Technical Specifications
Rev. E - 02/2022

Consolidated™ Valve Sizing and Selection

Baker Hughes

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API Standard Orifice Areas

Introduction

API Sizing

API establishes rules for sizing of pressure relief devices in the standard API RP 520. This recommended practice addresses only flanged spring loaded and pilot operated safety relief valves with a D - T orifice. Valves smaller or larger than those with a D - T orifice are not addressed by API RP 520.

The API rules are generic for pressure relief devices, and API recognizes that manufacturers of pressure relief devices may have criteria such as discharge coefficients and correction factors that differ from those listed in API RP 520. The API RP 520 equations and rules are intended for the estimation of pressure relief device requirements only. Final selection of the pressure relief device is accomplished by using the manufacturer's specific parameters, which are based on actual testing. The data given in this catalog is specific for Consolidated valves.

It is traditional to size and select pressure relief valves specified per API RP 526 for gas, vapor and steam applications using the API RP 520 K_d value of 0.975 and the effective areas of API RP 526. Although the API K_d values exceed the ASME certified K values, the ASME certified areas exceed the effective areas of API RP 526 with the product of the ASME certified K and area exceeding the product of the API RP 520 K_d and API RP 526 effective areas. This allows selection of a Consolidated valve series using the API Kd and area while still maintaining compliance with ASME flow certification.

The Consolidated 2900 series is a hybrid of the 1900 and 3900 series. The 2900 series meets the dimension requirements for spring loaded valves and the effective areas for both spring loaded and pilot actuated valves per API RP 526. Although the 2900 is not a true API RP 526 pressure relief valve, it may be used as a replacement for API RP 526 spring loaded pressure relief valves.

Flow Coefficient K (Coefficient of Discharge)

The K value has been established at the time valves are certified by ASME and are published for all ASME certified valves in "Pressure Relief Device Certifications" by the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, Ohio 43229.

Relating to sizing, API RP 526 details an effective discharge area. The sizing formulas listed on page 8 are in agreement with those published in API RP 520 for determining the required Consolidated valve series. On page 10, the equations of page 9 are modified to metric units with a units conversion factor K_u. The information listed in Tables 6-8 describing "API Standard Orifice Area" is in accordance with those listed in API RP 526.

Consolidated has elected to use its actual bellows backpressure correction factor for sizing and selection of the appropriate Consolidated valve series per API recommendations for using the Manufacturer's actual parameters. Consolidated has elected to use the ASME certified liquid K_d of 0.744 for types 1900 and 2900; 0.825 is used for type 3900; and 0.844 is used for 4900 instead of the API recommended Kd of 0.65, as the ASME certified coefficient pre-dates the API recommended value.

ASME Capacity Calculation

ASME codes establish the certified relieving capacities and corresponding media, which must be stamped on the valve name plates.

Sizing Program Information

Baker Hughes has software, SRVSpeQ*, which performs sizing and selection functions. Additionally, it will select materials, configure the complete value and provide a data sheet with a certified drawing including dimensions, weights, and materials. This software is available for download on valves.bakerhughes.com/resource-center.

Note: "USCS" indicates the U.S. Customary System Designation, which is similar to English Units.

Formula Symbols

Prior to sizing Safety Relief Valves, the user should understand the symbols used in the sizing and capacity calculation formulas.

A_c	The safety relief valve area required to prevent the vessel or system pressure from exceeding prescribed limits above the vessel or system MAWP. The units used are USCS (in^2) and metric (mm^2).
C	Dimensionless, whole number value determined from an expression of the ratio of specific heats of the gas or vapor (see Tables 4 and 5).
k	Dimensionless ratio of the constant pressure specific heat C_p to the constant volume specific heat C_v.
K	Flow Coefficient (K_d x 0.9). Select the value based on valve type and type of media (refer to sizing formulas for proper values).
K_b	Dimensionless value used to correct for the reduction in the safety relief valve capacity due to the effects of backpressure on conventional and balanced bellows valves. See Figure 3 for balanced bellows valve corrections and Figure 2 for non-bellows valves.
K_c	Pressure relief valve - rupture disk combination capacity factor.
K_d	Dimensionless value relating the actual vs. theoretical safety relief valve flow rate. Select the value based on valve type and type of media (refer to sizing formulas for proper values.)
K_{sh}	Dimensionless value to correct for superheated system. For saturated steam K_{sh} = 1.0 (refer to Table 12).
K_v	Dimensionless value used to correct for the reduction in the safety relief valve capacity due to viscosity effects for liquid applications (see Figure 4).
K_u	Dimensionless factor used to adjust for the type of units used in the sizing equation.
K_w	Dimensionless value used to correct for the reduction in the safety relief valve capacity due to backpressure for balanced bellows valves (only when used on liquid applications, see Figure 3.)
MW	Molecular Weight of the gas or vapor. This value should be obtained from process data (refer to Table 5).
MAWP	Maximum Allowable Working Pressure
P	The set pressure of the safety relief valve in gauge pressure units.
P_b	The pressure at the outlet of the valve in gauge pressure units. This value is coincident with the rated flowing pressure value.
P_1	The rated flowing pressure at the inlet of the safety relief valve in absolute pressure units (psia). This value is the stamped set pressure of the safety relief valve plus the overpressure plus the atmospheric pressure. Refer to the section "Set Pressure and Overpressure Relationships for Sizing".
P_2	P2 The pressure at the outlet of the valve in absolute pressure units (psia). This value is coincident with the rated flowing pressure value.
Q	Capacity in volume per time units.
R	Reynolds number. A dimensionless number used in obtaining the viscosity correction factor K_v.
ρ	Density of gas or vapor: ρ, for vapors = (SG) x (Density of Air) ρ, for liquids = (SG) x (Density of Water) Density of Air = 0.0763 lb/ft^3 at 14.7 psia, and 60°F (USCS) Density of Air = 1.2932 kg/m^3 at 760 mm Hg and 0°C (metric) Density of Water = 62.305 lb/ft^3 at 70°F (USCS) Density of Water = 998 kg/m^3 at 20°C (metric)
SG	Specific Gravity. A dimensionless number that relates the densities of a fluid to that of a standard fluid. The value of SG is 1.0 for the following standard conditions: Liquid Standard: Water at 70°F (USCS) Water at 20°C (metric) Gas Standard: Air at 14.696 psia and 60°F (USCS) Air at 760 mm Hg and 0°C (metric)
T	The temperature at the inlet of the valve in absolute temperature units. This value is coincident with the rated flowing pressure value, for example °F + 460.
W	Capacity in Mass Per Time Units.
Z	Compressibility factor for gas or vapor. If unknown, use Z=1.
K_n	Napier Factor. A dimensionless correction factor to the Napier steam flow equation used only for steam and only in the range of P_1 = 1580 to 3208 psia flowing pressure. Calculate K_n from the equation:

$$K_n = \frac{0.1906P_1 - 1000}{0.2292P_1 - 1061}$$

If P is 1423 psig or less, Kn = 1.0. If P is more than 1423 psig, up to and including 3223 psig, K_n is calculated.

Note: that P_1 is the flowing pressure and is in absolute pressure units.

Set Pressure and Overpressure Relationships for Sizing

Set pressure and overpressure requirements vary with the installation and application of the pressure relief valve(s). The installation may require one or more pressure relief valves per ASME Section VIII and API RP 520. The application will require the pressure relief valve(s) to provide overpressure protection caused by non-fire or fire-related events.

In all cases, the overpressure of the pressure relief valve will be the difference between the accumulation of the system and the pressure relief valve's set pressure. In determining the required pressure relief valve orifice area, the flowing pressure value (P_1) will be set equal to the system accumulation value.

Single Valve Installations

Used when only one pressure relief valve is required for system overpressure protection.

1. If the overpressure is not due to a fire exposure event:
    a. The set pressure may be equal to or less than the MAWP of the protected system.
    b. The accumulation of the system must not exceed the larger of 3 psi or 10% above the MAWP (see Table 1.)
2. If the overpressure is due to a fire exposure event on a vessel:
    a. The set pressure may be equal to or less than the MAWP of the protected system.
    b. The accumulation of the system must not exceed 21% above MAWP (see Table 2.)

