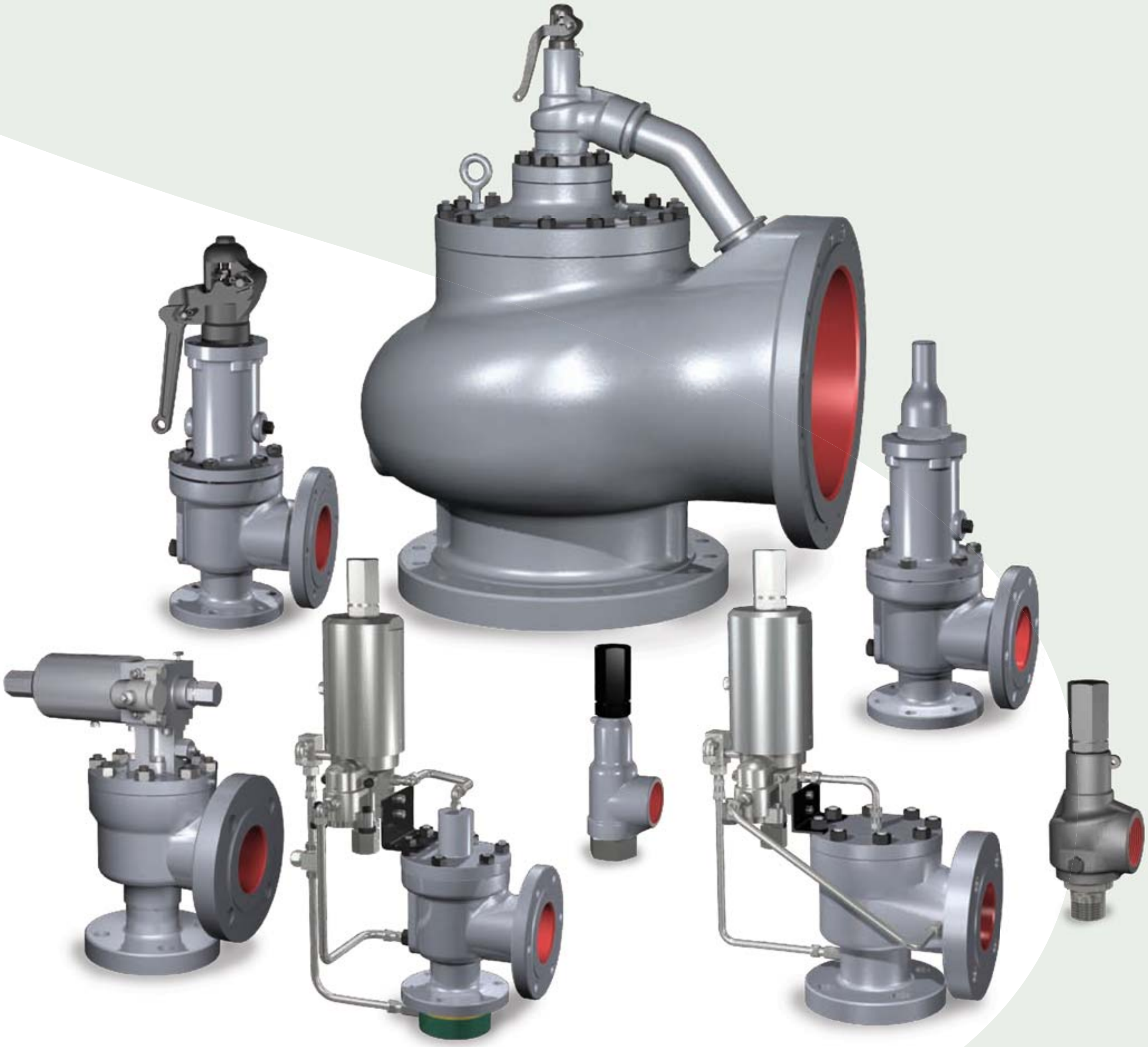
DRESSER Consolidated

Best Under Pressure

General Information

Safety Relief Valve



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Protection of personnel and equipment is the paramount concern in selection of Safety Relief Valves for plant operating systems. Only the most reliable Safety Relief Valves should be considered for such a crucial role.

The CONSOLIDATED valve line has consistently been recognized as a leader in the pressure relief valve field since its introduction over one hundred years ago. Leadership in design, manufacture and product service and support is founded on a reputation for unrelenting dedication to product innovation and improvement. A continuing program to keep abreast of constantly changing requirements of the valve market and a concentrated Research and Development effort assure strong support for customer needs. The resulting high quality of design and workmanship of CONSOLIDATED Valves gives assurance of maximum protection and longer trouble-free life for the user.

CONSOLIDATED provides maximum service to its valve customers through a worldwide factory trained sales force. These personnel are technically trained and available to provide guidance in sizing and selection of proper valves for specific applications as well as assistance in solving valve problems as they arise.

Spring Actuated Pressure Relief Valves

1900

The 1900 Series of pressure relief valves provides a wide scope of design in both pressure and temperature ranges. ASME B & PVC, Section VIII certified for vapor, liquid and steam applications meets most overpressure protection requirements of today's industry.

1900 / P1 & P3

Standard in both types, the patented Thermodisc™ Seat is designed for a high degree of seat tightness. Designed for ASME B & PVC, Section I organic fluids, flashing water and limited steam applications. (The P1 and P3 series designs are not for ASME B & PVC, Section I Boiler Drum, Superheater or Reheater applications.)

1982

ASME B & PVC, Section VIII certified threaded connection pressure relief valve for vapor and steam service applications.

19000

The 19000 Series of pressure relief valves are ASME B & PVC, Section VIII compliant for liquid service applications. Seat tightness, blowdown and capacity on all types of media meets the industry needs for overpressure protection in chemical, petrochemical, refinery, power generation (nuclear and conventional) and other commercial applications.

NOTE: Colors in the bars above the valves are consistent with tabs throughout this catalog.

A staff of factory trained Field Service Technicians are available for "on-the-job" emergencies, start-ups, and or turn-arounds. Field Service Technicians are strategically located to be available to Consolidated's customers both domestic and foreign.

Rigid manufacturing standards controlled by an ASME approved Quality Control Program ensure that each valve will be manufactured in accordance with established design criteria and tested for functional performance.

Consolidated is among a select number of U.S. companies holding ISO 9001 Quality System Certification (Registration). Our Quality Management System, Design Control, and Manufacturing Facility maintain compliance to industry standards through various certification and registration agencies. This quality controlled manufacturing and test program assures that each valve manufactured will provide long and reliable service.

Consolidated also holds a Safety Quality License for export of pressure relief valves to the People's Republic of China. The Consolidated 1900 spring loaded and 3900 series pilot operated safety relief valve is included among the list of products covered by the Safety Quality License.

A Green Tag® certification is attached to each valve following final test and inspection as evidence of Consolidated's emphasis on Quality. Our Green Tag® serves as a reminder that each Consolidated valve meets or exceeds the stringent performance and overpressure protection requirements set forth by the ASME Code, and backed by Consolidated. The symbol is also used by our Green Tag® Centers located worldwide. These centers are fully certified by us as Consolidated valve assembly and repair facilities. In North America, they also meet or exceed ASME and National Board standards for pressure relief valve assemblers and valve repair (VR) shops.

Consolidated spring loaded and pilot operated safety relief valves have been flow tested in accordance with ASME Code rules to establish rated capacities. Capacities specified in this catalog have been certified by the National Board of Boiler and Pressure Vessel Inspectors and are listed in the National Board publication "Pressure Relieving Device Certifications".

Pilot Operated Pressure Relief Valves

2900 MPV

Pop Action, Non-Flowing Pilot Operated Safety Relief Valve

The Consolidated 2900 PV pop action non-flowing pilot provides excellent performance with full lift at set pressure with minimal blowdown.

2900 MPV

Modulating Action, Non-Flowing Pilot Operated Safety Relief Valve

The Consolidated 2900 MV Pilot Operated Safety Relief Valve is a non-flowing modulating pilot valve that provides exceptional performance and stable operation.

3900 MPV

Pop Action, Non-Flowing Pilot Operated Safety Relief Valve

The Consolidated 3900 PV pop action non-flowing pilot provides excellent performance with full lift at set pressure with minimal blowdown.

13900

Pop Action, Flowing Pilot Operated Safety Relief Valve

The Consolidated 13900 pilot operated safety relief valve series is designed to contribute to the overall efficiency and profitability of plant operations.

3900 MPV

Modulating Action, Non-Flowing Pilot Operated Safety Relief Valve

The Consolidated 3900 MV Pilot Operated Safety Relief Valve is a non-flowing modulating pilot valve that provides exceptional performance and stable operation.

4900 MPV

Pop Action, Non-Flowing Pilot Operated Safety Relief Valve

The Consolidated 4900 pilot operated safety relief valve is the first tubeless, pop-action valve with full lift at set pressure with minimal blowdown.

4900 MPV

Modulating Action, Non-Flowing Pilot Operated Safety Relief Valve

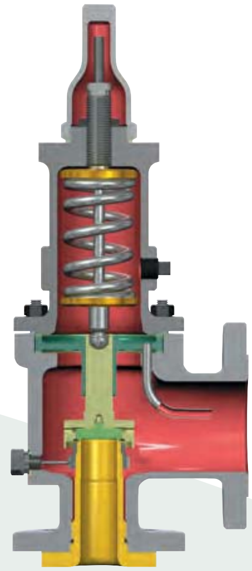
The Consolidated 4900 pilot operated safety relief valve is the first tubeless, modulating valve that provides exceptional performance and stable operation.

