASME Section IV Steam	Non-Code and ASME Section VIII Liquid
189	C	0.034	[0.219]	0.874			
	D	0.034	[0.219]	0.874			
264	C	0.110	[0.710]	0.766			0.408
	D	0.110	[0.710]	0.766			0.408
	E	0.110	[0.710]	0.766			0.408
337	H	1.838	[11.858]	0.860			
	J	2.786	[17.974]	0.860			
	K	4.037	[26.045]	0.860			
537	D	0.533	[3.439]			0.806	
	E	0.833	[5.374]			0.806	
	G	1.767	[11.400]			0.806	
	H	3.142	[20.271]			0.806	
910	D	0.121	[0.781]	0.878	0.878		0.710
	E	0.216	[1.394]	0.878	0.878		0.710
	F	0.337	[2.174]	0.878	0.878		0.710
	G	0.553	[3.568]	0.878	0.878		0.710
	H	0.864	[5.574]	0.878	0.878		0.710
	J	1.415	[9.129]	0.878	0.878		0.710
930	H	5.080	[32.774]			0.818	
	J	6.350	[40.968]			0.818	
	K	7.620	[49.161]			0.818	
6010	D	0.121	[0.781]	0.878	0.878	0.878	
	E	0.216	[1.394]	0.878	0.878	0.878	
	F	0.337	[2.174]	0.878	0.878	0.878	
	G	0.553	[3.568]	0.878	0.878	0.878	
	H	0.864	[5.574]	0.878	0.878	0.878	
	J	1.415	[9.129]	0.878	0.878	0.878	
6252	J	1.414	[9.123]	0.878	0.878	0.878	
	K	2.022	[13.045]	0.878	0.878	0.878	
	L	3.138	[20.245]	0.878	0.878	0.878	
	M	3.960	[25.548]	0.878	0.878	0.878	
	N	4.774	[30.800]	0.878	0.878	0.878	
	P	7.018	[45.277]	0.878	0.878	0.878	
	Q	12.155	[78.419]	0.878	0.878	0.878	
	R	17.600	[113.548]	0.878	0.878	0.878	

IX. Valve Sizing (continued on page 18)

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 280 [138]	300 [149]	320 [160]	340 [171]	360 [182]	380 [193]	400 [205]	420 [216]	440 [227]	460 [238]	480 [249]	500 [260]	520 [271]	540 [282]	560 [293]
15	[1.03]	250	[121]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
20	[1.38]	259	[126]	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92	.91	.90
40	[2.76]	287	[142]		1.00	1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
60	[4.14]	308	[153]			1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92	.91	.90
80	[5.52]	324	[162]				1.00	1.00	.99	.99	.98	.97	.96	.94	.93	.92	.91	.90
100	[6.90]	338	[170]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
120	[8.27]	350	[177]					1.00	1.00	.99	.98	.97	.96	.95	.94	.93	.92	.91
140	[9.65]	361	[183]						1.00	1.00	.99	.98	.96	.95	.94	.93	.92	.91
160	[11.0]	371	[188]						1.00	1.00	.99	.98	.97	.95	.94	.93	.92	.91
180	[12.4]	380	[193]							1.00	.99	.98	.97	.96	.95	.93	.92	.91
200	[13.8]	388	[198]							1.00	.99	.99	.97	.96	.95	.93	.92	.91
220	[15.2]	395	[202]							1.00	1.00	.9	.98	.96	.95	.94	.93	.92
240	[16.6]	403	[206]								1.00	.99	.98	.97	.95	.94	.93	.92
260	[17.9]	409	[210]								1.00	.99	.98	.97	.96	.94	.93	.92
280	[19.3]	416	[213]								1.00	1.00	.98	.97	.96	.95	.93	.92
300	[20.7]	422	[217]									1.00	.99	.98	.96	.95	.93	.92
350	[24.1]	436	[225]									1.00	1.00	.99	.96	.96	.94	.93
400	[27.6]	448	[231]										1.00	.99	.96	.96	.95	.93
450	[31.0]	460	[238]											1.00	.96	.96	.96	.94
500	[34.5]	470	[243]											1.00	.96	.96	.96	.94
550	[37.9]	480	[249]												.97	.97	.97	.95
600	[41.4]	489	[254]												.97	.97	.97	.97
650	[44.8]	497	[258]													1.00	.99	.97
700	[48.3]	506	[263]													1.00	.99	.97
750	[51.7]	513	[267]													1.00	1.00	.98
800	[55.2]	520	[271]														1.00	.99
850	[58.6]	527	[275]														1.00	.99
900	[62.1]	533	[278]														1.00	1.00
950	[65.5]	540	[282]															1.00
1000	[69.0]	546	[286]															1.00
1050	[72.4]	552	[289]															1.00
1100	[75.9]	558	[292]															
1150	[79.3]	563	[295]															
1200	[82.7]	569	[298]															