Multiple Valve Installations

Applies when more than one pressure relief valve is required for system overpressure protection.

1. If the overpressure is not due to a fire exposure event:
    a. The set pressure of at least one valve must be equal to or less than the MAWP of the protected system. The set pressure of any of the remaining valve(s) must not exceed 1.05 times the MAWP.
    b. The accumulation of the system must not exceed the larger of 4 psi or 16% above the MAWP (see Table 3.)
2. If the overpressure is due to a fire exposure event on a vessel:
    a. The set pressure of at least one valve must be equal to or less than the MAWP of the protected system. The set pressure of any of the remaining valve(s) must not exceed 1.10 times the MAWP.
    b. The accumulation of the system must not exceed 21% above MAWP (see Table 2.)

Set Pressure and Overpressure Relationships for Sizing

Table 1 - Flowing Pressure for Single Valve Installations

MAWP to 15 psig to 30 psig	P_1 = MAWP + 3 + 14.7
MAWP of 1.02 barg up to and including 2.06 barg	P_1 = MAWP + 0.206 + 1.01
MAWP of 1.05 kg/cm^{2}g up to and including 2.11 kg/cm^{2}g	P_1 = MAWP + 0.211 + 1.03
MAWP higher than 30 psig	P_1 = 1.1(MAWP) + 14.7
MAWP higher than 2.06 barg	P_1 = 1.1(MAWP) + 1.01
MAWP higher than 2.11 kg/cm^{2}g	P_1 = 1.1(MAWP) + 1.03

Table 2 - Flowing Pressure for FireSizing

MAWP higher than 15 psig	P_1 = 1.21(MAWP) + 14.7
MAWP higher than 1.02 barg	P_1 = 1.21(MAWP) + 1.01
MAWP higher than 1.05 kg/cm^{2}g	P_1 = 1.21(MAWP) + 1.03

Table 3 - Flowing Pressure for Multiple Valve Installations

MAWP of 15 psig to 25 psig	P_1 = MAWP + 4 + 14.7
MAWP of 1.02 barg up to and including 1.72 barg	P_1 = MAWP + 0.275 + 1.01
MAWP of 1.05 kg/cm^{2}g up to and including 1.75 kg/cm^{2}g	P_1 = MAWP + 0.281 + 1.03
MAWP higher than 25 psig	P1 = 1.16(MAWP) + 14.7
MAWP higher than 1.72 barg	P1 = 1.16(MAWP) + 1.01
MAWP higher than 1.75 kg/cm^{2}g	P1 = 1.16(MAWP) + 1.03

API Sizing Formulas - USCS

API RP 520 Sizing Formulas USCS Units

Refer to Tables 6 - 8a and select the next larger size above the A_c value calculated.

The value of A_c shall be compared to the API effective orifice areas.

VAPORS OR GASES
Mass Flow Rate Sizing
(W = lb/hr)

$$A_c = \frac{W\sqrt{T}\sqrt{Z}}{C\,K_d\,P_1\sqrt{M}\,K_b}$$

VAPORS OR GASES
Volumetric Flow Rate Sizing

(Q = Standard ft^3/Min Flow Rate at 14.7 psia & 60°F)

$$A_c = \frac{60\,Q_p\sqrt{T}\sqrt{Z}}{C\,K_d\,P_1\sqrt{M}\,K_b}$$

(ρ = density at standard conditions)

AIR
Volumetric Flow Rate Sizing

(Q = Standard ft^3/Min Flow Rate at 14.7 psia & 60°F)

$$A_c = \frac{60\,Q\,(0.0763)\sqrt{T}\sqrt{Z}}{356\,K_d\,P_1\,(5.3824)\,K_b}$$

STEAM
Mass Flow Rate Sizing
(W = lb/hr)

$$A_c = \frac{W}{51.5\,K_d\,P_1\,K_b\,K_{sh}\,K_n}$$

LIQUIDS
Certified Volumetric Flow Rate Sizing

$$A_c = \frac{Q\sqrt{SG}}{K_u\,K_d\sqrt{P_1 - P_2}\,K_v\,K_w}$$

K_d Factors

Valve Series	Steam, Gas or Vapor K_d	Liquid K_d
1900	.975	.744
2900	.975	.744
3900	.975	.826
4900	.975	.844

ASME Sizing Formulas - USCS

ASME Section XIII Sizing Formulas USCS Units

Refer to Tables 6 - 11 and select the next larger size above the A_c value calculated.

The value of A_c shall be compared to the ASME actual orifice areas.

VAPORS OR GASES
Mass Flow Rate Sizing
(W = lb/hr)

$$A_c = \frac{W \sqrt{T} \sqrt{Z}}{C\,K\,P_1 \sqrt{M}\,K_b}$$

STEAM
Mass Flow Rate Sizing
(W = lb/hr)

$$A_c = \frac{W}{51.5\,K\,P_1\,K_b\,K_{sh}\,K_n}$$

VAPORS OR GASES
Volumetric Flow Rate Sizing

(Q = Standard ft³ min flow rate at 14.7 psig and 60°F)

$$A_c = \frac{60\,Q\rho \sqrt{T} \sqrt{Z}}{C\,K\,P_1 \sqrt{M}\,K_b}$$

(ρ = density at standard conditions)

LIQUIDS
Certified Volumetric Flow Rate Sizing

(If Q = U.S. Gallons per minute, $K_u = 38$)
(If Q = Cubic feet per hour, $K_u = 5.2143$)

$$A_c = \frac{Q \sqrt{SG}}{K_u\,K \sqrt{P_1 - P_2}\,K_v\,K_w}$$

AIR
Volumetric Flow Rate Sizing

(Q = Standard ft³ min flow rate at 14.7 psig and 60°F)

$$A_c = \frac{60\,Q\,(0.0763) \sqrt{T} \sqrt{Z}}{356\,K\,P_1\,(5.3824)\,K_b}$$

K Factors (K_d x 0.9)

Valve Series	Steam, Gas or Vapor K	Liquid K
1900	.855	.670
1982	.855	.758
2900	.855	.670
3900	.878	.743
4900	.878	.760
13900 (all except 201 in²)	.877	N/A
13900 (201 in² only)	.850	N/A
19000	.878	.673

ASME Sizing Formulas - Metric

ASME Section XIII Sizing Formulas Metric Units

ASME permits metric unit stamping of name plates (ASME Code Case 2116). Refer to Tables 6 - 11 and select the next larger size above the A_c value calculated.

The value of A_c shall be compared to the ASME actual effective orifice areas.

VAPORS OR GASES
Mass Flow Rate Sizing
(W = kg/hr)

$$A_c = \frac{K_u W \sqrt{T} \sqrt{Z}}{C\,K\,P_1 \sqrt{M}\,K_b}$$

If P_1 = bara, K_u = 131.7
If P_1 = kg/cm² a, K_u = 134.26

STEAM
Mass Flow Rate Sizing
(W = kg/hr)

$$A_c = \frac{W}{K_u\,K\,P_1\,K_b, K_{sh}\,K_n}$$

If P_1 = bara, K_u = 0.5245
If P_1 = kg/cm²a, K_u = 0.5144

VAPORS OR GASES
Volumetric Flow Rate Sizing

(Q = Normal m³/hr Flow Rate at 760 mm Hg at 0°F)

$$A_c = \frac{K_u Q\rho \sqrt{T} \sqrt{Z}}{C\,K\,P_1 \sqrt{M}}$$

If P_1 = bara, K_u = 131.7
If P_1 = kg/cm² a, K_u = 134.26

(ρ = density at standard conditions)

LIQUIDS
Certified Volumetric Flow Rate Sizing

$$A_c = \frac{Q \sqrt{SG}}{K_u\,K \sqrt{P_1 - P_2}\,K_v\,K_w}$$

If P_1 & P_2 = bara and Q = liters/min, K_u = 0.849
If P_1 & P_2 = kg/cm²a and Q = liters/min, K_u = 0.841
If P_1 & P_2 = bara and Q = m³/hr, K_u = 0.0509
If P_1 & P_2 = ka/cm²a and Q = m³/hr, K_u = 0.0504