NOTE: All Pilot Operated Relief Valves are ASME B & PVC, Section VIII Code compliant.

Description of Safety Relief Valve Designs

Conventional Safety Relief Valve

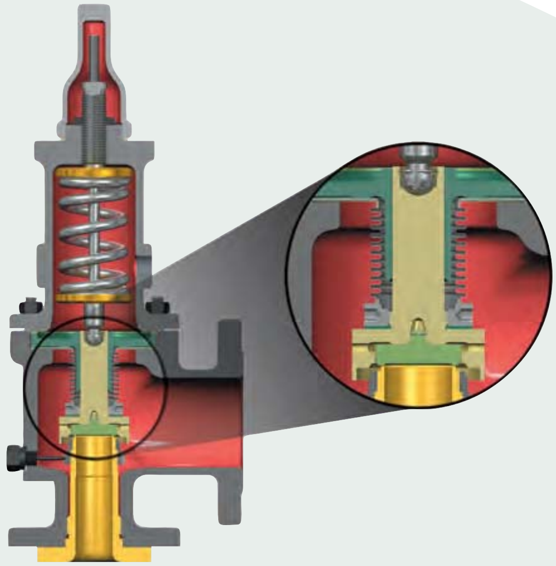
Conventional safety relief valves are for applications where excessive variable or built up back pressure is not present in the system into which the valve discharges. The operational characteristics (opening pressure, closing pressure and relieving capacity) are directly affected by changes of the back pressure on the valve.



Balanced Safety Relief Valve

A balanced safety relief valve is a pressure relief valve which incorporates means of minimizing the effect of back pressure on the operational characteristics. (Opening pressure, closing pressure and relieving capacity)

Comment: These design valves are typically equipped with a bellows which balances or eliminates the effect of variable or built up back pressure that may exist in the system into which the safety relief valve discharges.



Pilot Operated Safety Relief Valve

A pilot operated safety relief valve is a pressure relief valve in which the major relieving device is combined with and is controlled by a self-actuated auxiliary pressure relief valve.

Comment: Pilot operated relief valves are available in both pop action and modulating action designs. These valves are suitable for applications where it is desired to maintain system operating pressure very close to the valve set point (operating pressure).

Valve Selection Considerations

CONSOLIDATED Pressure Relief Valve Designs

CONSOLIDATED offers a broad range of pressure relief valve solutions, providing reliable protection for plant personnel and equipment. CONSOLIDATED achieves this goal by offering the most efficient solution for any specific pressure relief valve application. In general, most situations can be handled with either a pilot operated or a spring-loaded valve design. CONSOLIDATED offers both of these alternative solutions using world-class designs, and offering unparalleled application expertise and support. The following chart provides some basic guidelines on selecting the right solution for your application. Please consult with your local CONSOLIDATED sales office or local distributor to select the best and most economical solutions for your specific pressure relief applications.

Pilot Valves (POSRV) vs. Spring Loaded Valves (SRV)

If:	2900 POSRV	3900 POSRV	4900 POSRV	SRV
Temperature is greater than 505°F or less than -40°F*	✓	✓		✓
Design Pressure is greater than 6250 psig			✓	
Set Pressure is less than 15 psig				✓
Viscosity is greater 28 cp				✓
High Back Pressure Condition	✓	✓		
Operating/Set Pressure gap is less than 7% for gas and vapor applications or 12% for liquid applications	✓	✓	✓	
Inlet Pressure Drop exceeds 3% of set pressure**	✓	✓	✓	
Metal Seats are required (POSRV - Main Valve only)	✓	✓		✓
Soft Seats are required	✓	✓	✓	✓
Multi-Overpressure scenarios***	✓ one POSRV needed	✓ one POSRV needed	✓ one POSRV needed	✓ multiple SRV's needed
There is high potential for the valve to be subjected to shock or high vibration	✓	✓	✓	
Polymerization will occur				✓
Chemical compatibility with elastomers is a problem				✓
Installation Clearance is a primary issue	✓ POSRV > K orifice ****	✓ POSRV > K orifice	✓ POSRV > K orifice	
Full nozzle design required	✓			✓
Tubeless design required			✓	

* Heat Exchanger required.
** Remote Sensing required.
*** Modulator required.
**** 2900 has same center-to-face dimensions as 1900.

CONSOLIDATED strives to provide the best available information, data and assistance to its customers in the selection and application of our products. It is impractical, however, for CONSOLIDATED personnel to be trained in all systems and processes in which CONSOLIDATED products might be used. Ultimate responsibility remains with the customer as the process owner or designer.

Applications

Valve Type[1]	Standard End Connections[2]				Materials[3]			ASME Codes[4]				
	Inlet		Outlet		Standard			Sec. I	Sec. III		Sec. VIII	
	Type	Size	Type	Size	Body & Bonnet	Cover Plate	Trim	Steam	Steam & Vapor	Liquid	Steam & Vapor	Liquid
1900	Flanged	1" - 12"	Flanged	2" - 16"	C.S.	N/A	S.S.		X	X	X	X
1900/P	Flanged	1" - 8"	Flanged	2" - 10"	C.S.	N/A	S.S.	X	X		X	
1982	Threaded	1/2" - 2"	Threaded	3/4" - 2-1/2"	C.S.	N/A	S.S.		X	X	X	X
1982	Flanged	1" - 2"	Threaded	1" - 2-1/2"	C.S.	N/A	S.S.		X	X	X	X
19000	Threaded	1/2" - 2"	Threaded	1" - 2-1/2"	C.S.	N/A	S.S.		X	X	X	X
19000	Flanged	1/2" - 2"	Flanged	1" - 2-1/2"	C.S.	N/A	S.S.		X	X	X	X
19000	Socket Weld	1/2" - 2"	Socket Weld	1" - 2-1/2"	C.S.	N/A	S.S.		X	X	X	X
19096MBP	Threaded	1/2" - 1"	Threaded	1"	C.S.	N/A	S.S.		X	X	X	X
19096MBP	Flanged	1/2" - 1"	Flanged	1"	C.S.	N/A	S.S.		X	X	X	X
19096MBP	Socket Weld	1/2" - 1"	Socket Weld	1"	C.S.	N/A	S.S.		X	X	X	X
2900	Flanged	1" - 8"	Flanged	2" - 10"	C.S.	S.S	S.S.				X	X
3900	Flanged	1" - 10"	Flanged	2" - 10"	C.S.	C.S.	S.S.		X	X	X	X
4900	Flanged	1" - 8"	Flanged	2" - 10"	C.S.	C.S.	S.S.				X	X
13900	Flanged	16" - 20"	Flanged	18" - 24"	C.S.	C.S.	S.S.				X	

NOTES:
1 For pressure and temperature ratings refer to color coded product sections. Flanged valves are provided with ASME standard flanges.
2 Flanged inlets are available with a selection of ASME facings. Refer to the color coded product sections for description.
3 Refer to the color coded product sections for optional materials that are available. Contact the factory for special material requirements.
4 Pressure relief valves are ASME approved for application of the appropriate code symbol stamp.

Pressure / Temperature Ranges

Valve Type	Type	Set Pressure Range (psig)	Temperature Range Minimum °F (°C)	Temperature Range Maximum °F (°C)	NOTES
1900	Flanged	5-6250	-450 (-267)	1500 (815)	1
1900/P	Flanged	5-6000	90 (32)	850 (454)	1, 2
1982	Threaded	10-500	-20 (-28)	800 (426)	1
1982	Flanged	10-500	-20 (-28)	800 (426)	1
19000	Threaded	5-8000	-450 (-267)	1100 (593)	1
19000	Flanged	5-6250	-450 (-267)	1100 (593)	1
19000	Socket Weld	5-8000	-450 (-267)	1100 (593)	1
19096MBP	Threaded	50-2000	-300 (-184)	600 (315)	1
19096MBP	Flanged	50-2000	-300 (-184)	600 (315)	1
19096MBP	Socket Weld	50-2000	-300 (-184)	600 (315)	1
2900	Flanged	15-6250	-450 (-267)	1200 (648)	1
3900	Flanged	15-6250	-320 (-195)	650(343)	1
4900	Flanged	15-7200	-40 (-40)	505 (262)	1
13900	Flanged	50-300	250 (121)	550 (288)	1

NOTES: 1 Pressure and temperature ranges are limited by size, media, and materials. Refer to product section for specific pressure temperature ratings by size and material selections.

2 Used for steam and organic vapor applications only.

3 Used for liquid applications only.

How to Select a Spring Loaded or Pilot Operated Safety Relief Valve

The following guidelines should be followed when making a valve selection.