IX. Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 580 [305]	600 [316]	620 [326]	640 [338]	660 [349]	680 [360]	700 [371]	720 [382]	740 [393]	760 [405]	780 [416]	800 [427]	900 [482]	1000 [537]	1100 [593]
15	[1.03]	250	[121]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
20	[1.38]	259	[126]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
40	[2.40]	287	[142]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
60	[4.14]	308	[153]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
80	[5.52]	324	[162]	.89	.89	.88	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
100	[6.90]	338	[170]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
120	[8.27]	350	[177]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
140	[9.65]	361	[183]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
160	[11.0]	371	[188]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
180	[12.4]	380	[193]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
200	[13.8]	388	[198]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.78	.75	.72
220	[15.2]	395	[201]	.91	.90	.89	.88	.87	.86	.85	.84	.8	.83	.82	.81	.78	.75	.72
240	[16.6]	403	[206]	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.81	.78	.75	.72
260	[17.9]	409	[209]	.91	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.81	.78	.75	.72
280	[19.3]	416	[213]	.91	.90	.91	.88	.87	.86	.85	.85	.84	.83	.82	.82	.78	.75	.72
300	[20.7]	422	[217]	.91	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.78	.75	.72
350	[24.1]	436	[224]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.83	.82	.78	.76	.72
400	[27.6]	448	[231]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.79	.76	.72
450	[31.0]	460	[238]	.93	.92	.91	.89	.88	.87	.86	.86	.85	.84	.83	.82	.79	.76	.72
500	[34.5]	470	[243]	.93	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
550	[37.9]	480	[249]	.94	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
600	[41.4]	489	[254]	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.84	.83	.79	.76	.73
650	[44.8]	497	[258]	.95	.94	.92	.91	.90	.89	.87	.86	.86	.85	.84	.83	.79	.76	.73
700	[48.3]	506	[263]	.96	.94	.93	.91	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
750	[51.7]	513	[267]	.96	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
800	[55.2]	520	[271]	.97	.95	.94	.92	.91	.90	.88	.87	.86	.85	.84	.84	.80	.76	.73
850	[58.6]	527	[275]	.98	.96	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.76	.73
900	[62.1]	533	[278]	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.77	.73
950	[65.5]	540	[282]	.99	.97	.95	.94	.92	.91	.89	.88	.87	.86	.85	.84	.80	.77	.73
1000	[69.0]	546	[286]	.99	.98	.96	.94	.93	.91	.90	.89	.87	.86	.85	.84	.80	.77	.73
1050	[72.4]	552	[289]	1.00	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.80	.77	.73
1100	[75.9]	558	[292]	1.00	.99	.98	.95	.94	.92	.91	.89	.88	.87	.86	.85	.81	.77	.73
1150	[79.3]	563	[295]	1.00	.99	.98	.96	.94	.92	.91	.90	.88	.87	.86	.85	.81	.77	.73
1200	[82.7]	569	[298]	1.00	.99	.98	.97	.95	.93	.91	.90	.89	.87	.86	.85	.81	.77	.73

IX. Valve Sizing

Table C - Air and Gas Temperature Correction Factors

Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc
0	1.062	90	0.972	260	0.849	440	0.760
10	1.051	100	0.964	280	0.838	460	0.752
20	1.041	120	0.947	300	0.828	480	0.744
30	1.030	140	0.931	320	0.817	500	0.737
40	1.020	160	0.916	340	0.806	550	0.718
50	1.009	180	0.902	360	0.796	600	0.701
60	1.000	200	0.888	380	0.787	650	0.685
70	0.991	220	0.874	400	0.778	700	0.669
80	0.981	240	0.862	420	0.769	750	0.656

For temperatures other than 60°F at valve inlet, multiply standard SCFM by Tc.

Table D - Gas and Liquid Relative Density Correction Factors

Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc
0.07	3.770	0.60	1.290	1.05	0.975	1.70	0.768
0.08	3.530	0.65	1.240	1.10	0.955	1.80	0.745
0.09	3.333	0.70	1.195	1.15	0.933	1.90	0.725
0.10	3.160	0.75	1.155	1.20	0.913	2.00	0.707
0.20	2.240	0.80	1.117	1.25	0.895	2.50	0.633
0.30	1.825	0.85	1.085	1.30	0.877	3.00	0.577
0.40	1.580	0.90	1.055	1.40	0.845	3.50	0.535
0.50	1.414	0.95	1.025	1.50	0.817	4.00	0.500
0.55	1.350	1.00	1.000	1.60	0.791	4.50	0.471

For a specific gravity other than air or water (=1.0), multiply CFM or GPM by Dc.

IX. Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Acetone	58.08	1.12	329
Acetylene (Ethyne)	26.04	1.26	343
Air	28.97	1.40	356
Ammonia, Anhydrous	17.03	1.31	348
Argon	39.95	1.67	378
Benzene (Benzol or Benzole)	78.11	1.12	329
Boron Triflouride	67.82	1.20	337
Butadiene-1,3 (Divinyl)	54.09	1.12	329
Butane-n (Normal Butane)	58.12	1.09	326
Butylene (1-Butene)	56.11	1.11	328
Carbon Dioxide	44.01	1.29	346
Carbon Disulfide (C. Bisulfide)	76.13	1.21	33
Carbon Monoxide	28.01	1.40	356
Carbon Tetrachloride	153.82	1.11	328
Chlorine	70.91	1.36	353
Chloromethane (Methyl Chloride)	50.49	1.28	345
Cyclohexane	84.16	1.09	326
Cyclopropane (Trimethylene)	42.08	1.11	328
Decane-n	142.29	1.04	320
Diethylene Glycol (DEG)	106.17	1.07	323
Dimethyl Ether (Methyl Ether)	46.07	1.11	328
Dowtherm A	165.00	1.05	321
Dowtherm E	147.00	1.00	315
Ethane	30.07	1.19	336
Ethyl Alcohol (Ethanol)	46.07	1.13	330
Ethylene (Ethene)	28.05	1.24	341
Ethylene Glycol	62.07	1.09	326
Ethylene Oxide	44.05	1.21	338
Fluorocarbons:			
12, Dichlorodifluoromethane	120.93	1.14	331
13, Chlorotrifluoromethane	104.47	1.17	334
13B1, Bromotrifluoromethane	148.93	1.14	331
22, Chlorodifluoromethane	86.48	1.18	335
115, Chloropentafluoroethane	154.48	1.08	324
Glycerine (Glycerin or Glycerol)	92.10	1.06	322
Helium	4.00	1.67	378
Heptane	100.21	1.05	321

