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 of 15 psig [1.03 barg] or greater 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 MAWPs up to and including 60 psig [4.13 barg], and 5 percent for boilers with MAWPs 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" [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" [130 mm] and designed for use at or 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.

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 nameplate and the letters NB. Most Kunkle Valves have NB certified capacities.

Code Stamps

"V" V - applies to all ASME Section I valves

"HV" HV - applies to all ASME Section IV valves

"UV" 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 – 100	[4.62 – 6.90]		2 psi [0.14 barg] - 6%
101 - 250	[6.96 - 17.24]		2% - 6%
251 – 374	[17.31 – 25.79]		2% - 15 psig [1.03 barg]
375 – 1000	[25.86 – 68.96]		2% - 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%	

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%.
2. Maximum blowdown for "Special Use" Section I is 10%.

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]

General Safety and Relief Valve Information

Kunkle Factory Standard Seat Tightness

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].

API - 527 Seat Tightness

Model	Code Section	Service	Performance Standard
300/600 6000 900	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" or 10 cc/h/in of inlet valve size for inlet sizes 1" and larger at 10% below nameplate set pressure or 5 psig [0.35 barg] below nameplate set pressure, whichever is greater.

Note

API 527 is not available on air service for:

a. Plain lever "J" orifice Models 900 and 6000.
b. Plain lever Model 900 above 444 psig [30.6 barg] set pressure.

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.

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.
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 your sales representative.
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:

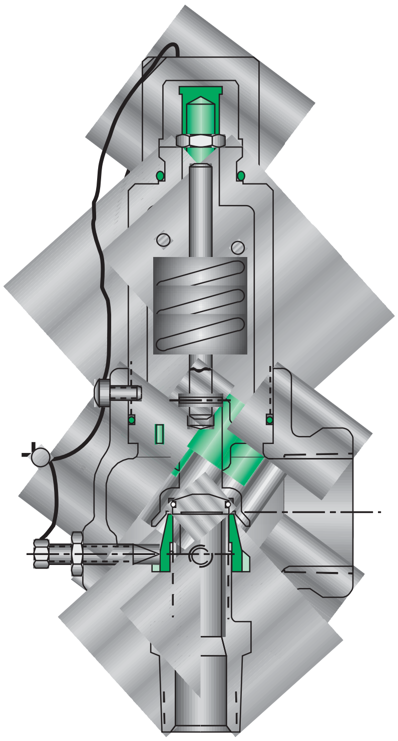
   A. Avoid excessive operation of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.

   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.

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.

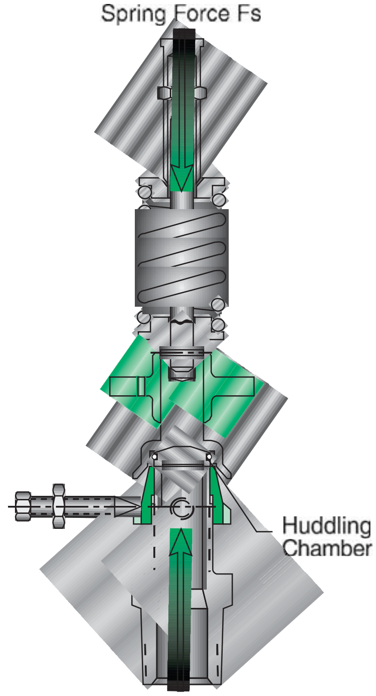


An adjustable nozzle ring, threaded onto the nozzle, controls the geometry of the fluid exit control chamber (huddling chamber). The huddling chamber geometry is very important in controlling valve opening and closing pressures, and stability of operation. The nozzle ring is locked into position by a 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.

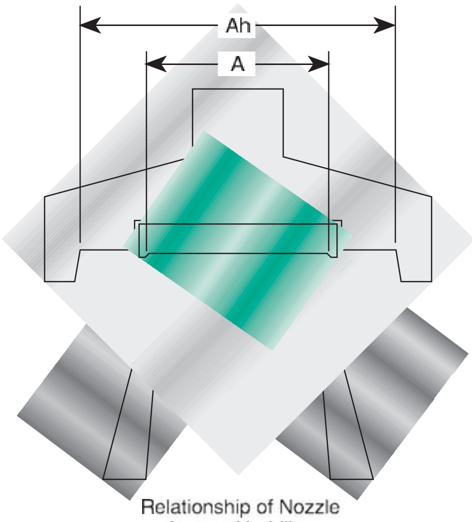
Under normal system operation the valve remains in the closed position because the spring force (Fs) is greater than the system pressure acting on the internal nozzle seating area (PA). If system pressure increases to a point when these forces are equal, the valve begins to simmer. The disc lifts and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

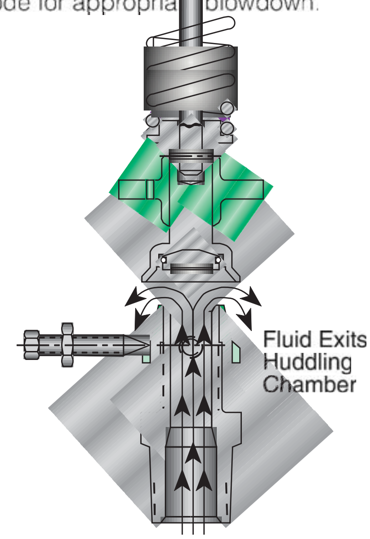


Safety and Relief Valve Principles of Operation



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 (first steady vertical flow).