Step 1

Calculate the proper valve orifice area (Ac) requirements. Refer to Valve Sizing Section of this catalog or use CONSOLIDATED SRVS.6 Computer Assisted Sizing Program. Utilize the following information:

- Operating pressure
- Set pressure
- Operating temperature
- Relieving temperature
- Design temperature
- Type of fluid
- Required relieving capacity
- Allowable overpressure
  (Choose one)
  - ASME Section VIII, Single Valve (10% overpressure)
  - ASME Section VIII, Multiple Valve (16% overpressure)
  - ASME Section VIII, Fire Sizing (21% overpressure)
  - ASME Section I, Single Valve (3% overpressure) (1900/P1 & P3)
- Back pressure
  - constant
  - variable (built up or super-imposed)
- Gas and vapors
  - compressibility
  - molecular weight
  - density
  - ratio of specific heat
- Liquids
  - specific gravity
  - viscosity

Step 2

Based on calculated orifice size, determine which pressure relief valve will meet the orifice area requirements.

Step 3

For spring loaded valves determine if back pressure limits are exceeded and if a bellows is required.
If a bellows is required, you must select a 1900 flanged valve.

Step 4

For spring loaded valves check the operating pressure requirements against the valve set pressure requirements. If the operating pressure exceeds 90% of the set pressure, or if the differential is less than 25 psig, review the possibilities for need of a soft seat O-Ring. If an O-Ring seat is not acceptable, review the system and valve setting parameters to achieve proper differential pressure.

SRVS Computer Assisted Sizing Program

SRVS is a Windows-based sizing program for pressure relief valves that can be used with the Windows operating systems. This software is also network compatible.

This program includes multi-lingual capability, the ability to save files in a standard Windows format, and the ability to print to any printer configured for the Windows system. The printout options for each valve selection include a detailed datasheet, a certified drawing showing dimensions, weight, materials, and the API designation, if applicable, and a calculation sheet showing the applicable formula used in the area or capacity calculation. Each selected valve is completely configured to match the order entry configuration, as well as the nameplate designation. Other features making this program the easiest and most convenient sizing program available include the capabilities of copying tag numbers, editing the selected valve options, and resizing tag numbers.

This sizing program may be used for the sizing and selection of consolidated spring-loaded and pilot-operated safety relief valves. Available sizing methods include single fluid, gas or liquid, sizing at 10% overpressure, multi-fluid sizing at 10% overpressure, and fire-sizing based upon required capacity, vessel dimensions, or vessel area at 21% overpressure. If necessary, multiple valves may be selected for a single application, using the 16% overpressure factor for the low set valve. Diers (two phase flow) sizing per API 520, Part I, Appendix D, October 1999 is also included.

Included in this software are the checks for ASME Sec. VIII compliance, ASME B16.34 pressure temperature limits, API pressure and temperature limits (if applicable), O-Ring and bellows requirements, spring chart limitations, and steam chart correlations. The output will include noise and reaction force calculation values, outline dimensional drawing (installation dimensions), bill of materials for valve component parts, as well as detailed valve selection criteria.

An extensive help file is included with this software. Help text is provided for every field and form. In addition, technical information on Code requirements, applicable industry standards, and general catalog information is included.

The Consolidated Sizing Program may be obtained through the www.dresser.com website; choose downloads.

INtools® users can now automate their Pressure Relief Valve sizing and selection. SRVS - INtools, an interface for Consolidated SRVS sizing and selection software and INtools design software is now available at www.dresser.com. This advanced software allows INtools users to accurately size and select Pressure Relief Valves in a fraction of the time previously required with standalone sizing and selection software.

How to Order a 1900 Safety Relief Valve

Specification Sheet

Page _____ of _____

Requisition No. ____________________
Job No. ____________________
Date ____________________
Revised ____________________
By ____________________

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code:
   - ❑ ASME Sec. I (1900/P series only)
   - ❑ ASME Sec. III
   - ❑ ASME Sec. VIII
   - ❑ OTHER Specify:
6. Comply with API 526: ❑ YES ❑ NO
7. ❑ Fire ❑ OTHER Specify:
8. Rupture Disk: ❑ YES ❑ NO

Valve Design

9. Type: Safety Relief
10. Design: ❑ Conventional ❑ Bellows
    ❑ Closed Bonnet ❑ Yoke/Open Bonnet
    ❑ Metal Seat ❑ Resilient Seat
    ❑ API 527 Seat Tightness
    ❑ OTHER Specify:

Connections

11. Inlet Size: Rating: Facing:
    Outlet Size: Rating: Facing:
12. ❑ OTHER Specify:

Materials

13. Body/Bonnet:
14. Guide/Rings:
15. Seat Material:
    Metal:
    Resilient:
16. Bellows:
17. Spring:
18. Comply with NACE MRO 175 ❑ YES ❑ NO
19. OTHER Specify:
20. Cap and Lever Selection
    ❑ Screwed Cap (Standard) ❑ Bolted Cap
    ❑ Plain Lever ❑ Packed Lever ❑ Gag
21. ❑ OTHER Specify:

Service Conditions

22. Fluid and State:
23. Required Capacity per Valve & Units:
24. Molecular Weight or Specific Gravity:
25. Viscosity at Flowing Temperature & Units:
26. Operating Pressure & Units:
27. Blowdown: ❑ Standard ❑ Other
28. Latent Heat of Vaporization & Units:
29. Operating Temperature & Units:
30. Relieving Temperature & Units:
31. Built-up Back Pressure & Units:
32. Superimposed Back Pressure & Units:
33. Cold differential Test Pressure & Units:
34. Allowable Overpressure in Percent or Units:
35. Compressibility Factor, Z:
36. Ratio of Specific Heats:

Sizing and Selection

37. Calculated Orifice Area (square inches):
38. Selected Orifice Area (square inches):
39. Orifice Designation (letter):
40. Manufacturer:
41. Model Number:
42. Vendor Calculations Required: ❑ YES ❑ NO

How to Order a 1982 or 19000 Safety Relief Valve

Specification Sheet

Page _____ of _____

Requisition No. ____________________
Job No. ____________________
Date ____________________
Revised ____________________
By ____________________

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code:
   - ❑ ASME Sec. III
   - ❑ ASME Sec. VIII
   - ❑ OTHER Specify:
6. ❑ Fire ❑ OTHER Specify:
7. Rupture Disk: ❑ YES ❑ NO

Valve Design

8. Type: Safety Relief
9. Design:
   - ❑ Metal Seat ❑ Resilient Seat
   - ❑ API 527 Seat Tightness
   - ❑ OTHER Specify:

Connections

10. Flanged
    - Inlet Size: Rating: Facing:
    - Outlet Size: Rating: Facing:
11. Threaded
    - Inlet ❑ MNPT ❑ FNPT
    - Outlet ❑ MNPT ❑ FNPT
12. ❑ OTHER Specify:

Materials

13. Base:
14. Bonnet:
15. Guide/Rings:
16. Seat Material:
    - Metal:
    - Resilient:
17. Spring:
18. Comply with NACE MRO 175 ❑ YES ❑ NO
19. OTHER Specify:
20. Cap and Lever Selection
    - ❑ Screwed Cap (Standard) ❑ Bolted Cap
    - ❑ Plain Lever ❑ Packed Lever ❑ Gag
21. ❑ OTHER Specify:

Service Conditions

22. Fluid and State:
23. Required Capacity per Valve & Units:
24. Molecular Weight or Specific Gravity:
25. Viscosity at Flowing Temperature & Units:
26. Operating Pressure & Units:
27. Blowdown: ❑ Standard ❑ Other
28. Latent Heat of Vaporization & Units:
29. Operating Temperature & Units:
30. Relieving Temperature & Units:
31. Built-up Back Pressure & Units:
32. Superimposed Back Pressure & Units:
33. Cold differential Test Pressure & Units:
34. Allowable Overpressure in Percent or Units:
35. Compressibility Factor, Z:
36. Ratio of Specific Heats:

Sizing and Selection

37. Calculated Orifice Area (square inches):
38. Selected Orifice Area (square inches):
39. Orifice Designation (letter):
40. Manufacturer:
41. Model Number:
42. Vendor Calculations Required: ❑ YES ❑ NO

How to Order a 2900 POSRV

POSRV Specification Sheet

Page _____ of _____

Requisition No. ____________
Job No. ____________
Date ____________
Revised ____________
By ____________

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code: ASME VIII Stamp Required: ❑ YES ❑ NO
   ❑ OTHER Specify
6. Comply with API 526: ❑ YES ❑ NO
7. ❑ Fire ❑ OTHER Specify:
8. Rupture Disk: ❑ YES ❑ NO

Valve Design, Pilot

9. Design Type: Pilot
10. Number of Pilots:
11. Pilot Action: ❑ Pop -❑ Modulating
12. Pilot Sense: ❑ Internal ❑ Remote NOTE 1
13. Seat Type: Resilient
14. Seat Tightness: ❑ API 527 ❑ OTHER
    ❑ Specify:
15. Pilot Vent: ❑ Atmosphere ❑ Outlet
    ❑ OTHER Specify:

Valve Design, Main Base

16. ❑ Metal Seat ❑ Resilient Seat
17. Bellows: ❑ YES ❑ NO

Connections

18. Inlet Size: Rating: Facing:
19. Outlet Size: Rating: Facing:
20. ❑ OTHER Specify:

Materials, Main Valve

21. Body:
22. Nozzle:
23. Seat O-Ring:
24. Disc:
25. Piston Seal:
26. Other O-Rings:
27. Guide:
28. Cover Plate:

Materials, Pilot

29. Body/Bonnet:
30. Internals:
31. Seals:
32. Tubing/Fittings:
33. Spring:
34. Comply with NACE MR0175: ❑ YES ❑ NO
35. ❑ OTHER Specify:

Accessories

36. External Filter: ❑ YES ❑ NO
37. Lifting Lever: N/A
38. Field Test Connection: ❑ YES ❑ NO
39. Backflow Preventer: ❑ YES ❑ NO
40. Manual Blowdown Valve: ❑ YES ❑ NO
41. Heat Exchanger (For High and Low Temperature Applications):
    ❑ YES ❑ NO
42. Dirty Service: ❑ YES ❑ NO
43. ❑ OTHER Specify:

Service Conditions

44. Fluid and State:
45. Required Capacity per Valve & Units:
46. Molecular Weight or Specific Gravity:
47. Viscosity at Flowing Temperature & Units:
48. Operating Pressure & Units:
49. Blowdown: ❑ Standard ❑ Other
50. Latent Heat of Vaporization & Units:
51. Operating Temperature & Units:
52. Relieving Temperature & Units:
53. Built-up Back Pressure & Units:
54. Superimposed Back Pressure & Units:
55. Cold differential Test Pressure & Units:
56. Allowable Overpressure in Percent or Units:
57. Compressibility Factor, Z:
58. Ratio of Specific Heats:

Sizing and Selection

59. Calculated Orifice Area (square inches):
60. Selected Orifice Area (square inches):
61. Orifice Designation (letter):
62. Manufacturer:
63. Model Number:
64. Vendor Calculations Required: ❑ YES ❑ NO

Heat Exchanger

65. Sizing Required:
66. Back Pressure Restrictions on Temperature:
67. Set Pressure (psig):
68. Specific Volume of Media at Inlet Conditions (ft3/lbm):
69. Entropy of Media at Inlet Conditions (btu/lbm*°R):
70. Temperature of Ambient Air (°F) (Min./Max.):
71. Media Temperature Before it Enters the Heat Exchanger (°F):

Remote Sensing

72. Sizing Required:
73. Set Pressure (psig):
74. Orifice Selection:
75. Fluid Density of Media in the condensed State (lbm/ft3):
76. Length of Sensing Line (ft)NOTE 1:
77. Equivalent Length of Sensing Line for Valves, Elbows, Tees, etc.:
78. Total Change in Height (ft):

Notes:

1 To assure proper valve operation when pilot is remotely sensed use 3/8" diameter tubing for lengths up to ten feet. Contact factory for proper size of tubing when sensing line exceeds ten feet.

How to Order a 3900 POSRV

POSRV Specification Sheet

Page ______ of ______

Requisition No. ____________________
Job No. ____________________
Date ____________________
Revised ____________________
By ____________________

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code: ASME VIII Stamp Required: ❑ YES ❑ NO
   ❑ OTHER Specify
6. Comply with API 526: ❑ YES ❑ NO
7. ❑ Fire ❑ OTHER Specify:
8. Rupture Disk: ❑ YES ❑ NO

Valve Design

9. Design Type: Pilot
10. Number of Pilots:
11. Pilot Action: ❑ Pop ❑ Modulating
12. Pilot Sense: ❑ Internal ❑ Remote[NOTE 1]
13. Seat Type: Resilient
14. Seat Tightness: ❑ API 527 ❑ OTHER ❑ Specify:
15. Pilot Vent: ❑ Atmosphere ❑ Outlet
    ❑ OTHER Specify:
16. Main Base: ❑ Metal Seat ❑ Resilient Seat

Connections

17. Inlet Size: Rating: Facing:
18. Outlet Size: Rating: Facing:
19. ❑ OTHER Specify:

Materials, Main Valve

20. Body:
21. Nozzle:
22. Seat O-Ring:
23. Disc:
24. Disc Seal:
25. Other O-Rings:
26. Guide:
27. Cover Plate:

Materials, Pilot

28. Body/Bonnet:
29. Internals:
30. Seat: Seals:
31. Tubing/Fittings:
32. Spring:
33. Comply with NACE MR0175: ❑ YES ❑ NO
34. ❑ OTHER Specify:

Accessories

35. External Filter: ❑ YES ❑ NO
36. Lifting Lever: N/A
37. Field Test Connection: ❑ YES ❑ NO
38. Backflow Preventer: ❑ YES ❑ NO
39. Manual Blowdown Valve: ❑ YES ❑ NO
40. Heat Exchange (For High & Low Temperature Applications)
    ❑ YES ❑ NO
41. Dirty Service: ❑ YES ❑ NO
42. ❑ OTHER Specify:

Service Conditions

43. Fluid and State:
44. Required Capacity per Valve & Units:
45. Molecular Weight or Specific Gravity:
46. Viscosity at Flowing Temperature & Units:
47. Operating Pressure & Units:
48. Blowdown: ❑ Standard ❑ Other
49. Latent Heat of Vaporization & Units:
50. Operating Temperature & Units:
51. Relieving Temperature & Units:
52. Built-up Back Pressure & Units:
53. Superimposed Back Pressure & Units:
54. Cold differential Test Pressure & Units:
55. Allowable Overpressure in Percent or Units:
56. Compressibility Factor, Z:
57. Ratio of Specific Heats:

Sizing and Selection

58. Calculated Orifice Area (square inches):
59. Selected Orifice Area (square inches):
60. Orifice Designation (letter):
61. Manufacturer:
62. Model Number:
63. Vendor Calculations Required: ❑ YES ❑ NO

Remote Sensing

64. Sizing Required
65. Set Pressure (psig):
66. Orifice Selection:
67. Fluid Density of Media in the condensed State (lbm/ft^3):
68. Length of Sensing Line (ft)[NOTE1]:
69. Equivalent Length of Sensing Line for Valves, Elbows, Tees, etc:
70. Total Change in Height (ft):

Notes:

1 To assure proper valve operation when pilot is remotely sensed use 3/8" diameter tubing for lengths up to ten feet. Contact factory for proper size of tubing when sensing line exceeds ten feet.

How to Order a 4900 POSRV

POSRV Specification Sheet

Page ______ of ______

Requisition No. ______
Job No. ______
Date ______
Revised ______
By ______

General

1. Item Number:
2. Tag Number:
3. Service, Line or Equipment No:
4. Number Required:

Basis of Selection

5. Code: ASME VIII Stamp Required: ❑ YES ❑ NO
   ❑ OTHER Specify
6. Comply with API 526: ❑ YES ❑ NO
7. ❑ Fire ❑ OTHER Specify:
8. Rupture Disk: ❑ YES ❑ NO

Valve Design

9. Design Type: Pilot
10. Pilot Action: ❑ Pop ❑ Modulating
11. Pilot Sense: NOTE1 ❑ Internal ❑ Remote
12. Seat Type: Resilient
13. Seat Tightness: ❑ API 527 ❑ OTHER Specify:
14. Pilot Vent: Body Bowl is standard
   ❑ OTHER Specify:

Connections

15. Inlet Size: Rating: Facing:
16. Outlet Size: Rating: Facing:
17. ❑ OTHER Specify:

Materials, Main Valve

18. Body:
19. Nozzle:
20. Seat O-Ring:
21. Disc:
22. Disc Seal:
23. Other O-Rings:
24. Guide:
25. Cover Plate:

Materials, Pilot

26. Body/Bonnet:
27. Internals:
28. Seat: Seals:
29. Tubing/Fittings: N/A
30. Spring:
31. Comply with NACE MR0175: ❑ YES ❑ NO
32. ❑ OTHER Specify:

Accessories

33. External Filter: ❑ YES ❑ NO
34. Lifting Lever: N/A
35. Field Test Connection: Standard on all 4900 valves
36. Backflow Preventer: Standard on all 4900 valves
37. Manual Blowdown Valve: Standard on all 4900 valves
38. Dirty Service: N/A
39. ❑ OTHER Specify:

Service Conditions

40. Fluid and State:
41. Required Capacity per Valve & Units:
42. Molecular Weight or Specific Gravity:
43. Viscosity at Flowing Temperature & Units:
44. Operating Pressure & Units:
45. Blowdown: ❑ Standard ❑ Other
46. Latent Heat of Vaporization & Units:
47. Operating Temperature & Units:
48. Relieving Temperature & Units:
49. Built-up Back Pressure & Units:
50. Superimposed Back Pressure & Units:
51. Cold differential Test Pressure & Units:
52. Allowable Overpressure in Percent or Units:
53. Compressibility Factor, Z:
54. Ratio of Specific Heats:

Sizing and Selection

55. Calculated Orifice Area (square inches):
56. Selected Orifice Area (square inches):
57. Orifice Designation (letter):
58. Manufacturer:
59. Model Number:
60. Vendor Calculations Required: ❑ YES ❑ NO

Remote Sensing

61. Sizing Required
62. Set Pressure (psig):
63. Orifice Selection:
64. Fluid Density of Media in the condensed State (lbm/ft^3):
65. Length of Sensing Line (ft)NOTE1:
66. Equivalent Length of Sensing Line for Valves, Elbows, Tees, etc:
67. Total Change in Height (ft):

Notes:

1 To assure proper valve operation when pilot is remotely sensed use 3/8" diameter tubing for lengths up to ten feet. Contact factory for proper size of tubing when sensing line exceeds ten feet.