IX. Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Hexane	86.18	1.06	322
Hydrogen	2.02	1.41	357
Hydrogen Chloride, Anhydrous	36.46	1.41	357
Hydrogen Sulfide	34.08	1.32	349
Isobutane(2-Methylpropane)	58.12	1.10	327
Isoprene (2-Methyl-1, 3 Butadiene)	68.12	1.09	326
Isoproply Alcohol (Isopropanol)	60.10	1.09	326
Krypton	83.80	1.71	380
Methane	16.04	1.31	348
Methyl Alcohol (Methanol)	32.04	1.20	337
Methylamines, Anhydrous			
Monomethylamine (Methylamine)	31.06	1.02	317
Dimethylamine	45.08	1.15	332
Trimethylamine	59.11	1.18	335
Methyl Mercapton (Methanethiol)	48.11	1.20	337
Napthalene (Napthaline)	128.17	1.07	323
Natural Gas (specific gravity = 0.60)	17.40	1.27	344
Neon	20.18	1.64	375
Nitrogen	28.01	1.40	356
Nitrous Oxide	44.01	1.30	347
Octane	114.23	1.05	321
Oxygen	32.00	1.40	356
Pentane	72.15	1.07	323
Propadiene (Allene)	40.07	1.69	379
Propane	44.10	1.13	330
Propylene (Propene)	42.08	1.15	332
Propylene Oxide	58.08	1.13	330
Styrene	104.15	1.07	323
Sulfur Dioxide	64.06	1.28	345
Sulfur Hexafluoride	146.05	1.09	326
Steam	18.02	1.31	348
Toluene (Toluol or Methylbenzene)	92.14	1.09	326
Triethylene Glycol (TEG)	150.18	1.04	320
Vinyl Chloride Monomer (VCM)	62.50	1.19	336
Xenon	131.30	1.65	376
Xylene (p-Xylene)	106.17	1.07	323

IX. Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Acetaldehyde	0.779	68	20
Acetic Acid	1.051	68	20
Acetone	0.792	68	20
Ammonia, Anhydrous	0.666	68	20
Automotive Crankcase and Gear Oils:			
SAE-5W Through SAE 150	0.88-0.94	60	15.6
Beer	1.01	60	15.6
Benzene (Benzol)	0.880	68	20
Boron Trifluoride	1.57	-148	-100
Butadiene - 1, 3	0.622	68	20
Butane-n (Normal Butane)	0.579	68	20
Butylene (1-Butene)	0.600	68	20
Carbon Dioxide	1.03	-4	-20
Carbon Disulfide (C. Bisulfide)	1.27	68	20
Carbon Tetrachloride	1.60	68	20
Chlorine	1.42	68	20
Chloromethane (Methyl Chloride)	0.921	68	20
Crude Oils:			
32.6 Deg API	0.862	60	15.6
35.6 Deg API	0.847	60	15.6
40 Deg API	0.825	60	15.6
48 Deg API	0.79	60	15.6
Cyclohexane	0.780	68	20
Cyclopropane (Trimethylene)	0.621	68	20
Decane-n	0.731	68	20
Diesel Fuel Oils	0.82-0.95	60	15.6
Diethylene Glycol (DEG)	1.12	68	20
Dimethyl Ether (Methyl Ether)	0.663	68	20
Dowtherm A	0.998	68	20
Dowtherm E	1.087	68	20
Ethane	0.336	68	20
Ethyl Alcohol (Ethanol)	0.79	68	20
Ethylene (Ethene)	0.569	-155	-104
Ethylene Glycol	1.115	68	20
Ethylene Oxide	0.901	68	20

IX. Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Fluorocarbons:			
R12, Dichlorodifluoromethane	1.34	68	20
R13, Chlorotrifluoromethane	0.916	68	20
R13B1, Bromotrifluoromethane	1.58	68	20
R22, Chlorodifluoromethane	1.21	68	20
R115, Chloropentafluoromethane	1.31	68	20
Fuel Oils, Nos. 1, 2, 3, 5 and 6	0.82-0.95	60	15.6
Gasolines	0.68-0.74	60	15.6
Glycerine (Glycerin or Glycerol)	1.26	68	20
Heptane	0.685	68	20
Hexane	0.660	68	20
Hydrochloric Acid	1.64	60	15.6
Hydrogen Sulfide	0.78	68	20
Isobutane (2-Methylpropane)	0.558	68	20
Isoprene (2-Methyl - 1, 3-Butadiene)	0.682	68	20
Isopropyl Alcohol (Isopropanol)	0.786	68	20
Jet Fuel (average)	0.82	60	15.6
Kerosene	0.78-0.82	60	15.6
Methyl Alcohol (Methanol)	0.792	68	20
Methylamines, Anhydrous:			
Monomethylamine (Methylamine)	0.663	68	20
Dimethylamine	0.656	68	20
Trimethylamine	0.634	68	20
Methyl Mercapton (Methanethiol)	0.870	68	20
Nitric Acid	1.50	60	15.6
Nitrous Oxide	1.23	-127	-88.5
Octane	0.703	68	20
Pentane	0.627	68	20
Propadiene (Allene)	0.659	-30	-34.4
Propane	0.501	68	20
Propylene (Propene)	0.514	68	20
Propylene Oxide	0.830	68	20
Styrene	0.908	68	20
Sulfur Dioxide	1.43	68	20

IX. Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Sulfur Hexafluoride	1.37	68	20
Sulfuric Acid:			
95–100%	1.839	68	20
60%	1.50	68	20
20%	1.14	68	20
Toluene (Toluol or Methylbenzene)	0.868	68	20
Triethylene Glycol (TEG)	1.126	68	20
Vinyl Chloride Monomer (VCM)	0.985	-4	-20
Water, fresh	1.00	68	20
Water, sea	1.03	68	20
Xylene (p-Xylene)	0.862	68	20

Sizing – Determining K_v and K_w

English Units

$$R = \frac{V_L\,(2{,}800\ G)}{\mu\sqrt{A}}$$

or

$$R = \frac{12{,}700\ V_L}{U\sqrt{A}}$$

Metric Units

$$R = \frac{31{,}313\ V_L\ G}{\mu\sqrt{A}}$$

Determining K_v

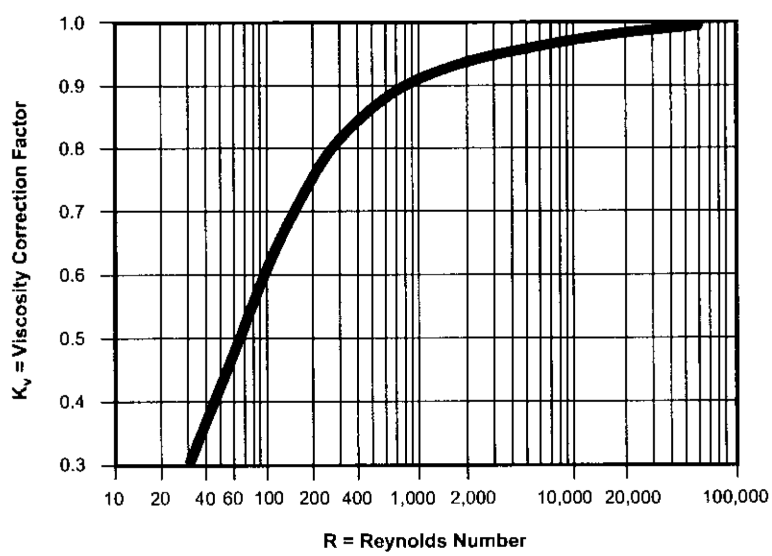
V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