AIR
Volumetric Flow Rate Sizing

(Q = Normal m³/hr Flow Rate at 760 mm Hg at 0°C)

$$A_c = \frac{K_u Q\,(1.2932) \sqrt{T} \sqrt{Z}}{356\,K\,P_1\,(5.3824)\,K_b}$$

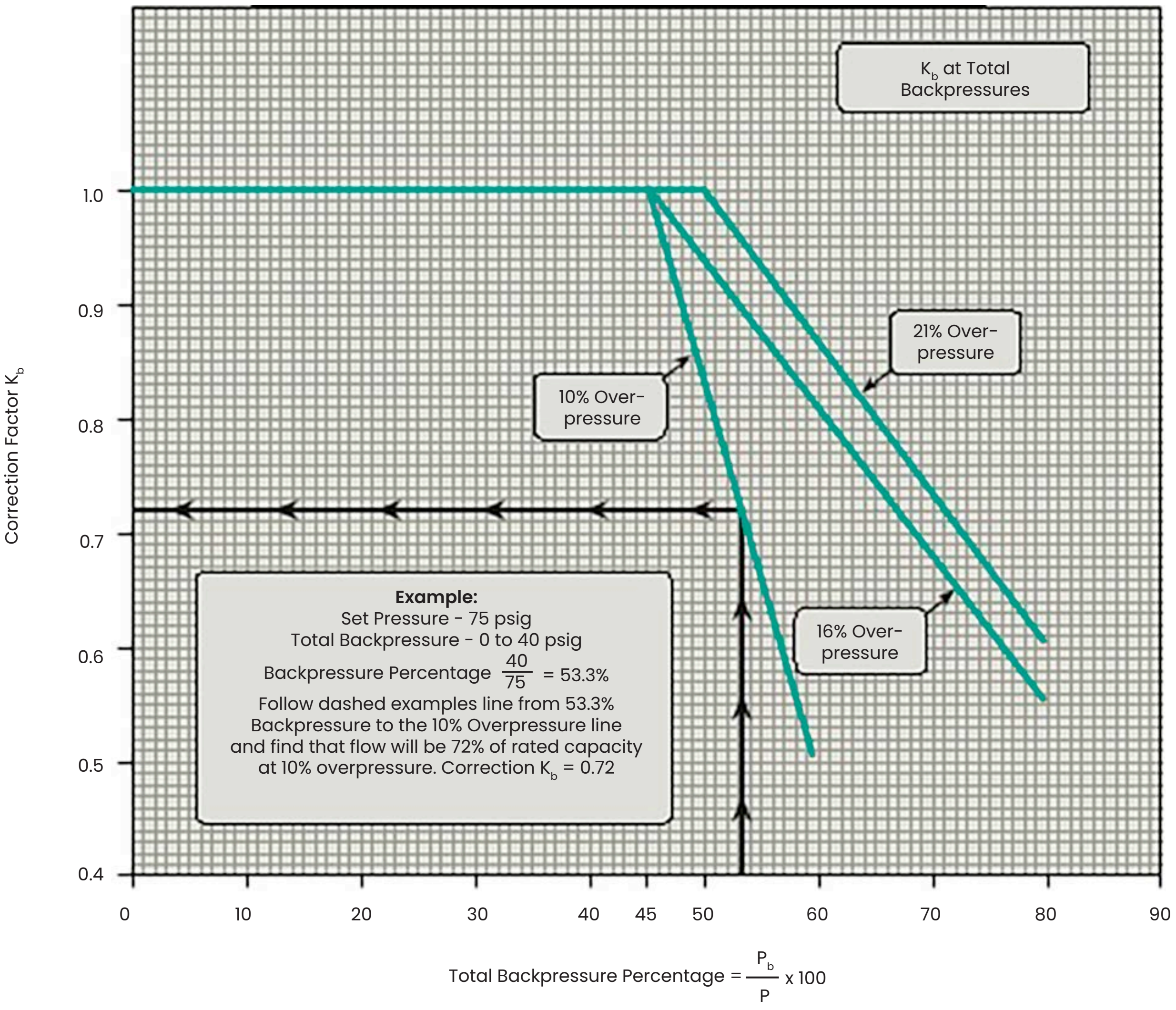
If P_1 = bara, K_u = 131.71
If P_1 = kg/cm²a, K_u = 134.26

K Factors (K_d x 0.9)

Valve Series	Steam, Gas or Vapor K	Liquid K
1900	.855	.670
1982	.855	.758
2900	.855	.670
3900	.878	.743
4900	.878	.760
13900 (all except 201 in²)	.877	N/A
13900 (201 in² only)	.850	N/A
19000	.878	.673

Correction Factors

Figure 1 - 1900 Balanced Bellows Valves and 19096M-BP Valves Vapors and Gases - Correction Factor K_b

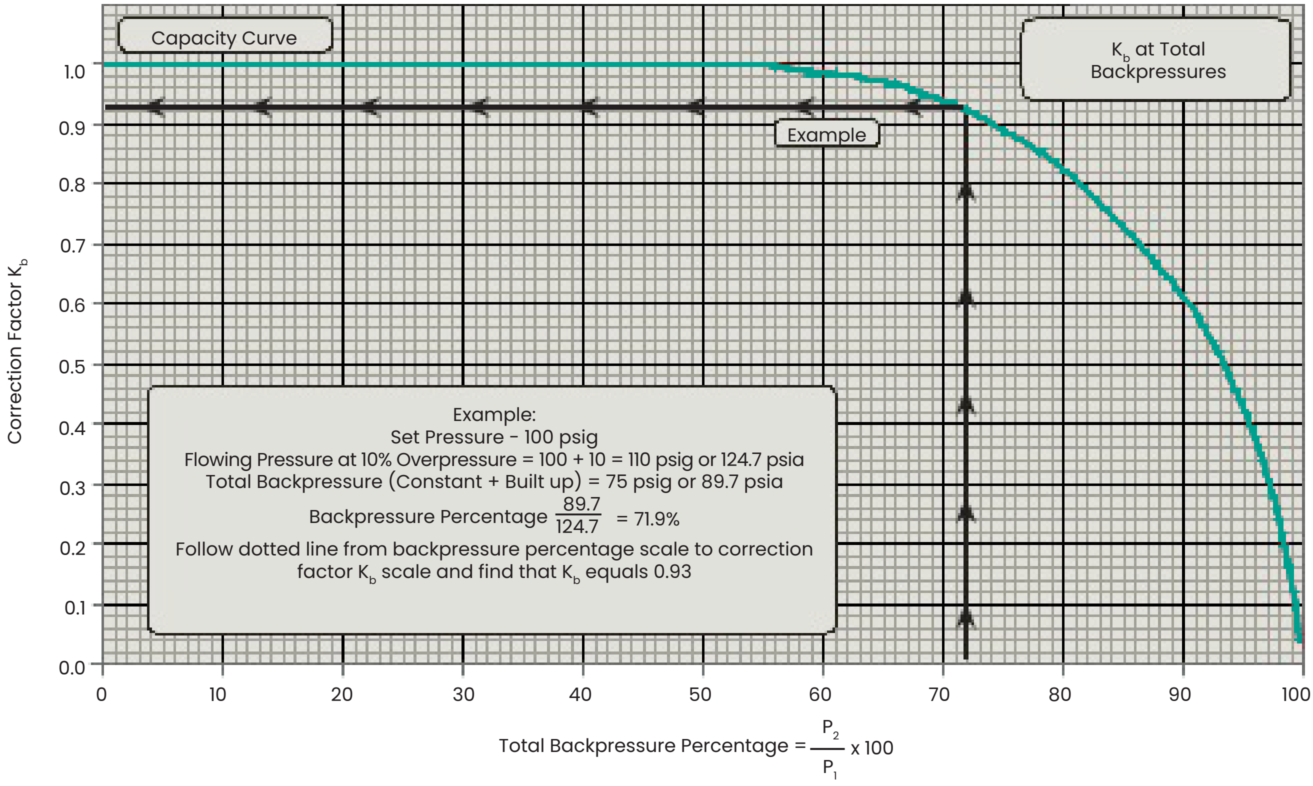


Example:
Set Pressure - 75 psig
Total Backpressure - 0 to 40 psig
Backpressure Percentage $\frac{40}{75}$ = 53.3%
Follow dashed examples line from 53.3% Backpressure to the 10% Overpressure line and find that flow will be 72% of rated capacity at 10% overpressure. Correction K_b = 0.72