How to Order a 13900 POSRV

POSRV Specification Sheet

Page ______ of ______

Requisition No. ______________________

Job No. ______________________

Date ______________________

Revised ______________________

By ______________________

General

1. Number of Valves:
2. Size of Valve Inlet:
3. Type Number of Valve:
4. CONSOLIDATED Manufacturer:
5. Body Material:
6. Trim Material (if any other than standard is required):
7. O-Ring Seat Material
8. Set Pressure:
9. Operating Temperature and Relieving Temperature:
10. Back Pressure, if any (indicate if Constant or Variable):
11. Required Capacity:
12. Lading Fluid:
13. Allowable Overpressure:
14. Density
    a) Vapor - molecular weight
    b) Gases - specific gravity (air = 1)

Other

15. Code marking required
    a) ASME Unfired Pressure Vessel Code

Notes:

1900 Flanged Valve Coding

Customer orders for CONSOLIDATED safety relief valves are acknowledged by a computer printout of our internal code. We have supplied the following information for your easy interpretation of this coding.

Code Position	Description	Codes
19	SRV	19
05	Pressure Class	05, 06, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28
-00	Non Bellows	-00
	Bellows	-30
-J	Orifice (D thru W)	-J
-c	Temp. Class: c = to 450°F; t = 451°F & Above	-c, -t
-2	Interchangeability No.	-2
-CC	Material Class, CC Carbon Steel is Standard (NOTE 1)	-CC, -C1, -S2, -S3, -S4, -M1, -MB (M1-1/2), -M2, -M3, -M4, -H1, -H2, -H3, -H4, -L1, -L2, -L3, -T1, -T2, -A1, -A2, -A3, -A4, -HA
*	Deviation from Standard*	*
-MS	Seat Design	-MS, -DA, -TD
-31	Lever/Cap Design	-31, -32, -33, -34, -35, -36, -37
-RF	Inlet Facing	-RF, -RJ, -LM, -SM, -LF, -SF, -LT, -ST, -LG, -SG, -LJ, -BW, -GL, -OC
-GS	Service	-GS, -LA, -SS
-HP	Disc Holder Pressure (Selected by Dresser)	-HP, -LP
-SG1	Sour Gas	-SG1, -SG10, -SG5, -SG15
-G1	Guide Surface Coating	-G1, -G2, -G3

Pressure Class

05 = 150 lb.
06 = 300 lb.
10 = 300 lb.
12 = 600 lb.
14 = 900 lb.
16 = 1500 lb.
18 = 2500 lb.
20 = 300 lb.
22 = 600 lb.
24 = 900 lb.
26 = 1500 lb.
28 = 2500 lb.

Seat Design

MS = Metal Seat
DA = O-Ring
TD = THERMODISC™

Lever/Cap Design

31 = Screwed
32 = Bolted
33 = Packed
34 = Plain
35 = "L" Type
36 = "R" Type
37 = Air Operated

Inlet Facing

RF = Raised Face/Serrated
RJ = Ring Joint
LM = Large Male
SM = Small Male
LF = Large Female
SF = Small Female
LT = Large Tongue
ST = Small Tongue
LG = Large Groove
SG = Small Groove
LJ = Lens Joint
BW = Butt Weld
GL = Grayloc
OC = OTECO

Service

GS = Gas
LA = Liquid
SS = Steam

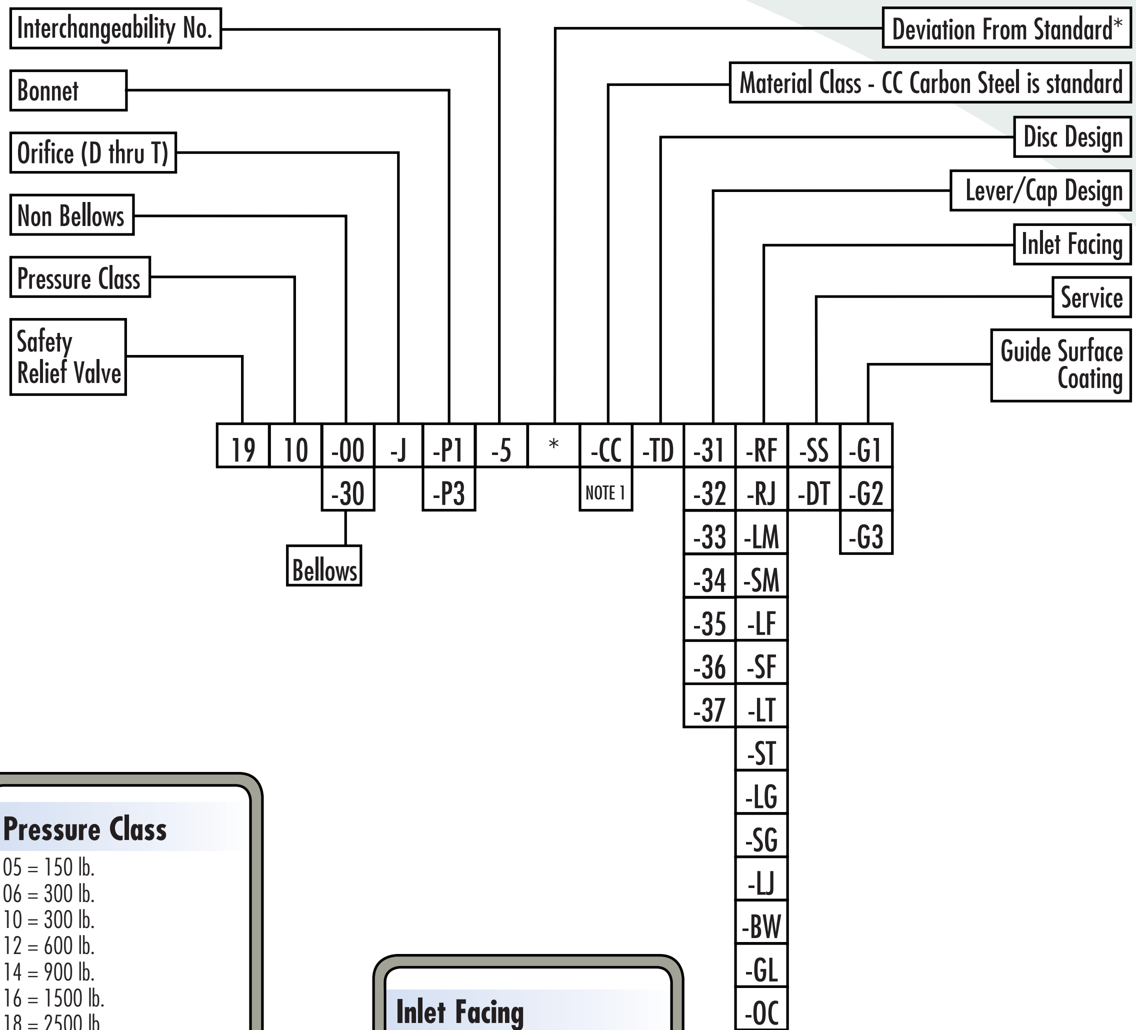
Guide Surface Coating

G1 = GLIDE-ALOY™ Disc Holder
G2 = GLIDE-ALOY™ Guide
G3 = GLIDE-ALOY™ Holder and Guide

When * appears in code, nameplate will be stamped SPEC.

NOTE 1: See 1900 section for materials.

1900/P1, P3 Valve Coding



Pressure Class

05 = 150 lb.
06 = 300 lb.
10 = 300 lb.
12 = 600 lb.
14 = 900 lb.
16 = 1500 lb.
18 = 2500 lb.
20 = 300 lb.
22 = 600 lb.
24 = 900 lb.
26 = 1500 lb.
28 = 2500 lb.

Disc Design

TD = Thermodisc™

Lever/Cap Design

31 = Screwed
32 = Bolted
33 = Packed
34 = Plain
35 = "L" Type
36 = "R" Type
37 = Air Operated

Inlet Facing

RF = Raised Face/Serrated
RJ = Ring Joint
LM = Large Male
SM = Small Male
LF = Large Female
SF = Small Female
LT = Large Tongue
ST = Small Tongue
LG = Large Groove
SG = Small Groove
LJ = Lens Joint
BW = Butt Weld
GL = Grayloc
OC = OTECO

Service

SS = Steam
DT = Dowtherm

Bonnet

P1 = Closed
P2 = Open

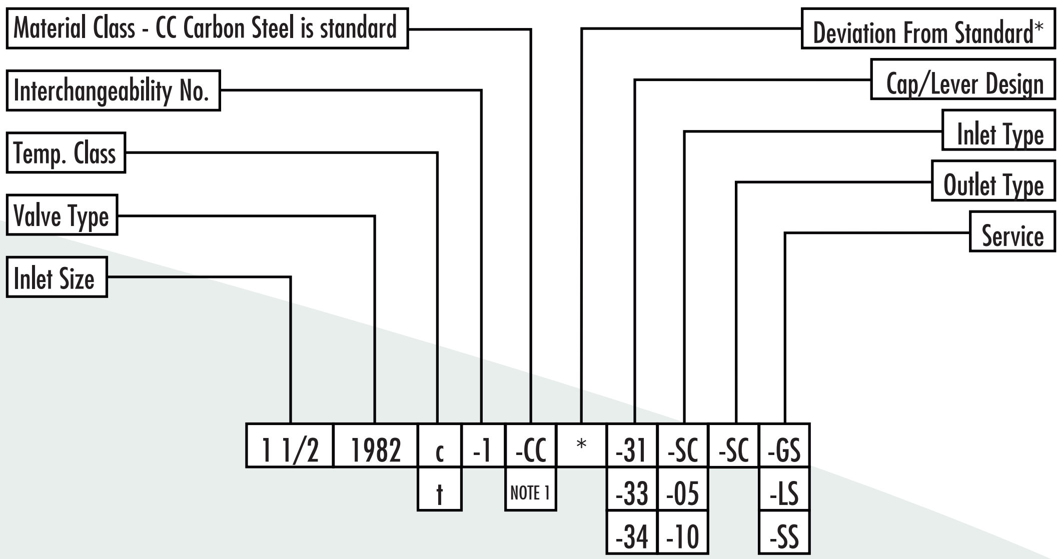
Guide Surface Coating

G1 = GLIDE-ALOY™ Disc Holder
G2 = GLIDE-ALOY™ Guide
G3 = GLIDE-ALOY™ Holder and Guide

When * appears in code, nameplate will be stamped SPEC.