G = Specific gravity of liquid at flowing temperature referred to water = 1.00 at 70°F [21°C]

μ = Absolute viscosity at the flowing temperature, in centipoises

A = Effective discharge area, in square inches [cm²] (from manufacturer's standard orifice areas)

U = Viscosity at the flowing temperature, in Saybolt Universal seconds



After the value of R is determined, the factor K_v is obtained from the graph. Factor K_v is applied to correct the 'preliminary required discharge area.' If the corrected area exceeds the 'chosen standard orifice area,' the calculations should be repeated using the next larger standard orifice size.

X. Conversion Factors

Notes

1. Kinematic viscosity x specific gravity = absolute viscosity.
2. Centistokes x specific gravity = centipoise.
3. Saybolt Second Universal (SSU) x 0.216 x specific gravity = centipoise.

Absolute Viscosity

Given	To find desired value, multiply 'Given' value by factor below			
	poise	Centipoise	$\frac{gm}{cm-sec}$	$\frac{lb}{ft-sec}$
poise	—	100	1	0.0672
centipoise	0.01	—	0.01	0.000672
$\frac{gm}{cm-sec}$	1	100	—	0.0672
$\frac{lb}{ft-sec}$	14.88	1488	14.88	—

Kinematic Viscosity

Given	To find desired value, multiply 'Given' value by factor below			
	stoke	Centistoke	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$
stoke	—	100	1	0.001076
centistoke	0.01	—	0.01	1.076×10^{-5}
$\frac{cm^2}{sec}$	1	100	—	0.001076
$\frac{ft^2}{sec}$	929.0	92900	929.0	—

Note

1. G = Specific gravity of liquid at its relieving temperature compared to that of water at 68°F [20°C], where G_{water} = 1.00.

Liquid Flow Conversions

Given	To find desired value, multiply 'Given' value by factor below				
	l/hr	gpm - US	gpm - Imp	barrels/day	m^3/hr
l/hr (litres/hour)	—	0.00440	0.003666	0.1510	0.0010
gpm (US gallons per minute)	227.1	—	0.8327	34.29	0.2271
gpm (Imperial gallons per minute)	272.8	1.201	—	41.18	0.2728
barrels/day (petroleum - 42 US gallons)	6.624	0.02917	0.02429	—	0.006624
m^3/hr (cubic meters per hour)	1000	4.403	3.666	151.0	—
m^3/s (cubic meters per second)	3.6×10^6	0.02917	0.02429	—	0.006624
kg/hr (kilograms per hour)	$\frac{1}{G}$	$\frac{1}{227.1G}$	$\frac{1}{272.8G}$	$\frac{0.151}{G}$	$\frac{1}{1000G}$
lb/hr (pounds per hour)	$\frac{1}{2.205G}$	$\frac{1}{500.8G}$	$\frac{1}{601.5G}$	$\frac{1}{14.61G}$	$\frac{1}{2205G}$

X. Conversion Factors

Gas Flow Conversions

Given	SCFM	SCFH	lb/hr	[kg/hr]	[Nm³/hr]	[Nm³/min]
	To find desired value, multiply 'Given' value by factor below					
scfm[2]	—	60	$\frac{M}{6.32}$	$\frac{M}{13.93}$	1.608	0.0268
scfh[2]	0.01677	—	$\frac{M}{379.2}$	$\frac{M}{836.1}$	0.0268	0.000447
lb/hr[3] or #/hr[3]	$\frac{6.32}{M}$	$\frac{379.2}{M}$	—	0.4536	$\frac{10.17}{M}$	$\frac{0.1695}{M}$
kg/hr[4]	$\frac{13.93}{M}$	$\frac{836.1}{M}$	2.205	—	$\frac{22.40}{M}$	$\frac{0.3733}{M}$
Nm³/hr[5]	0.6216	37.30	$\frac{M}{10.17}$	$\frac{M}{22.40}$	—	0.01667
Nm³/min[5]	37.30	2238	5.901 M	2.676 M	60	—

If flow is expressed in actual volume, such as cfm (cubic feet per minute) or acfm (actual cfm) as is often done for compressors, where the flow is described as displacement or swept volume, the flow may be converted to scfm as follows (or from flow expressed in m³/hr to Nm³/hr).

Inch-Pound Units

$$SCFM = \begin{pmatrix} \text{cfm} \\ \text{or} \\ \text{acfm} \end{pmatrix} \times \frac{14.7 + p}{14.7} \times \frac{520}{460 + t}$$

Where:

p = gauge pressure of gas or vapor in psig

t = temperature of gas or vapor in °F

Metric Units

$$Nm^3/hr = n^3hr = x\ \frac{1.013 + p}{1.013} \times \frac{273}{273 + t}$$

Where:

p = gauge pressure of gas or vapor in barg

t = temperature of gas or vapor in °C

Notes

1. M = Molecular weight of vapor or gas.
2. Volumetric flow (per time unit of hour or minute as shown) in standard cubic feet per minute at 14.7 psia [1.013 bara], 60°F [16°C].
3. Weight flow in pounds per hour.
4. Weight flow in kilograms per hour.
5. Volumetric flow (per time unit of hour or minute as shown) at 1.013 bara 32°F [0°C]. This represents the commercial standard, known as the Normal Temperature and Pressure (NTP).

Conversions from one volumetric flow rate to another or to weight flow (and vice versa) may only be done when the volumetric flow is expressed in the standard conditions shown above. If flows are expressed at temperature or pressure bases that differ from those listed above, they must first be converted to the standard base.