Total Backpressure Percentage = $\frac{P_b}{P}$ x 100

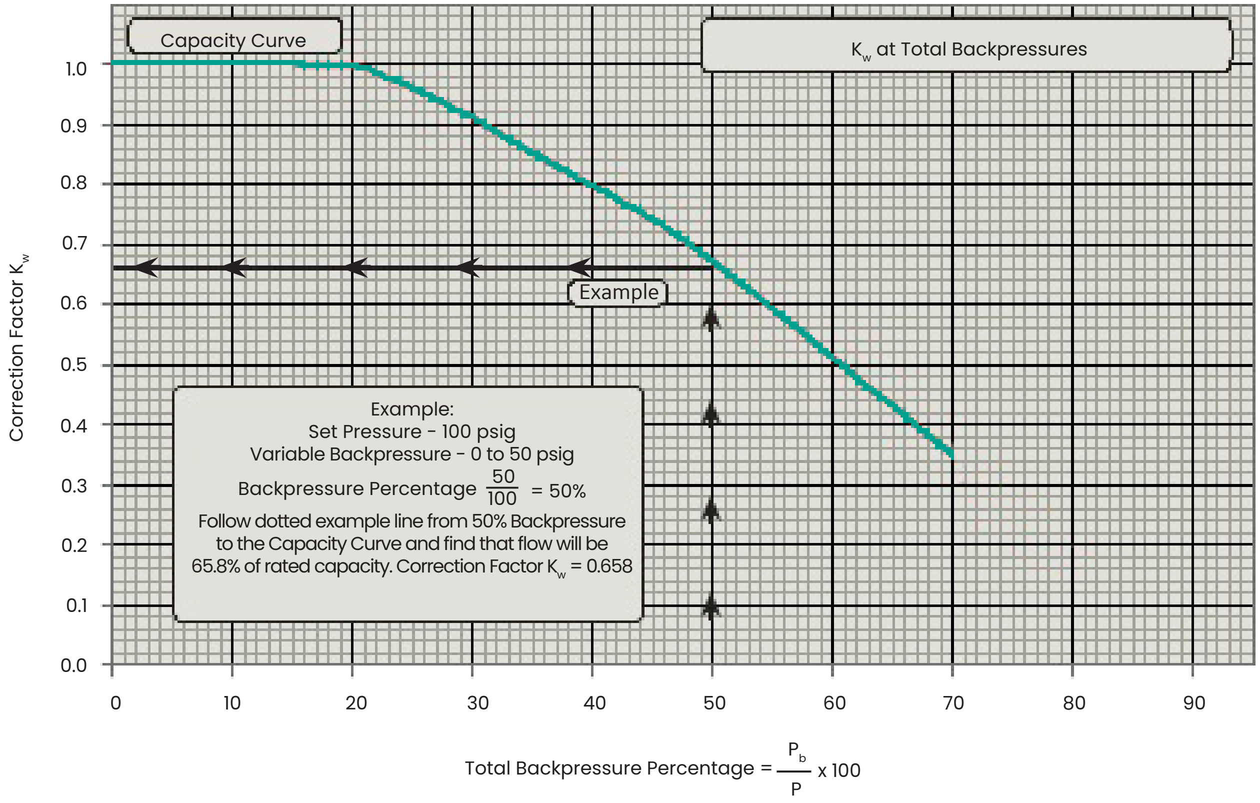
Correction Factors

Figure 2 - Non-Bellows Valves
Vapor or Gas Flow Curve at All Backpressures, Correction Factor K_b



Example:
Set Pressure - 100 psig
Flowing Pressure at 10% Overpressure = 100 + 10 = 110 psig or 124.7 psia
Total Backpressure (Constant + Built up) = 75 psig or 89.7 psia
Backpressure Percentage $\frac{89.7}{124.7}$ = 71.9%
Follow dotted line from backpressure percentage scale to correction factor K_b scale and find that K_b equals 0.93

Figure 3 - 1900 Balanced Bellows and 19096M-BP Only - Liquids - Correction Factor K_w



Example:
Set Pressure - 100 psig
Variable Backpressure - 0 to 50 psig
Backpressure Percentage $\frac{50}{100}$ = 50%
Follow dotted example line from 50% Backpressure to the Capacity Curve and find that flow will be 65.8% of rated capacity. Correction Factor K_w = 0.658

Correction Factors

When using the following method, it is suggested that the safety relief valve be sized first with available application data in order to obtain a preliminary required discharge area (A_c). From the standard orifice sizes, the next larger orifice size should be used in determining the Reynolds number (R) from either of the following relationships:

$$R = \frac{Q\,(2{,}800)\,SG}{Cp\,\sqrt{A}}$$

OR

$$R = \frac{12{,}700 \times Q}{SSU \times \sqrt{A}}$$

Where:

Q = actual flow rate at the flowing temperature (U.S. gallons per minute)

SG = specific gravity of the liquid at the flowing temperature referred to water = 1.00 at 70°F

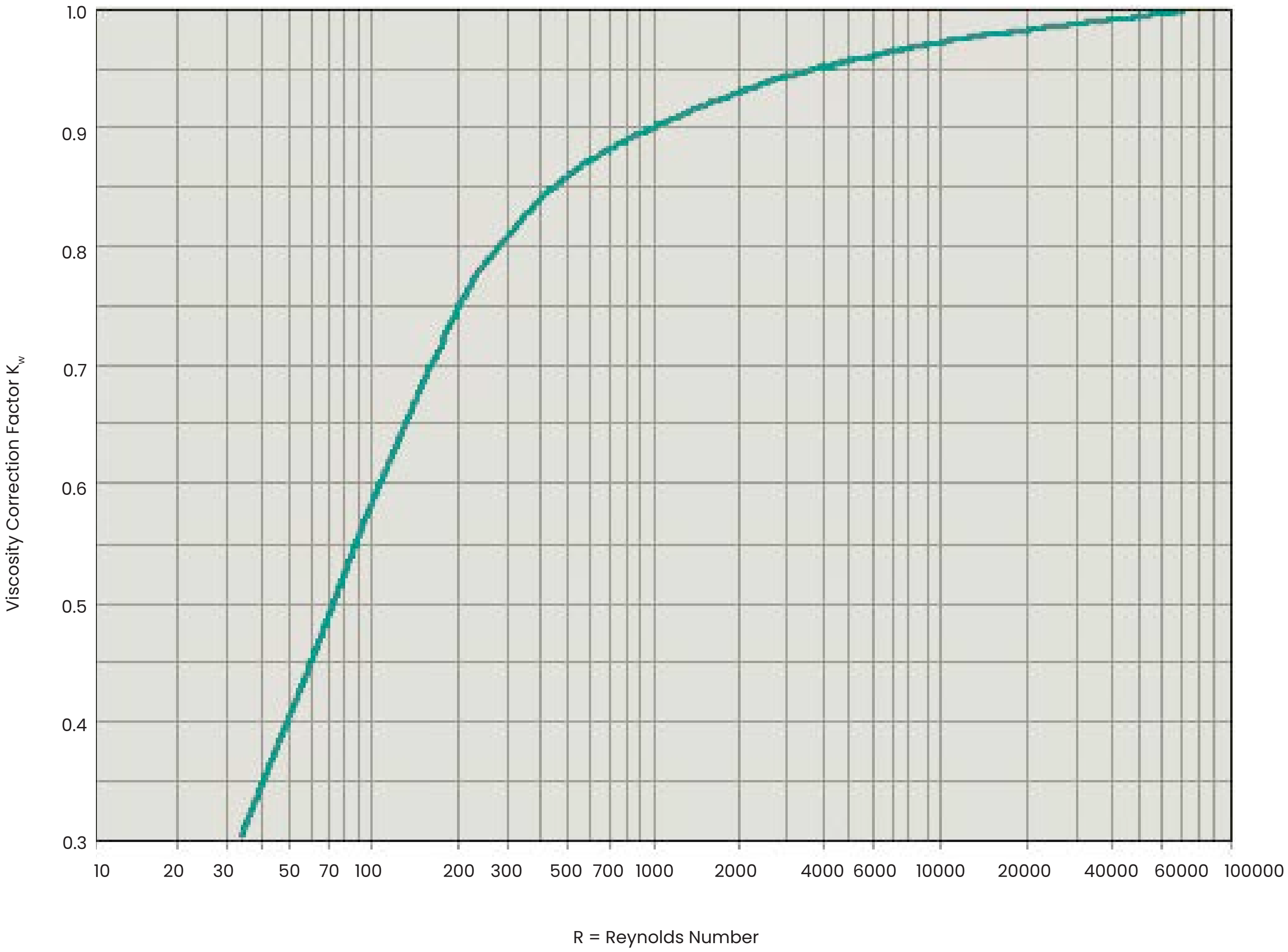
C_p = absolute viscosity at the flowing temperature (in centipoises)