NOTE 1: For other special material requirements, contact factory.

1982 Valve Coding



Temperature Class

400°F & Below = c
401°F & Above = t

Cap/Lever Design

31 = Screwed Cap
33 = Packed
34 = Plain

Inlet Type

SC = Screwed
05 = 150# R.F.
10 = 300# R.F.

Outlet Type

SC = Screwed

Service

GS = Gas
LA = Liquid
SS = Steam

When * appears in code, nameplate will be stamped SPEC.

NOTE 1: For other special material requirements, contact factory.

19000 Valve Coding

Inlet Size	SRV	Orifice Size (Decimal)	Pressure Range	Temperature Class (c = 800°F & Below; t = 801°F & Above)	Temperature Range Variations	Interchangeability No.	Material - CC Carbon Steel is standard	Deviation From Standard*	Seat Type NOTE 1	Cap/Lever	Inlet Type	Outlet Type	Service	Surface Coating	Back Pressure Design
1-1/2	19	357	L	c	D	-2	-CC	*	-MS	-31	-FT	-FT	-LA	-G1	-BP
1/2		096	M	t	E		-S2		-DA	-33	-MT	-MT	-GS	-G2	
3/4		110	H		F		-S3		-DL	-34	-SW	-SW	-SS	-G3	
1		126	P		G		-S4				-BW	-05			
2		226			H		-M1				-05	-10			
		567			O		-MB				-10	-25			
							-M2				-12	-20			
							-M3				-14	-PF			
							-M4				-16				
							-H1				-18				
							-H2				-25				
							-H3				-20				
							-H4				-22				
							-SG				-24				
							-PF				-26				
							-A1				-28				
							-A2				-PF				
							-A3								
							-A4								
							-C1								

Press. Range - psig

L = 5 - 290
M = 291 - 2000
H = 2001 - 8000
P = 15 - 300(PF)

Temp. Range Variations

D = 250°F & Below (PF)
E = 251°F & Above (PF)
F = All Temps. (MS)
G = 251°F & Above (SS/MS)
H = 251°F & Above (MS/SG)
O = DA (Soft Seat)

Seat Type

MS = Metal Seat
DA = Soft Seat
DL = NOTE 1

Cap/Lever

31 = Screwed
33 = Packed
34 = Plain

Inlet Type

FT = Female NPT
MT = Male NPT
SW = Socket Weld
BW = Butt Weld
05 = 150# R.F.
10 = 300# R.F.
12 = 600# R.F.
14 = 900# R.F.
16 = 1500# R.F.
18 = 2500# R.F.
25 = 150# R.J.
20 = 300# R.J.
22 = 600# R.J.
24 = 900# R.J.
26 = 1500# R.J.
28 = 2500# R.J.
PF = Sanitary Fitting (Max. Press. B/P 400psig) NOTE 2

NOTES: 1 Soft seat low pressure liquid service 100 psig and below except .110 Sq. In. Orifice.
2 PF design is for clean service applications and is fully described in separate catalog number SRVPF-2.

Outlet Type

FT = Female NPT
MT = Male NPT
SW = Socket Weld
05 = 150# R.F.
10 = 300# R.F.
25 = 150# R.J.
20 = 300# R.J.
PF = Sanitary Fitting NOTE 2

Service

GS = Gas, Air
LA = Liquid
SS = Steam

Surface Coating

G1 = GLIDE ALOY™ Holder
G2 = GLIDE ALOY™ Guide
G3 = GLIDE ALOY™ Holder & Guide

Back Pressure Design

Med. Pressure
50 - 2000 psig
Max. B/P 400 psig

When * appears in code, nameplate will be stamped SPEC.

2900 POSRV Main Valve Coding

Customer orders for CONSOLIDATED safety relief valves are acknowledged by a computer printout of our internal code. We have supplied the following information for your easy interpretation of this coding.

POSRV	29
Pressure Class	10
Non Bellows / Bellows	-00 (Non Bellows), -30 (Bellows)
Orifice (D thru W)	J
Interchangeability Number	-1
Material Class (CC Carbon Steel is standard[NOTE 1])	-CC, -A1, -A2, -A4, -C1, -D1, -D2, -D4, -H1, -H2, -H4, -L1, -L2, -L3, -M1, -MB, -M2, -M4, -S2, -S4, -T1
Deviation from Standard*	*
Seat Design	-MS, -DA, -TD
Piston O-Ring Material (DA Seat Material Same)	-B, -V, -E, -K, -T
Inlet Facing	-RF, -RJ, -LM, -SM, -LF, -SF, -LT, -ST, -LG, -SG, -LJ, -BW, -SW, -GL, -OC
Service	-GS, -LS, -SS
Sensing	-RS, -SR
Guide Surface Coating	-G1, -G2, -G3, -M7, -M8, -M9
Heat Exchanger	-HH, -HL
Sour Gas	-SG

Pressure Class

05 = 150 lb.
06 = 300 lb.
10 = 300 lb.
12 = 600 lb.
14 = 900 lb.
16 = 1500 lb.
18 = 2500 lb.
20 = 300 lb.
22 = 600 lb.
24 = 900 lb.
26 = 1500 lb.
28 = 2500 lb.

Seat Design

MS = Metal Seat
DA = O-Ring
TD = THERMODISC™

Inlet Facing

RF = Raised Face/Serrated
RJ = Ring Joint
LM = Large Male
SM = Small Male
LF = Large Female
SF = Small Female
LT = Large Tongue
ST = Small Tongue
LG = Large Groove
SG = Small Groove
LJ = Lens Joint
BW = Butt Weld
SW = Socket Weld
GL = Grayloc
OC = Oteco

Heat Exchanger

HH = Media is 506°F or above
HL = Media is -41°F or below

When * appears in code, nameplate will be stamped SPEC.