Pressure Conversion

Given	kPa	psig	kg/cm²	barg
	To find desired value, multiply 'Given' value by factor below			
kPa (kilopascal)	—	0.1450	0.0102	0.0100
psig (pounds/in²)[3]	6.895	—	0.0703	0.06895
kg/cm²[(1)] (kilograms/cm²)	98.07	14.22	—	0.9807
barg	100.00	14.50	1.020	—

Area Conversion

Given	in²	ft²	mm²	cm²
	To find desired value, multiply 'Given' value by factor below			
in²	—	0.006944	645.16	6.4516
cm²	0.155	1.076×10^{-3}	100	—
ft²	144	—	92900	929
mm²	0.00155	1.076×10^{-5}	—	0.01

Notes

1. Also expressed as kp/cm² and kgf/cm².
2. Normal Temperature and Pressure (NTP) Conditions are, at sea level, equal to 1.013 bara or 1.033 kg/cm² (kilograms force per square centimeter absolute) at a base temperature of 32°F [0°C]. This differs slightly from Metric Standard Conditions (MSC), which uses 1.013 bara 60°F [15°C] for the base temperature.
3. Inch-Pound Standard Conditions are, at sea level, equal to 14.7 psia (pounds force per square inch absolute), rounded up from 14.696 psia, and at a base temperature of 60°F [16°C].

Temperature Conversion

Degrees Celsius (°C)	Degrees Fahrenheit (°F)
C + 273.15 = K (Kelvin)	F + 459.67 = R (Rankine)
(C x 1.8) + 32 = F (Fahrenheit)	(F - 32) x 0.556 = C (Celsius)

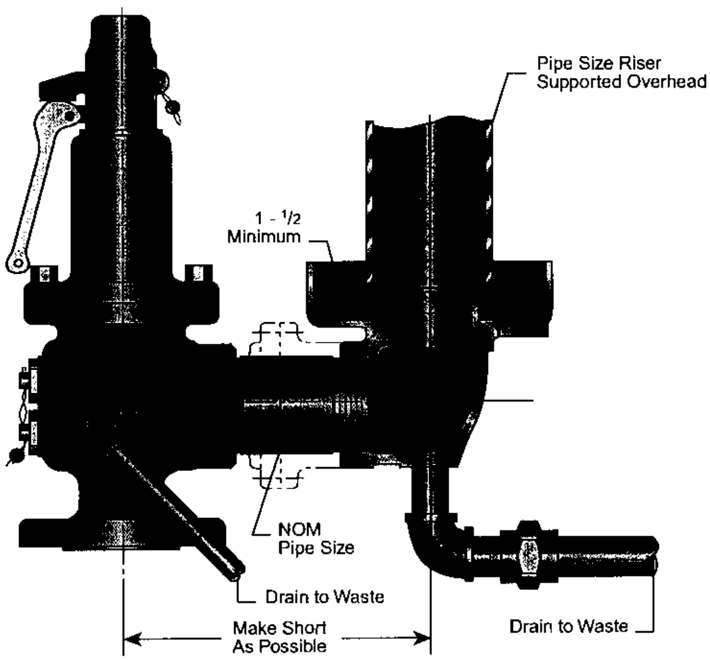
XI. Installation

1. Before installing a new safety/relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Install the valve in a vertical position so that discharge piping and code required drains can be properly piped to prevent build-up of back pressure and accumulation of foreign material around the valve seat area.
3. Avoid over-tightening as this can distort safety/relief valve seats. One need only remember that as the vessel and valve are heated the expansion involved will grasp the valve more firmly.
4. When installing flange connected valves, use new gaskets and draw the mounting bolts down evenly.
5. Do not use the valve outlet or cap as a lever for installation. Use only flat jawed wrenches on the flats provided.
6. Avoid excessive 'popping' of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
7. Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the safety/relief valve.
8. Avoid having the operating pressure too near the safety/relief valve set pressure. A very minimum differential of 5 psig or 10 percent (whichever is greater) is recommended. An even greater differential is desirable, when possible, to assure better seat tightness and valve longevity. Safety/relief valves in high-temperature hot water and organic fluid service are more susceptible to damage and leakage than safety valves for steam. It is recommended that the maximum allowable working pressure of the boiler and the safety/relief valve setting be selected substantially higher than the operating pressure. A differential of 30-40 percent is recommended.
9. Avoid discharge piping where its weight is carried by the safety/relief valve. Even though supported separately, changes in temperature alone can cause piping strain. We recommend that drip pan elbows or flexible connections be used wherever possible (see Type A, B, C Installation, page 28).
10. Apply a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage.

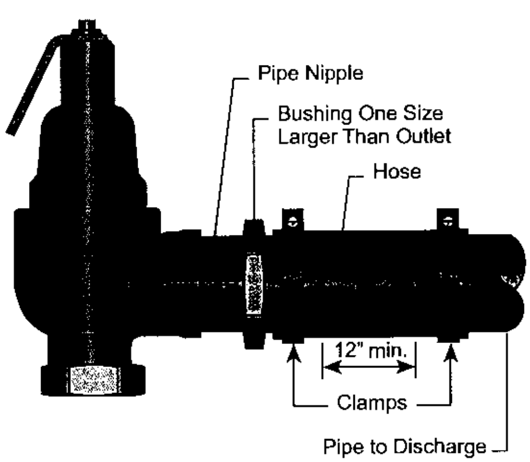
XI. Installation

Recommended Discharge Installation

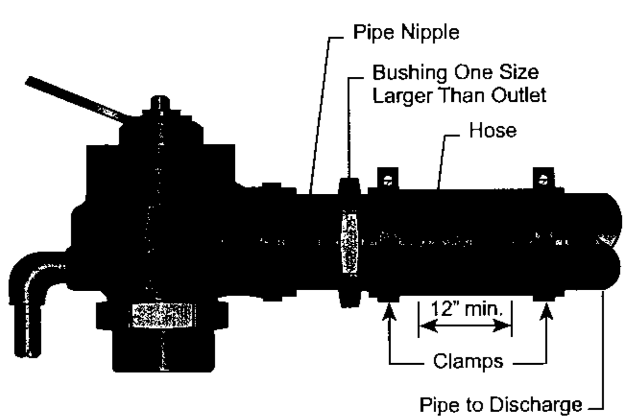
Type 'A' Installation



Type 'B' Installation



Type 'C' Installation



XII. Maintenance

1. Develop a regular program of visual inspection, looking for clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.
2. Test the valve every two to six months (depending on valves' age and condition) preferably by raising the system pressure to the valves set pressure or operating the hand lever (see #3 in Operation).
3. Do not paint, oil, or otherwise cover any interior or working parts of any safety valve. They do not require any lubrication or protective coating to work properly.