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.

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 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 14-25). 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 6) 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 11-13) 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 sales representative.

Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Steam (ASME Section I - Power Boilers)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[1] Press.		Min/Max Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
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]	15/1400	[1.0/96.5]	-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	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)

Model(s)	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
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	[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]	-20/750	[-29/399]
910	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/250	[0.21/17.2]	-320/406	[-195/208]
913	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/425	[-195/219]
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	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)

Model(s)	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
930	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	15 only	[1.0]	250 only	[122]
6933, 6934	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6935	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	15 only	[1.0]	250 only	[122]
6254	Iron	SS	X	X	1 1/2 - 6"	[38.1 - 152.4]	15 only	[1.0]	250 only	[122]

Steam (Non-code)[2]

Model(s)	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°F	[°C]
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 [1.0 barg] are non-code only.
2. See also ASME Section VIII steam valves for non-code steam applications.

Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Air/Gas (ASME Section VIII)

Model(s)	Material		Connections		Inlet Size Range		Min/Max[3] Press.		Min/Max[4] Temp.	
	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°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	[-195/427]
330[5]	Aluminum	SS	X		1/4"	[6.35]	1000/5500	[69/379.3]	-20/185	[-29/85]
330S, 333S[5]	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]
338	Aluminum	Brass	X		2"	[50.8]	5/30	[0.3/2.07]	-30/400	[-34/204]
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	[3.4/172.4]	-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)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
6010, 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	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)	Body	Trim	NPT	FLGD	in	[mm]	psig	[barg]	°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)	Body	Trim	NPT	FLGD	in	[mm]	in Hg	[mm Hg]	°F	[°C]
215V	Iron	Bronze	X		2 - 3"	[50.8 - 76.2]	2/29	[50/736]	-20/406	[-29/208]
910, 916 (soft seat)[4]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-20/800	[-29/427]
911, 917 (soft seat)[4]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/800	[-195/427]
912, 918 (soft seat)[4]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/406	[-195/208]
913, 919 (soft seat)[4]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	6/29	[152/736]	-320/425	[-195/219]

X = Standard O = Optional

Notes

1. Soft seat available on some models.
2. See also Section VIII air valves for non-code air/gas applications.
3. Set pressures less than 15 psig [1.0 barg] are non-code only.
4. Temperature limits of soft seats determine operating limits of valve.
5. Kynar® or Urethane Seat.

Valve Selection Guide

(For specific minimum/maximum temperature/pressure ranges refer to individual product sections.)

Model(s)	Material Body	Material Trim	Connections NPT	Connections FLGD	Inlet Size Range in	Inlet Size Range [mm]	Min/Max[1] Press. psig	Min/Max[1] Press. [barg]	Min/Max[2] Temp. °F	Min/Max[2] Temp. [°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	[-29/121]
Liquid (ASME Section VIII)										
910, 916 (soft seat)[2]	CS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
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]	-20/550	[-29/288]
171S	SS	SS	X		1/2 - 2"	[12.7 - 50.8]	1/400	[0.07/27.6]	-20/550	[-29/288]
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]	3/1400	[0.21/96.5]	-20/800	[-29/427]
911, 917 (soft seat)[2]	SS	SS	X	O	1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/800	[-195/427]
912, 918 (soft seat)[2]	Bronze	Brass	X		1/2 - 2"	[12.7 - 50.8]	3/300	[0.21/20.7]	-320/406	[-195/208]
913, 919 (soft seat)[2]	Bronze	SS	X		1/2 - 2"	[12.7 - 50.8]	3/1400	[0.21/96.5]	-320/425	[-195/219]
Liquid - Underwriters Laboratories (UL) For Oil Services										
200A	Bronze	Brass	X		3/4 - 1 1/2"	[19.05 - 38.1]	1/200	[0.07/13.8]	-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]
918 (soft seat)[2,3]	Bronze	Brass	X		3/4 - 1"	[19.05 - 25.4]	60/250	[4.1/17.2]	-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

Notes

1. Set pressures below 15 psig [1.0 barg] are non-code only.
2. Temperature limits of soft seats determine operating limits of valve.
3. FM Approved only.

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 18-20). Valves may also be sized by performing sizing calculations per the formulas (pages 15 and 16) 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 your sales representative 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 your sales representative 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 10-13).
2. From Table A (page 17), 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 17) that has a Flow Area closest to, but not less than the minimum required orifice area calculated in step 3.

Valve Sizing

U.S. Units | **Metric Units**

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

U.S. 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)

U.S. 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)

U.S. 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)

U.S. 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)

U.S. Units:

$$A = \frac{Q}{38\ K_d} \sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

Metric Units:

$$A = \frac{Q}{5.094\ K_d} \sqrt{\frac{G}{(1.1\ p_1 - p_2)}}$$

Liquid - Non-Code

U.S. 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

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

Note

1. Consult your sales representative 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.

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	Definition
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)

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	

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] 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]															

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.