Service

GS = Gas
LS = Liquid
SS = Steam

Sensing

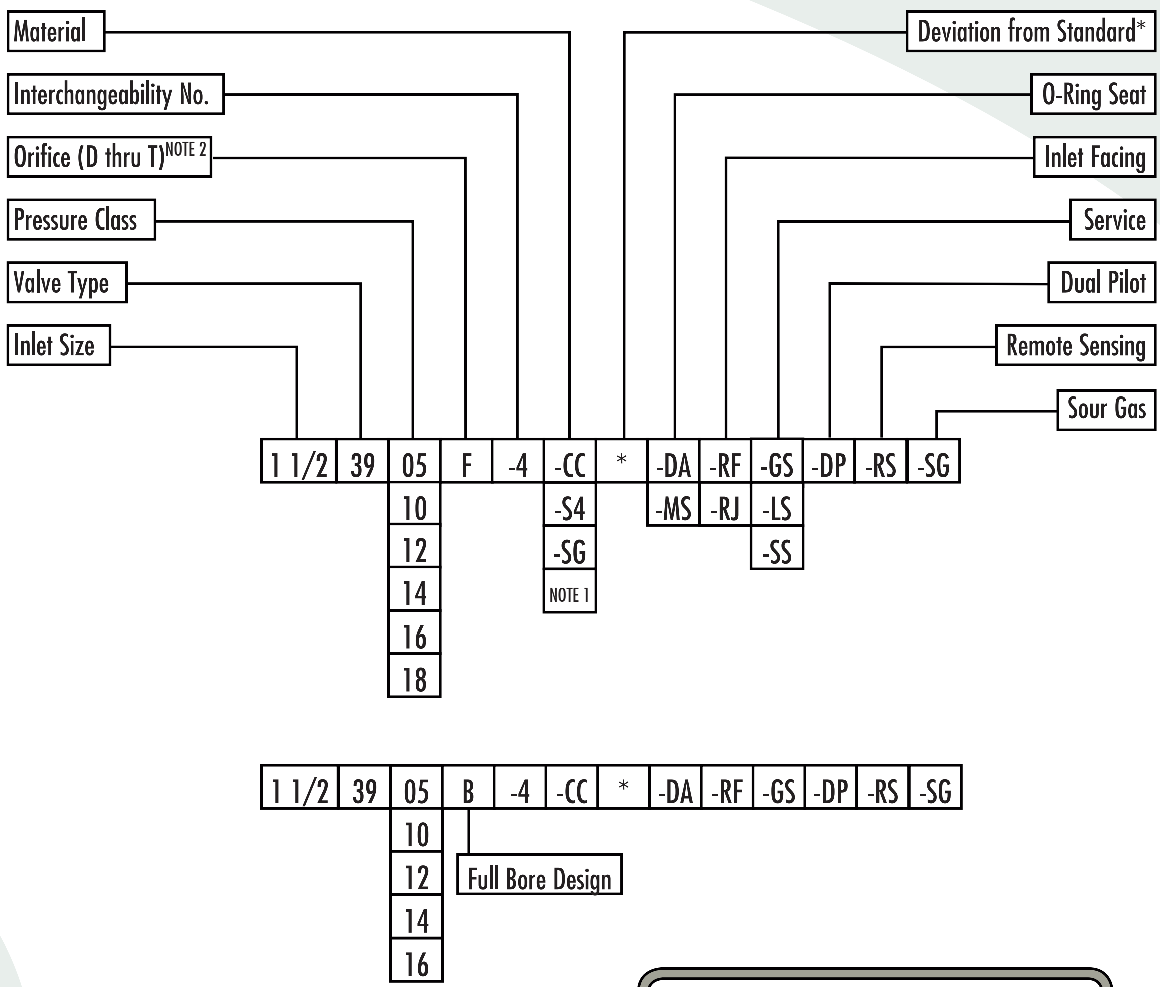
RS = Remote Sensing
SR = Sensing Ring

Guide Surface Coating

G1 = GLIDE-ALOY™ Disc Holder and Piston
G2 = GLIDE-ALOY™ Guide and Cover Plate
G3 = GLIDE-ALOY™ Disc Holder, Piston, Guide and Cover Plate
M7 = Mellonite Disc Holder and Piston
M8 = Mellonite Guide and Cover Plate
M9 = Mellonite Disc Holder, Piston, Guide, and Cover Plate

NOTE 1: See 2900 section for materials.

3900 POSRV Main Valve Coding



Seat Design

DA = O-ring
MS = Metal Seat

Pressure Class

05 = 150 Class
10 = 300 Class
12 = 600 Class
14 = 900 Class
16 = 1500 Class
18 = 2500 Class

When * appears in code, nameplate will be stamped SPEC.

Material

CC = Standard Material
S4 = Entirely 316 Stainless Steel
C1 = LCC Base and 316 Stainless Steel Cover Plate
SG = Sour Gas
M1 = Monel Wetted
M4 = Entirely Monel
H1 = Hastelloy Wetted
H4 = Entirely Hastelloy
D1 = Duplex Wetted (Consult Factory)
D4 = Entirely Duplex (Consult Factory)
A1 = Alloy 20 Wetted
A4 = Entirely Alloy 20

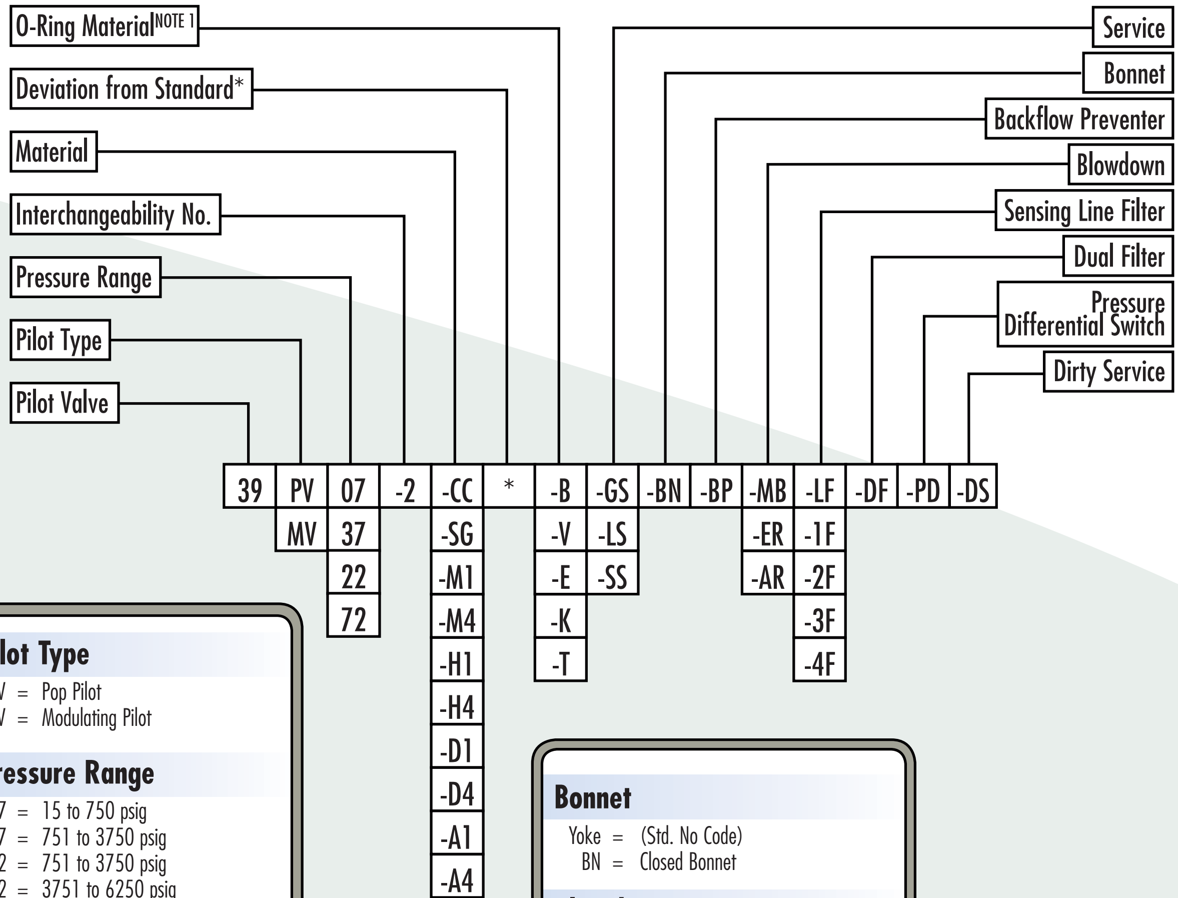
Service

GS = Gas
LS = Liquid
SS = Steam

NOTES: 1 For other special material requirements contact factory
2 Orifice D thru T are standard bore. Inlet Sizes 1-1/2" thru 10".

POSRV Pilot Valve Coding

39PV & 39MV pilots are the actuating mechanisms available for valve designs 2900 and 3900



Pilot Type
PV = Pop Pilot
MV = Modulating Pilot

Pressure Range
07 = 15 to 750 psig
37 = 751 to 3750 psig
22 = 751 to 3750 psig
72 = 3751 to 6250 psig

Material
A1 = Alloy 20 Wetted
A4 = Entirely Alloy 20
CC = Standard Material
SG = Sour Gas
M1 = Monel Wetted
M4 = Entirely Monel
H1 = Hastelloy C Wetted
H4 = Entirely Hastelloy C
D1 = Duplex Wetted (Consult Factory)
D4 = Entirely Duplex (Consult Factory)

O-Ring Material
B = Buna N (Nitrile)
V = Viton
E = Ethylene Propylene
K = Kalrez
T = Teflon

Service
GS = Gas
LS = Liquid
SS = Steam

Bonnet
Yoke = (Std. No Code)
BN = Closed Bonnet

Blowdown
MB = Manual Blowdown
ER = Electronic Remote
AR = Air Remote

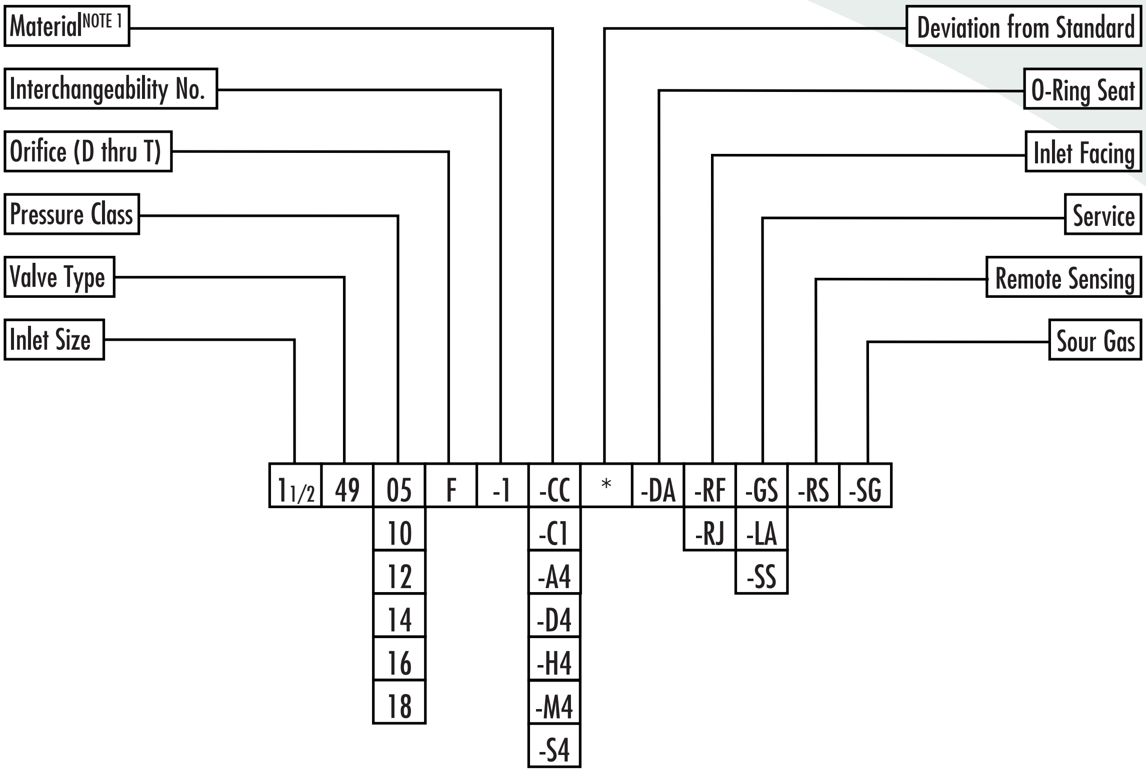
Sensing Line Filter
LF = Line Filter (Std)

Aux. Hi Capacity Filter Option
1F = Carbon Steel
2F = Stainless Steel
3F = Carbon Steel w/ Flush Valve
4F = Stainless Steel w/ Flush Valve

When * appears in code, nameplate will be stamped SPEC.