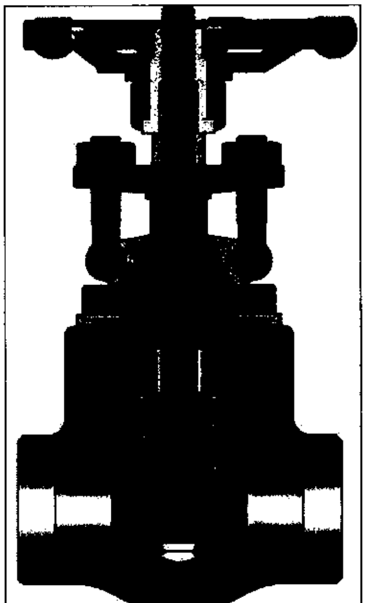
When safety/relief valves require repair, service adjustments, or set pressure changes, work shall be accomplished by the manufacturer, or holders of 'V', 'UV', and/or 'VR' stamps.

Powell Valves
2503 Spring Grove Ave.
Cincinnati, OH 45214
Phone: 513-852-2000
Fax: 513-852-2997

POWELL VALVES
Established 1846

API 602 GATE VALVES

FORGED CARBON , STAINLESS STEEL OR ALLOY STEEL
¼" TO 2" (6 TO 50 mm)
ASME CLASSES 150 TO 2680



	GA01
	GAL1
	GA03
	GAL3
	GA06
	GAL6
	GA08
	GAL8
	GA15
	GAL5
	GA16
	GA25
	GA26

DESIGN FEATURES:

- **Wedges** are accurately guided thru the entire stroke.
- **Standard trim** is stellite faced seat rings, 13% chrome wedge seat surfaces, and 13% chrome stem (API trim 8). Other trims available on request.
- **Seat faces** lapped for smooth finish and superior sealing.
- **Stems** are non-rotating with surface finish to maximize packing seal for low fugitive emissions.
- **Each** valve is shell, seat and back-seat pressure tested per industry standard API 598.
- **Gland** is two piece gland / gland flange design for optimal alignment and uniform packing compression.

STANDARD MATERIALS (Other materials available)

	A105	A182 F11	A182 F22	A182F316 (1)
	A105	A182 F11	A182 F22	A182 F316
	SST 420			A182 F316
	SST 410 + Stellite 6 Faced			SST 316
	A182 F6a			A182 F316
	A 439 Ductile NI-Resist Gr. D2			
	A105			Series 300 SST
	A193 Gr. B7	A193 Gr. B16		A193 Gr. B8M
	A194 Gr. 2H	A194 Gr. 7		A194 Gr.8M
	SST 420			SST 316
	Graphite			PTFE
	SST 410			SST 316
	Spiral Wound SST with Graphite			Spiral Wound SST with PTFE
	Malleable Iron or Steel			
	Malleable Iron or Steel			
	Steel			
	A193 Gr. B7	A193 Gr. B16		A193 Gr. B8M
	Series 300 SST			

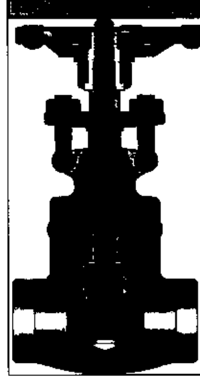
(1) Threaded and weld end valve bodies A182 F316L
(2) Welded bonnet design also available.

NOTE: See page 51 for flow, safety and maintenance information.

- **End Flanges** have the following raised faces per ASME B16.5:
  Classes 150-300: 1/16" (2mm).
  Classes 600: 1/4" (7mm).
- **Weld** ends are available per ASME B16.25/B16.11 or per customer's specification.
- **Extended** body ends available on gate valves.
- **Other** available options as follows:
  -Alternate valve materials such as chrome and stainless steel alloys
  -Alternate trim materials
  -NACE service
  -Special cleaning for applications such as oxygen or chlorine
  -Other options available as specified.

Design Specifications

	API 602
	ASME B16.34
	API 602 & B16.34
	ASME B16.10
	ASME B16.5
	ASME B1.20.1
	ASME B16.25
	ASME B16.11
	ASTM



Welded Bonnet Design

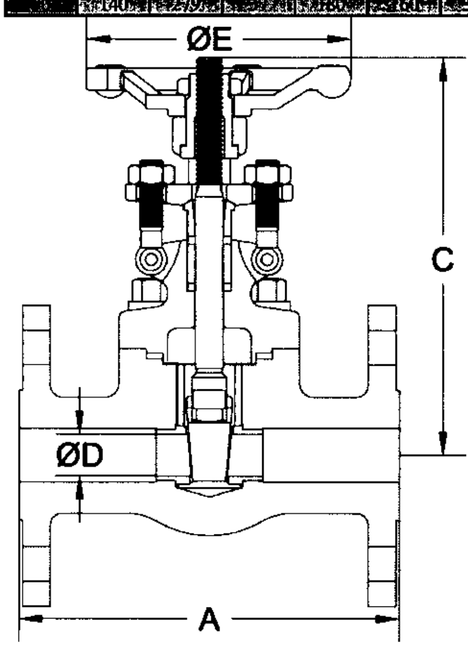
GATE VALVE DIMENSIONS (CLASS 150—800).