A = valve orifice discharge area (square inches)

SSU = Seconds Universal (viscosity at the flowing temperature)

After the value of R is determined, the factor K_v is obtained from Figure 4. Factor K_v is applied to correct the "preliminary required discharge area." If the corrected area exceeds the "chosen standard orifice area", the above calculations should be repeated using the next larger standard orifice size.

Figure 4



Fluid Properties

Table 4 - Gas Constant C

k	C	k	C	k	C
0.50	238	1.02	318	1.52	366
0.52	242	1.04	320	1.54	368
0.54	246	1.06	322	1.56	369
0.56	250	1.08	325	1.58	371
0.58	254	1.10	327	1.60	373
0.60	257	1.12	329	1.62	374
0.62	261	1.14	331	1.64	376
0.64	264	1.16	333	1.66	377
0.66	268	1.18	335	1.68	379
0.68	271	1.20	337	1.70	380
0.70	274	1.22	339	1.72	382
0.72	277	1.24	341	1.74	383
0.74	280	1.26	343	1.76	384
0.76	283	1.28	345	1.78	386
0.78	286	1.30	347	1.80	387
0.80	289	1.32	349	1.82	389
0.82	292	1.34	351	1.84	390
0.84	295	1.36	353	1.86	391
0.86	279	1.38	354	1.88	393
0.88	300	1.40	356	1.90	394
0.90	303	1.42	358	1.92	395
0.92	305	1.44	360	1.94	397
0.94	308	1.46	361	1.96	398
0.96	310	1.48	363	1.98	399
0.98	313	1.50	365	2.00	400
1.01	317				

The relationship of “k” and “C” are expressed by the equation:

$$C = 520 \sqrt{k\left(\frac{2}{K+1}\right)^{\frac{k+1}{k-1}}}$$

Fluid Properties

Table 5 - Constant and Capacity Conversion Factors for Common Fluids

	Gas & Vapor Phase			Liquid Phase			
Fluid	**K(1)**	**MW**	**G(1) Air = 1**	**G Water = 1**	**G Temp °F**	**Boiling Point(1) °F**	**Critical Temp °F**
Acetaldehyde	1.14	44.05	1.521	0.783	64	68	370
Acetic Acid	1.15	60.05	2.073	1.049	68	245	611
Acetone	-	-	-	0.791	68	133	455
Acetylene	1.26	26.04	0.899	-	-	-119	97
Air	1.40	28.97	1.00	-	-	-	-222
Ammonia	1.33	17.03	0.588	0.817	-110	-27	270
Argon	1.67	39.94	1.388	1.65	-387	-301	-188
Benzene	1.12	78.11	2.696	0.879	68	176	551
Butadiene 1,3	1.12	54.09	1.867	0.621	68	24	306
Butane N-	1.094	58.12	2.006	0.579	68	31	307
Butane ISO-	1.094	58.12	2.006	0.557	68	11	273
Carbon Dioxide	1.30	44.01	1.519	1.101	-35	SUBL.	88
Carbon Disulfide	1.21	76.13	2.628	1.263	68	116	523
Carbon Monoxide	1.40	28.00	0.966	0.814	-318	-314	-218
Chlorine	1.36	70.90	2.45	1.58	-29	-30	291
Cyclohexane	1.09	84.16	2.905	0.779	69	177	538
Ethane	1.22	30.07	1.04	0.546	-126	-127	90
Ethyl Alcohol	1.13	46.07	1.59	0.789	68	173	469
Ethyl Chloride	1.19	64.52	2.227	0.903	50	54	369
Ethylene (Ethene)	1.26	28.05	0.968	0.566	-152	-155	49
Helium	1.66	4.00	0.138	-	-	-452	-450
N-Hexane	1.06	86.17	2.974	0.659	68	156	454
Hydrogen Chloride	1.41	36.50	1.26	-	-	-118	124
Hydrogen	1.41	2.016	0.069	0.0709	-423	-423	-400
Hydrogen Sulfide	1.32	34.07	1.176	-	-	-76	213
Kerosene	-	-	-	0.815	60	-	-
Methane	1.31	16.04	0.554	0.415	-263	-258	-116
Methyl Alcohol	1.20	32.04	1.11	0.792	68	149	464
Methyl Butane	1.08	72.15	2.49	0.625	60	82	370
Methyl Chloride	1.20	50.49	1.743	0.952	32	-11	290
Natural Gas (typical)	1.27	19.00	0.656	-	-	-	-
Nitric Acid (HNO_3)	-	-	-	1.502	60	187	-
Nitric Oxide	1.40	30.00	1.0036	1.269	-239	-240	-137
Nitrogen	1.40	28.00	0.967	1.026	-422	-321	-233
Nitrous Oxide	1.30	44.00	1.519	1.226	-128	-131	98
Oxygen	1.40	32.00	1.104	1.426	-422	-297	-182
N-Pentane	1.07	72.15	2.49	0.631	60	97	386
Propane	1.13	44.09	1.522	0.585	-49	-44	206
Propylene	1.15	42.08	1.453	0.609	-53	-54	197
Styrene	1.07	104.14	3.60	0.906	68	293	706
Sulfur Dioxide	1.29	64.06	2.21	1.434	32	14	315

1. Value at 14.7 pounds per square inch, absolute.

API Standard Orifice Areas - 1900

Table 6 - 1900 Series (USCS)

(A_c) API Effective Orifice Area (In^2)	Orifice Letter Size(1)	(A_c) ASME and Actual Orifice Area (In^2)	API Set Pressure Range (psig)	Available Set Pressure Range (psig)
0.110	D	0.1279	5 - 6000	5 - 6250
0.196	E	0.2279	5 - 6000	5 - 6250
0.307	F	0.3568	5 - 5000	5 - 6250
0.503	G	0.5849	4 - 3705	4 - 5000
0.785	H	0.9127	4 - 2750	4 - 3418
1.287	J	1.4960	5 - 2700	5 - 2700
1.838	K	2.1380	5 - 2200	5 - 2540
2.853	L	3.3170	5 - 1500	5 - 2200
3.600	M	4.1860	5 - 1100	5 - 1600
4.340	N	5.0470	6 - 1000	6 - 1600
6.380	P	7.4170	7 - 1000	7 - 1500
11.050	Q	12.8500	7 - 600	7 - 900
16.000	R	18.6000	7 - 300	7 - 650
26.000	T	30.2100(2)	9 - 300	9 - 300
N/A	V	50.26	N/A	15 - 300
N/A	W	78.996	N/A	15 - 300

1. V and W orifices should be sized using ASME formula and orifice area.
2. Prior to 1999 this area was 28.62 in^2. Consult factory for clarification.

API Standard Orifice Areas - 2900

Table 7 - 2900 Series (USCS)

(A_c) API Effective Orifice Area (In^2)	Orifice Letter Size(1)	(A_c) ASME and Actual Orifice Area (In^2)	API Set Pressure Range (psig)	Available Set Pressure Range (psig)
0.110	**D**	**0.1279**	**15 - 6000**	**15 - 6250**
0.196	E	0.2279	15 - 6000	15 - 6250
0.307	F	0.3568	15 - 5000	15 - 6250
0.503	G	0.5849	15 - 3705	15 - 6250
0.785	H	0.9127	15 - 2750	15 - 3750
1.287	J	1.4960	15 - 2700	15 - 3750
1.838	K	2.1380	15 - 2220	15 - 3750
2.853	L	3.3170	15 - 1500	15 - 3750
3.600	M	4.1860	15 - 1100	15 - 2250
4.340	N	5.0470	15 - 1000	15 - 2250
6.380	P	7.4170	15 - 1000	15 - 2250
11.050	Q	12.8500	15 - 600	15 - 1500
16.000	R	18.6000	15 - 300	15 - 1500
26.000	T	30.2100	15 - 300	15 - 905
N/A	V	50.26	N/A	15 - 675
N/A	W	78.996	N/A	15 - 535

1. V and W orifices should be sized using ASME formula and orifice area.

API Standard Orifice Areas - 3900 and 4900

Table 8 - 3900 Series (USCS)

(A_c) API Effective Orifice Area (In^2)	Orifice Letter Size	(A_c) ASME and Actual Orifice Area (In^2)	API Set Pressure Range (psig)	Available Set Pressure Range (psig)
0.110	D	0.1279	15 - 3705	15 - 6250
0.196	E	0.2279	15 - 3705	15 - 6250
0.307	F	0.3568	15 - 3705	15 - 6250
0.503	G	0.5849	15 - 3705	15 - 6250
0.785	H	0.9127	15 - 3705	15 - 6250
1.287	J	1.496	15 - 3705	15 - 6250
1.838	K	2.138	15 - 3705	15 - 6250
2.853	L	3.317	15 - 3705	15 - 6250
3.600	M	4.186	15 - 3705	15 - 3750
4.340	N	5.047	15 - 3705	15 - 3750
6.380	P	7.417	15 - 3705	15 - 3750
11.050	Q	12.85	15 - 1480	15 - 1500
16.000	R	18.6	15 - 915	15 - 1500
26.000	T	30.21(1)	15 - 900	15 - 1500

1. Prior to 1999 this area was 28.62 in^2. Consult factory for clarification.

Table 8a - 4900 Series (USCS)

(A_c) API Effective Orifice Area (In^2)	Orifice Letter Size	(A_c) ASME and Actual Orifice Area (In^2)	API Set Pressure Range (psig)	Available Set Pressure Range (psig)
0.110	D	0.1314	15 - 3705	15 - 7200
0.196	E	0.288	15 - 3705	15 - 7200
0.307	F	0.359	15 - 3705	15 - 7200
0.503	G	0.594	15 - 3705	15 - 7200
0.785	H	0.930	15 - 2750	15 - 7200
1.287	J	1.513	15 - 2700	15 - 7200
1.838	K	2.160	15 - 2200	15 - 7200
2.853	L	3.350	15 - 1500	15 - 7200
3.60	M	4.229	15 - 1100	15 - 3750
4.34	N	5.098	15 - 1100	15 - 3750
6.38	P	7.491	15 - 1000	15 - 3750
11.05	Q	12.979	15 - 600	15 - 1500
16.00	R	18.783	15 - 300	15 - 1500
26.00	T	30.542	15 - 300	15 - 1500

Standard Orifice Areas - 19000

Table 9 - 19000 Series (USCS)

Inlet Size (in)	Model Number	(A_c) ASME and Actual Orifice Area (In^2)	Set Pressure Range (psig)
1/2, 3/4, 1	19096L	.096	5 - 290
1/2, 3/4, 1	19110L	.110	5 - 290
3/4, 1	19126L	.126	5 - 290
1	19226L	.226	5 - 290
1 ½	19357L	.357	5 - 290
2	19567L	.567	5 - 290
1/2, 3/4, 1	19096M	.096	291 - 2000
1/2, 3/4, 1	19110M	.110	291 - 2000
3/4, 1	19126M	.126	291 - 2000
1	19226M	.226	291 - 2000
1 ½	19357M	.357	291 - 1500
2	19567M	.567	291 - 1500
3/4	19096H	.096	2001 - 5000
3/4, 1	19110H	.110	2001 - 5000
3/4	19126H	.126	2001 - 8000
1	19226H	.226	2001 - 6400

Standard Orifice Areas 1982 and 13900

Table 10 - 1982 Series (USCS)

Inlet Size (in)	(A_c) Actual (ASME) Orifice Area (In^2)	Set Pressure Range (psig)
1/2	0.121	10 - 500
3/4	0.216	10 - 500
1	0.332	10 - 500
1 ½	0.857	10 - 500

Table 11 - 13900 Series (USCS)

Inlet Size (in)	(A_c) Actual (ASME) Orifice Area (In^2)	Set Pressure Range (psig)
16	114.0	50 - 300
18	143.1	50 - 300
20	176.7	50 - 300
22	201.0	50 - 300

Superheat Correction Factors

Table 12 - Superheat Correction Factor K_{sh}

Flowing Press. (psia)	Superheat Correction Factor K_{sh}, Total Temperature in °F of Superheated Steam																
	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
50	0.987	0.957	0.930	0.905	0.882	0.861	0.841	0.823	0.805	0.789	0.774	0.759	0.745	0.732	0.719	0.708	0.696
100	0.998	0.963	0.935	0.909	0.885	0.864	0.843	0.825	0.807	0.790	0.775	0.760	0.746	0.733	0.720	0.708	0.697
150	0.984	0.970	0.940	0.913	0.888	0.866	0.846	0.826	0.808	0.792	0.776	0.761	0.747	0.733	0.721	0.709	0.697
200	0.979	0.977	0.945	0.917	0.892	0.869	0.848	0.828	0.810	0.793	0.777	0.762	0.748	0.734	0.721	0.709	0.698
250	-	0.972	0.951	0.921	0.895	0.871	0.850	0.830	0.812	0.794	0.778	0.763	0.749	0.735	0.722	0.710	0.698
300	-	0.968	0.957	0.926	0.898	0.874	0.852	0.832	0.813	0.796	0.780	0.764	0.750	0.736	0.723	0.710	0.699
350	-	0.968	0.963	0.930	0.902	0.877	0.854	0.834	0.815	0.797	0.781	0.765	0.750	0.736	0.723	0.711	0.699
400	-	-	0.963	0.935	0.906	0.880	0.857	0.836	0.816	0.798	0.782	0.766	0.751	0.737	0.724	0.712	0.700
450	-	-	0.961	0.940	0.909	0.883	0.859	0.838	0.818	0.800	0.783	0.767	0.752	0.738	0.725	0.712	0.700
500	-	-	0.961	0.946	0.914	0.886	0.862	0.840	0.820	0.801	0.784	0.768	0.753	0.739	0.725	0.713	0.701
550	-	-	0.962	0.952	0.918	0.889	0.864	0.842	0.822	0.803	0.785	0.769	0.754	0.740	0.726	0.713	0.701
600	-	-	0.964	0.958	0.922	0.892	0.867	0.844	0.823	0.804	0.787	0.770	0.755	0.740	0.727	0.714	0.702
650	-	-	0.968	0.958	0.927	0.896	0.869	0.846	0.825	0.806	0.788	0.771	0.756	0.741	0.728	0.715	0.702
700	-	-	-	0.958	0.931	0.899	0.872	0.848	0.827	0.807	0.789	0.772	0.757	0.742	0.728	0.715	0.703
750	-	-	-	0.958	0.936	0.903	0.875	0.850	0.828	0.809	0.790	0.774	0.758	0.743	0.729	0.716	0.703
800	-	-	-	0.960	0.942	0.906	0.878	0.852	0.830	0.810	0.792	0.774	0.759	0.744	0.730	0.716	0.704
850	-	-	-	0.962	0.947	0.910	0.880	0.855	0.832	0.812	0.793	0.776	0.760	0.744	0.730	0.717	0.704
900	-	-	-	0.965	0.953	0.914	0.883	0.857	0.834	0.813	0.794	0.777	0.760	0.745	0.731	0.718	0.705
950	-	-	-	0.969	0.958	0.918	0.886	0.860	0.836	0.815	0.796	0.778	0.761	0.746	0.732	0.718	0.705
1000	-	-	-	0.974	0.959	0.923	0.890	0.862	0.838	0.816	0.797	0.779	0.762	0.747	0.732	0.719	0.706
1050	-	-	-	-	0.960	0.927	0.893	0.864	0.840	0.818	0.798	0.780	0.763	0.748	0.733	0.719	0.707
1100	-	-	-	-	0.962	0.931	0.896	0.867	0.842	0.820	0.800	0.781	0.764	0.749	0.734	0.720	0.707
1150	-	-	-	-	0.964	0.936	0.899	0.870	0.844	0.821	0.801	0.782	0.765	0.749	0.735	0.721	0.708
1200	-	-	-	-	0.966	0.941	0.903	0.872	0.846	0.823	0.802	0.784	0.766	0.750	0.735	0.721	0.708
1250	-	-	-	-	0.969	0.946	0.906	0.875	0.848	0.825	0.804	0.785	0.767	0.751	0.736	0.722	0.709
1300	-	-	-	-	0.973	0.952	0.910	0.878	0.850	0.826	0.805	0.786	0.768	0.752	0.737	0.723	0.709
1350	-	-	-	-	0.977	0.958	0.914	0.880	0.852	0.828	0.807	0.787	0.769	0.753	0.737	0.723	0.710
1400	-	-	-	-	0.982	0.963	0.918	0.883	0.854	0.830	0.808	0.788	0.770	0.754	0.738	0.724	0.710
1450	-	-	-	-	0.987	0.968	0.922	0.886	0.857	0.832	0.809	0.790	0.771	0.754	0.739	0.724	0.711
1500	-	-	-	-	0.993	0.970	0.926	0.889	0.859	0.833	0.811	0.791	0.772	0.755	0.740	0.725	0.711
1550	-	-	-	-	-	0.972	0.930	0.892	0.861	0.835	0.812	0.792	0.773	0.756	0.740	0.726	0.712
1600	-	-	-	-	-	0.973	0.934	0.894	0.863	0.836	0.813	0.792	0.774	0.756	0.740	0.726	0.712
1650	-	-	-	-	-	0.973	0.936	0.895	0.863	0.836	0.812	0.791	0.772	0.755	0.739	0.724	0.710
1700	-	-	-	-	-	0.973	0.938	0.895	0.863	0.835	0.811	0.790	0.771	0.754	0.738	0.723	0.709
1750	-	-	-	-	-	0.974	0.940	0.896	0.862	0.835	0.810	0.789	0.770	0.752	0.736	0.721	0.707