[redacted]

½	4.25	6.0	0.50	3.9	5.50	6.0	0.50	3.9	6.50	6.0	0.50	3.9
[redacted]	[illegible]	[illegible]	[illegible]	[illegible]	140	[illegible]	[illegible]	100	165	[illegible]	[illegible]	100
¾	4.62	6.0	0.50	3.9	6.00	6.0	0.50	3.9	7.50	6.0	0.50	3.9
[redacted]	117	153	13	100	152	153	13	100	190	153	13	100
1	5.00	7.3	0.71	4.9	6.50	7.3	0.71	4.9	8.50	7.3	0.71	4.9
[redacted]	127	185	18	125	165	185	18	125	216	185	18	125
1¼	5.50	8.7	0.94	6.3	7.00	8.7	0.94	6.3	9.00	8.7	0.94	6.3
[redacted]	140	222	24	160	178	222	24	160	229	222	24	160
1½	6.50	9.4	1.14	6.3	7.50	9.4	1.14	6.3	9.50	9.4	1.14	6.3
[redacted]	165	240	29	160	190	240	29	160	241	240	29	160
2	7.00	11.0	1.46	7.1	8.50	11.0	1.46	7.1	11.50	11.0	1.46	7.1
[redacted]	178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	180	[illegible]	[illegible]	[illegible]	180

[redacted]

¼	3.11	5.9	0.31	3.9	-	-	-	-	3.11	6.2	0.31	3.9	-	-	-	-
[redacted]	79	149	[illegible]	100	[illegible]	[illegible]	[illegible]	[illegible]	79	157	8	100	[illegible]	[illegible]	[illegible]	[illegible]
⅜	3.11	5.9	0.39	3.9	-	-	-	-	3.11	6.2	0.39	3.9	-	-	-	-
[redacted]	79	149	10	100	[illegible]	[illegible]	[illegible]	[illegible]	79	157	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
½	3.11	6.0	0.50	3.9	3.62	6.0	0.50	3.9	3.11	6.3	0.50	3.9	3.62	6.3	0.50	3.9
[redacted]	79	153	[illegible]	100	[illegible]	153	13	100	79	161	[illegible]	100	[illegible]	161	13	100
¾	3.62	6.0	0.50	3.9	4.37	7.3	0.71	4.9	3.62	6.3	0.50	3.9	4.37	7.5	0.71	4.9
[redacted]	92	153	13	100	111	185	18	125	92	161	[illegible]	100	111	190	18	125
1	4.37	7.3	0.71	4.9	4.72	8.7	0.94	6.3	4.37	7.5	0.71	4.9	4.72	8.7	0.94	6.3
[redacted]	111	185	18	125	120	222	24	160	111	190	18	125	120	220	[illegible]	160
1¼	4.72	8.7	1.14	6.3	4.72	9.4	1.14	6.3	4.72	8.7	1.14	6.3	4.72	9.4	1.14	6.3
[redacted]	120	222	29	160	120	240	29	160	120	220	29	160	120	240	29	160
1½	4.72	9.4	1.14	6.3	5.51	11.0	1.46	7.1	4.72	9.4	1.14	6.3	5.51	11.0	1.46	7.1
[redacted]	120	240	29	160	[illegible]	[illegible]	37	180	120	240	29	160	140	279	[illegible]	180
2	5.51	11.0	1.46	7.1	6.30	13.1	1.89	7.9	5.51	11.0	1.46	7.1	6.30	12.6	1.89	7.9
[redacted]	140	279	[illegible]	180	160	333	48	200	140	279	37	180	160	319	48	200

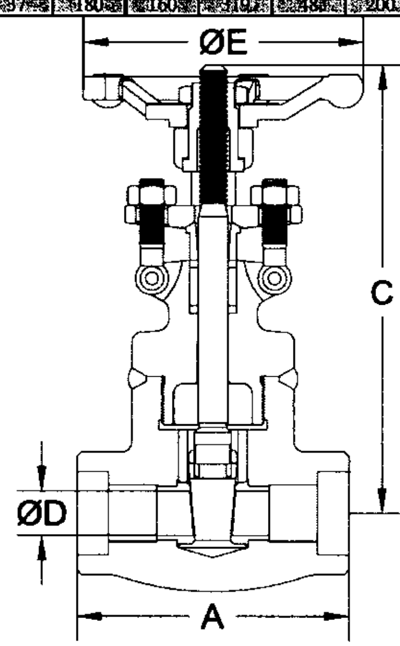


Bolted Bonnet Flanged Ends Design

ADDITIONAL MATERIALS AND CLASSES AVAILABLE UPON REQUEST.

WE = Socket Weld / Threaded Ends
FE = Flanged ends

C = Center to top open

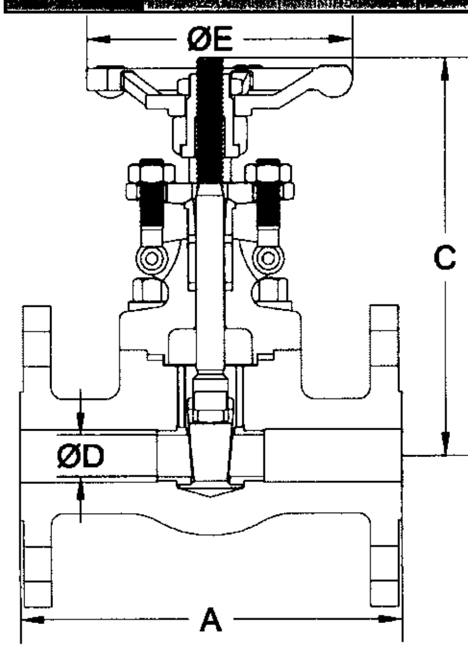


Welded Bonnet Socket Weld Ends Design

GATE VALVE DIMENSIONS (CLASS 1500—2680).