Superheat Correction Factors

Table 12 - Superheat Correction Factor K_{sh}

Flowing Press. (psia)	Superheat Correction Factor K_{sh}, Total Temperature in °F of Superheated Steam																
	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200
1800	–	–	–	–	–	0.975	0.942	0.897	0.862	0.834	0.810	0.788	0.768	0.751	0.735	0.720	0.705
1850	–	–	–	–	–	0.976	0.944	0.897	0.862	0.833	0.809	0.787	0.767	0.749	0.733	0.718	0.704
1900	–	–	–	–	–	0.977	0.946	0.898	0.862	0.832	0.807	0.785	0.766	0.748	0.731	0.716	0.702
1950	–	–	–	–	–	0.979	0.949	0.898	0.861	0.832	0.806	0.784	0.764	0.746	0.729	0.714	0.700
2000	–	–	–	–	–	0.982	0.952	0.899	0.861	0.831	0.805	0.782	0.762	0.744	0.728	0.712	0.698
2050	–	–	–	–	–	0.985	0.954	0.899	0.860	0.830	0.804	0.781	0.761	0.742	0.726	0.710	0.696
2100	–	–	–	–	–	0.988	0.956	0.900	0.860	0.828	0.802	0.779	0.759	0.740	0.724	0.708	0.694
2150	–	–	–	–	–	–	0.956	0.900	0.859	0.827	0.801	0.778	0.757	0.738	0.722	0.706	0.692
2200	–	–	–	–	–	–	0.955	0.901	0.859	0.826	0.799	0.776	0.755	0.736	0.720	0.704	0.690
2250	–	–	–	–	–	–	0.954	0.901	0.858	0.825	0.797	0.774	0.753	0.734	0.717	0.702	0.687
2300	–	–	–	–	–	–	0.953	0.901	0.857	0.823	0.795	0.772	0.751	0.732	0.715	0.699	0.685
2350	–	–	–	–	–	–	0.952	0.902	0.856	0.822	0.794	0.769	0.748	0.729	0.712	0.697	0.682
2400	–	–	–	–	–	–	0.952	0.902	0.855	0.820	0.791	0.767	0.746	0.727	0.710	0.694	0.679
2450	–	–	–	–	–	–	0.951	0.902	0.854	0.818	0.789	0.765	0.743	0.724	0.707	0.691	0.677
2500	–	–	–	–	–	–	0.951	0.902	0.852	0.816	0.787	0.762	0.740	0.721	0.704	0.688	0.674
2550	–	–	–	–	–	–	0.951	0.902	0.851	0.814	0.784	0.759	0.738	0.718	0.701	0.685	0.671
2600	–	–	–	–	–	–	0.951	0.903	0.849	0.812	0.782	0.756	0.735	0.715	0.698	0.682	0.664
2650	–	–	–	–	–	–	0.952	0.903	0.848	0.809	0.779	0.754	0.731	0.712	0.695	0.679	0.664
2700	–	–	–	–	–	–	0.952	0.903	0.846	0.807	0.776	0.750	0.728	0.708	0.691	0.675	0.661
2750	–	–	–	–	–	–	0.953	0.903	0.844	0.804	0.773	0.747	0.724	0.705	0.687	0.671	0.657
2800	–	–	–	–	–	–	0.956	0.903	0.842	0.801	0.769	0.743	0.721	0.701	0.684	0.668	0.653
2850	–	–	–	–	–	–	0.959	0.902	0.839	0.798	0.766	0.739	0.717	0.697	0.679	0.663	0.649
2900	–	–	–	–	–	–	0.963	0.902	0.836	0.794	0.762	0.735	0.713	0.693	0.675	0.659	0.645
2950	–	–	–	–	–	–	–	0.902	0.834	0.790	0.758	0.731	0.708	0.688	0.671	0.655	0.640
3000	–	–	–	–	–	–	–	0.901	0.831	0.786	0.753	0.726	0.704	0.684	0.666	0.650	0.635
3050	–	–	–	–	–	–	–	0.899	0.827	0.782	0.749	0.722	0.699	0.679	0.661	0.645	0.630
3100	–	–	–	–	–	–	–	0.896	0.823	0.777	0.744	0.716	0.693	0.673	0.656	0.640	0.625
3150	–	–	–	–	–	–	–	0.894	0.819	0.772	0.738	0.711	0.688	0.668	0.650	0.634	0.620
3200	–	–	–	–	–	–	–	0.889	0.815	0.767	0.733	0.705	0.682	0.662	0.644	0.628	0.614

ASME Rupture Disk Combinations K_c

A) Rupture Disk not Certified with the Safety Relief Valve

For those situations, the safety relief valve is sized in accordance with previously identified methods. However, this combination of rupture disk and pressure relief valve can only be credited with 90% of its ASME certified relieving capacity.

B) Rupture Disk is certified with the Safety Relief Valve K_c

In this case, the particular type of safety relief valve has been actually flow tested in combination with a unique rupture disk supplier's design type and a combination capacity factor established. The combination capacity factor is published by the National Board of Boiler & Pressure Vessels.

The safety relief valve ASME certified relieving capacity must be multiplied by the combination capacity factor to obtain the allowable ASME relieving capacity for the combination of the safety relief valve and rupture disk.

C) In all cases, ASME installation requirements must be followed. Refer to ASME Code Section XIII, parts 8 & 12..

API Fire Sizing

API Fire Sizing

The hazard of fire in operating plants that handle or process flammable liquids or gases must be a consideration in the sizing of safety relief valves. Any pressure vessel, or other pressure containing equipment protected by pressure relief valves under normal operating conditions, should be fire sized in the event that the equipment may be exposed to fire (although contents of the vessel are not flammable.)

A fire may occur due to leakage of flammable material from equipment and pipe lines, or may be caused by operational mishaps. If accidentally ignited, this burning material will immediately endanger adjacent vessels and equipment. Burning material can become an open, free burning fire quickly and carried some distance from the source of the leak by the slope of the ground in the case of liquids and by air currents with gas or vapor.

In the event that an open fire occurs around equipment or vessels, heat will naturally be absorbed by anything coming in contact with the flames and/or hot gases of the fire. If this heat absorption in a vessel continues for a long enough time, the vessel contents will be heated and the pressure will rise until the safety relief valve opens.

Therefore it is necessary, when determining the safety relief valve size, to consider the probability of fire exposure.

A. Fire Sizing For Liquid Hydrocarbons

1) The following information is necessary prior to fire sizing a vessel containing a liquid:

- Tank size (dimensions describing shape)
- Mounting (horizontal or vertical; height above ground)
- Fluid (composition by names)
- Normal liquid level (NLL): % full, depth of fluid or liquid-full
- F factor - See Table A1; if not known, use a factor of 1
- Operating pressure
- Set pressure
- Operating temperature
- Saturation temperature at P_1
- K (ratio of specific heats)
- M (molecular weight)
- Z (compressibility factor); if not known, assume Z = 1

Table A1 - Type of Equipment - Factor F[1]

Bare vessel	1.0
Insulated vessel[2] (These arbitrary insulation conductance values are shown as examples and are in British Thermal Units per hour per square foot per degree Fahrenheit):	
4.	0.3
2.	0.15
1	0.075
0.67.	0.05
0.5	0.0376
0.4	0.03
0.33.	0.026
Water application facilities, on bare vessel[3]	1.0
Depressurizing and emptying facilities[4]	1.0

1. These are suggested values for the conditions assumed in A.2. When these conditions do not exist, engineering judgment should be exercised either in selecting a higher factor or in providing means of protecting vessels from fire exposure as suggested in API RP 520, Part 1 - Sizing and Selection, D.8.
2. Insulation shall resist dislodgement by fire-hose streams. For the examples, a temperature difference of 1600°F was used. These conductance values are based on insulation having thermal conductivity of 4 BTU/hr-ft2 -˚F per inch at 1600°F and correspond to various thicknesses of insulation between 1 and 12 inches.
3. No reduction is given due to the inherent variables present (e.g. freezing weather, high winds clogged systems, etc.).
4. No reduction is given due to the inherent variables present, e.g. inaccessibility of manual controls, timing of depressurization, direction of automated controls, etc.

2) Determine Heat Absorption

$$Q = 21{,}000\ FA_s^{0.82}$$

Where:

Q = Total heat absorption (input) into the wetted surface in BTU(British Thermal Units) per hour

F = Environment Factor (see Table A1)

A_s = Total wetted surface area in square feet

When adequate draining and fire fighting equipment do not exist,

$$Q = 34{,}500\ FA_s^{0.82}$$

The determination of the total wetted surface area can become lengthy for certain vessel configurations, such as a horizontal cylindrical vessel with elliptical ends. Total surface area formulas for several different vessel shapes are listed in Table A2.

Total wetted surface area (A) = F_{wp} x Total vessel surface area
(F_{wp} = Wetted Perimeter factor)

For horizontal vessels, use Table A3 and Figure 3. For vertical vessels, use Table A2.

3) Determination of vapor discharge capacity in lb/hr

$$W = \frac{Q}{\text{Latent Heat of Vaporization}}$$

Determine Q from Step (2).

Determine latent heat of vaporization from the fluid properties.

API Fire Sizing

Table A2 - Total Surface Area Formulas[1]
SPHERE $A_s = \pi D^2$
Vertical cylinder with flat ends . . . . $A_s = \pi(DL + D^2/2)$
Vertical cylinder with elliptical ends. . $A_s = \pi\ DL + 2.61D^2$
Vertical cylinder with hemispherical ends $A_s = \pi(DL + D^2)$
Horizontal cylinder with flat ends . . . . $A_s = \pi(DL + D^2/2)$
Horizontal cylinder with elliptical ends $A_s = \pi\ DL + 2.61D^2$
Horizontal cylinder with hemispherical ends $A_s = \pi(DL+D^2)$
$\pi = 3.1416$
[1] It is recommended that the total wetted surface ("A" in the above formulas) is at least that wetted surface included within a height of 25 feet above grade, or in the case of spheres and spheroids, at least the elevation of the maximum horizontal diameter or a height of 25 feet, whichever is greater. The term "grade" usually refers to ground grade, but may be at any level at which a sizable fire could be sustained.

Table A3 - Liquid Level for Horizontal Cylindrical Vessels

% full < 0.5	% full ≥ 0.5
$\theta = \cos^{-1}\dfrac{\left(\frac{D}{2} - D(1 - \%\ \text{Full})\right)}{\frac{D}{2}}$ $A_{ws} = A_s * \left(\dfrac{2\theta}{2\pi}\right)$	$\theta = \cos^{-1}\dfrac{\left(\frac{D}{2} - D(1 - \%\ \text{Full})\right)}{\frac{D}{2}}$ $A_{ws} = A_s * \left(\dfrac{2\pi - 2\theta}{2\pi}\right)$

Where θ is in radians

w (vapor discharge capacity) $= W = \dfrac{Q}{H_{fg}}$

Where H_{fg} = latent heat of vaporization (btw/lb)

4) Determination of orifice area requirements Valves are to be sized in accordance with previously defined methods given in "Sizing Formulas" (see pages 8 - 9.)

API Fire Sizing

B. Fire Sizing For Vessels Containing Gases

1) The following information is necessary prior to fire sizing a vessel containing a vapor or gas.

- Tank Size: Dimensions describing shape
- Mounting: Horizontal or vertical; height above ground
- Fluid: Composition by names of specific heats
- Operating pressure: P^o (psia)
- Set pressure, P (psig)
- Operating temperature: T^o (˚F + 460)
- Relieving temperature: If not known calculate as shown below:

  P = Set pressure, psig
  P_1 = Flowing pressure, psia = (P x 1.21) + 14.7
  P_o = Normal Operating pressure, psia
  T_o = Normal operating temperature absolute (˚R)
  T_1 = Relieving temperature = T1 - 460

Note: Use caution when T1 exceeds 1100ºF for carbon steel.

$$T_1 = \frac{P_1 \times T_o}{P_o}$$

2) Determine orifice area requirement.

The required orifice area for a safety relief valve on a gas-containing vessel exposed to an open fire can be determined by the following formula.

$$A = \frac{F^1 \times A^1}{\sqrt{P_1}}$$

F^1 can be determined from the following relationship. The recommended minimum value of F^1 is 0.01; when the minimum value is unknown, F^1 = 0.045 should be used.

$$F^1 = \frac{0.1406}{CK_D} \times \frac{(T_\omega - T_1)^{1.25}}{(T_1)^{0.6506}}$$

Where:

A = effective discharge area of the valve, in square inches.

A^1 = exposed surface area of the vessel, in square feet.

P_1 = upstream relieving pressure, in pounds per square inch absolute. This is the set pressure plus the allowable overpressure plus the atmospheric pressure.

C = coefficient determined by the ratio of the specific heat of the gas at standard conditions. This can be obtained from Tables 4 and 5.

T_ω = vessel wall temperature, in degrees Rankine.

T_1 = gas temperature, absolute, in degrees Rankine, at the upstream pressure, determined from the following relationship:

$$T_1 = \frac{P_1 \times T_n}{P_n}$$

Where:

P_n = normal operating gas pressure, in pounds per square inch absolute.

T_n = normal operating gas temperature, in degrees Rankine.

The recommended maximum vessel wall temperature for the usual carbon steel plate materials is 1100ºF. Where vessels are fabricated from alloy materials, the value for T_ω should be changed to a more appropriate recommended maximum.

Determination of Relief Valve Factor F^1:

$$F^1 = \frac{0.1406\,(T_\omega - T_1)^{1.25}}{CK_D \times (T_1)^{0.6506}}$$

Determine the exposed vessel surface area using the appropriate formula in Table A2.

Now calculate Ac as follows:

$$A_C = \frac{F^1 \times A_S}{\sqrt{P_1}}$$

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