[illegible]																	
¼	-	3.11	6.9	0.31	3.9	-	-	-	-	3.11	6.9	0.31	3.9	-	-	-	-
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
⅜	-	3.62	7.0	0.50	3.9	-	-	-	-	3.62	6.9	0.50	3.9	-	-	-	-
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
½	8.50	3.62	7.1	0.50	4.9	4.37	7.1	0.50	4.9	3.62	7.1	0.50	4.9	4.37	7.1	0.50	4.9
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
¾	9.00	4.37	7.1	0.50	4.9	4.72	8.6	0.71	6.3	4.37	7.1	0.50	4.9	4.72	8.6	0.71	6.3
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	10.00	4.72	8.6	0.71	6.3	4.72	9.3	0.94	6.3	4.72	8.6	0.71	6.3	4.72	9.3	0.94	6.3
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1¼	11.00	4.72	9.3	0.94	6.3	5.51	10.8	1.14	7.1	4.72	9.3	0.94	6.3	5.51	10.8	1.14	7.1
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1½	12.00	5.51	10.8	1.14	7.1	6.30	12.6	1.46	7.9	5.51	10.8	1.14	7.1	6.30	12.6	1.46	7.9
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	14.50	6.30	12.6	1.46	7.9	9.1	13.6	1.89	7.9	6.30	12.6	1.46	7.9	9.1	13.6	1.89	7.9
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]								
½	5.91	11.2	0.55	6.3	5.91	10.0	0.55	6.3
	150	[illegible]	[illegible]	160	150	[illegible]	[illegible]	160
¾	5.91	11.2	0.55	6.3	5.91	10.0	0.55	6.3
	150	[illegible]	[illegible]	160	150	[illegible]	[illegible]	[illegible]
1	6.69	12.9	0.75	7.9	6.69	11.5	0.75	7.9
	[illegible]	[illegible]	[illegible]	200	170	[illegible]	[illegible]	[illegible]
1¼	7.87	14.7	1.00	9.8	7.87	13.3	1.00	9.8
	[illegible]	[illegible]	[illegible]	250	200	[illegible]	[illegible]	[illegible]
1½	7.87	14.8	1.10	9.8	7.87	13.5	1.10	9.8
	[illegible]	[illegible]	[illegible]	250	200	[illegible]	[illegible]	[illegible]
2	9.84	17.1	1.38	11.8	9.84	15.7	1.38	11.8
	[illegible]	[illegible]	[illegible]	300	250	[illegible]	[illegible]	[illegible]

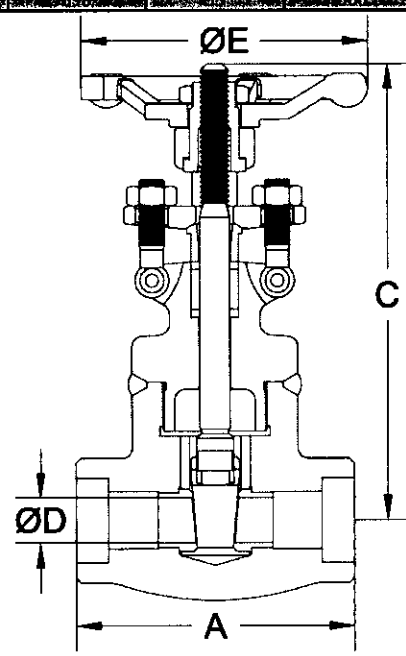


Bolted Bonnet Flanged Ends Design

ADDITIONAL MATERIALS AND CLASSES AVAILABLE UPON REQUEST.

WE = Socket Weld / Threaded Ends
FE = Flanged Ends

C = Center to top open



Welded Bonnet Socket Weld Ends Design

POWELL VALVES
Established 1846

API 602 GATE VALVES
FORGED CARBON , STAINLESS STEEL OR ALLOY STEEL
¼" TO 2" (6 TO 50 mm)
ASME CLASSES 150 TO 2680

¼	-	-	-	-	-	-	4.2	5	-	-	3.7	5	-	-
[illegible]	[illegible]		[illegible]		[illegible]		1.9		[illegible]		1.7		[illegible]	
⅜	-	-	-	-	-	-	4.2	8	-	-	3.7	8	-	-
10	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
½	6.6	13	7.9	13	9.3	13	4.4	13	7.3	13	4.0	13	7.1	13
15	3.0		[illegible]		[illegible]		2.0		[illegible]		[illegible]		[illegible]	
¾	7.7	13	10.8	13	12.8	13	4.9	13	8.4	25	4.4	13	8.2	25
19	3.5		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
1	12.1	30	15.4	30	19.4	30	7.9	30	12.8	45	7.5	30	12.6	45
25	5.5		7.0		[illegible]		[illegible]		5.8		[illegible]		[illegible]	
1¼	15.0	70	20.7	70	26.7	70	13.7	70	14.8	70	11.7	70	14.6	70
[illegible]	6.8		[illegible]		[illegible]		[illegible]		6.7		[illegible]		6.6	
1½	22.9	70	29.3	70	34.4	70	13.7	70	22.7	110	13.2	70	22.5	110
38	10.4		[illegible]		[illegible]		[illegible]		10.3		6.0		10.2	
2	31.7	120	39.7	80	43.0	120	21.4	120	33.5	220	20.9	120	33.3	220
50	[illegible]		[illegible]		[illegible]		[illegible]		15.2		[illegible]		[illegible]	

¼	-	6.6	5	-	-	6.2	5	-	-	-	-	-	-
6	-	3.0		-		2.8		-		-		-	
⅜	-	7.1	13	-	-	6.6	13	-	-	-	-	-	-
10	-	3.2		-		3.0		-		-		-	
½	15.9	7.7	13	9.5	13	7.3	13	9.3	13	21.6	20	15.0	20
13	7.2	3.5		4.3		3.3		4.2		9.8		6.8	
¾	25.4	8.8	13	13.9	25	8.2	13	13.7	25	22.0	20	15.4	20
19	11.5	4.0		6.3		3.7		6.2		10.0		7.0	
1	34.4	13.2	25	16.1	45	12.6	25	15.9	45	49.6	25	22.0	25
25	15.6	6.0		7.3		5.7		7.2		22.5		10.0	
1¼	35.7	15.4	45	24.7	70	14.8	45	24.5	70	69.9	55	43.4	55
32	16.2	7.0		11.2		6.7		11.1		31.7		19.7	
1½	49.8	23.8	70	35.1	110	23.1	70	34.8	110	70.5	70	57.3	70
38	22.6	10.8		15.9		10.5		15.8		32.0		26.0	
2	62.2	34.2	120	36.4	220	33.5	120	36.2	220	83.8	120	69.9	120
50	28.2	15.5		16.5		15.2		16.4		38.0		[illegible]	

FE = Flanged Ends
WE = Socket Weld / Threaded Ends

WT = Weight
C_V = Flow Coefficient