NOTE 1: See 2900 section for special materials for pilot valves

4900 POSRV Main Valve Coding



Pressure Class

05 = 150 Class
10 = 300 Class
12 = 600 Class
14 = 900 Class
16 = 1500 Class
18 = 2500 Class

Service

GS = Gas
SS = Steam
LA = Liquid

Material

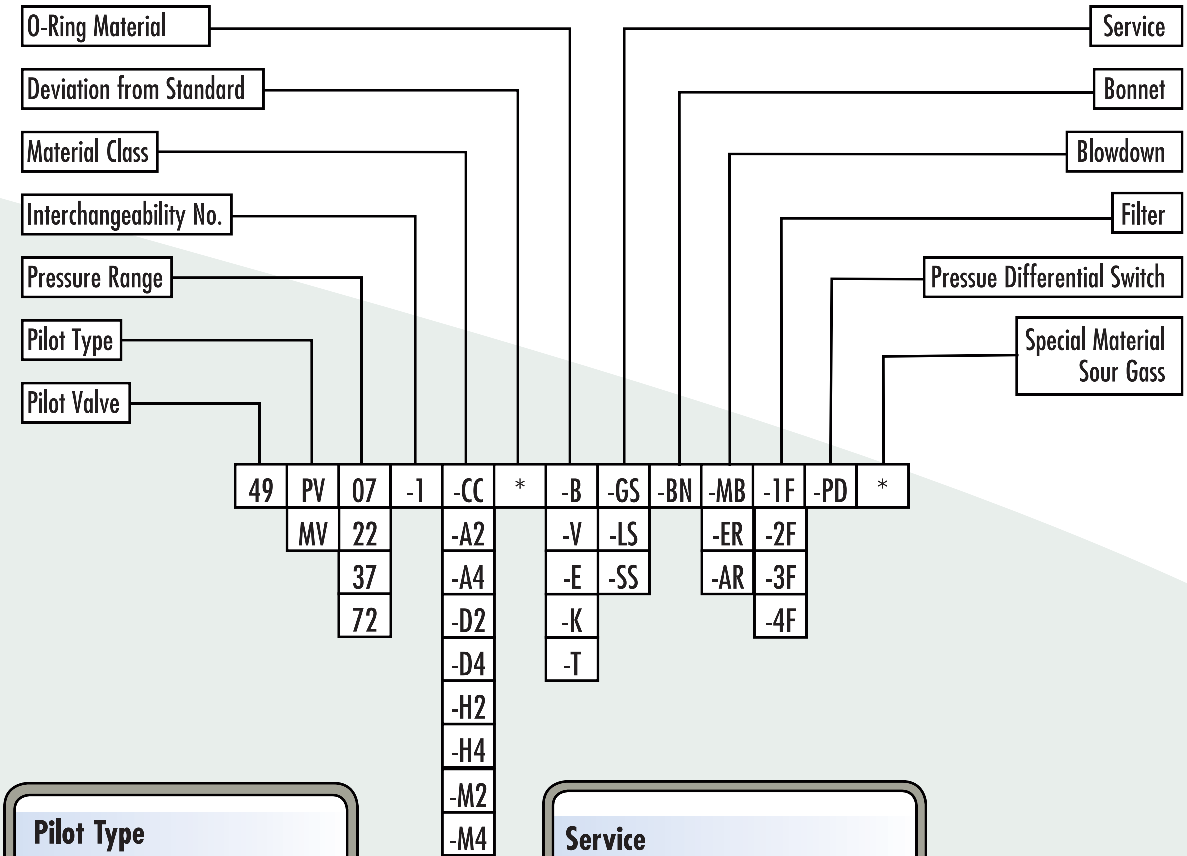
CC = Standard Material
C1 = LCC Base & 316 SS Cover Plate
A4 = Entirely Alloy 20
D4 = Entirely Duplex (Consult Factory)
H4 = Entirely Hastelloy C
M4 = Entirely Monel
S4 = Entirely 316 Stainless Steel

Inlet Facing

RF = Raised Face-Serrated
RJ = Ring Joint
LM = Large Male
SM = Small Male
LF = Large Female
SF = Small Female
LT = Large Tongue
ST = Small Tongue
LG = Large Groove
SG = Small Groove
LJ = Lens Joint
BW = Butt Weld
SW = Socket Weld
GL = Grayloc
OC = OTECO

NOTE 1: For special materials, contact the factory.

4900 POSRV Pilot Valve Coding



Pilot Type

PV = Pop Pilot
MV = Modulating Pilot

Pressure Range

07 = 15 to 750 psig
22 = 751 to 3750 psig
37 = 751 to 3750 psig
72 = 3751 to 7200 psig

Material

CC = Standard Material
A2 = Alloy 20 Wetted (Consult Factory)
A4 = Entirely Alloy 20 (Consult Factory)
D2 = Duplex Wetted (Consult Factory)
D4 = Entirely Duplex (Consult Factory)
H2 = Hastelloy C Wetted
H4 = Entirely Hastelloy C
M2 = Monel Wetted
M4 = Entirely Monel

O-Ring Material

B = Buna (Nitrile)
V = Viton (Fluorocarbon)
E = Ethylene Propylene
K = Kalrez
T = Teflon

Service

GS = Gas
LS = Liquid
SS = Steam

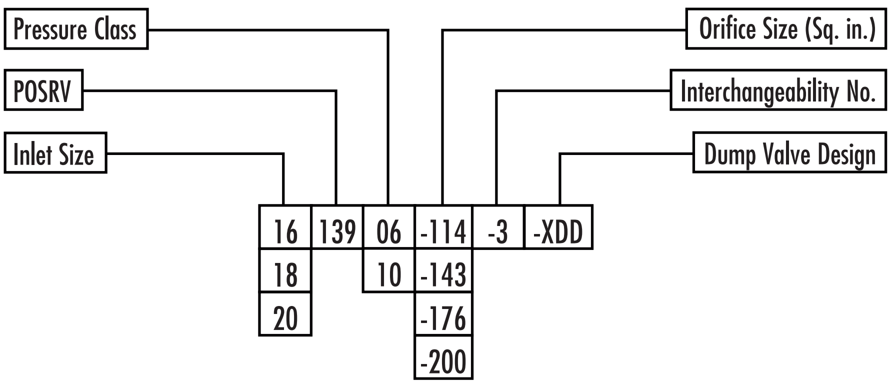
Blowdown

MB = Manual Blowdown
ER = Electronic Remote
AR = Air Remote

Filter

1F = Carbon Steel
2F = Stainless Steel
3F = Carbon Steel with Flush Valve
4F = Stainless Steel with Flush Valve

13900 POSRV Valve Coding



As a leading provider of pressure relief valve solutions, CONSOLIDATED offers world-class global aftermarket services. The global aftermarket program is designed to provide consistent and exceptional repair services, technical training, field support, spare parts production and management, complete equipment replacement, and comprehensive diagnostic services. This global support network consists of Green Tag Centers (GTC®), and CONSOLIDATED field service technicians that provide OEM experience, knowledge and technology to support all of your MRO needs worldwide, including hands-on training and on-site support.

The CONSOLIDATED aftermarket service program offers complete services for pressure relief valve products, including on-site installation and start-up, predictive and preventative maintenance programs, equipment testing, rebuilding and trouble-shooting, and complete valve turn-around management. The program also includes on-site inventory planning, diagnostic data interpretation services, on-site machining, field retrofitting, and hands-on training. CONSOLIDATED aftermarket service support is accessible 24 hours a day and seven days a week year round.

OEM Parts - CONSOLIDATED fully understands that quick response in obtaining replacement parts and overhaul services is a critical factor in maintaining a smooth operating plant. As a result, WE have placed extremely high importance on this customer need within our global aftermarket program.

Service Parts Inventory Philosophy - CONSOLIDATED'S formulated service parts inventory philosophy is designed to provide prompt valve service capability, thus preventing extended maintenance downtime. Your CONSOLIDATED sales representative or local Green Tag Center can assist you in developing an optimum inventory plan to fit your company's inventory needs.

CONSOLIDATED also provides integrated programs, using tools such as "ValvKeep®" to help manage the support of your installed equipment. These programs are location specific and include plant surveys, data management, scheduling and planning of maintenance, repairs, and overhauls. Historical data and trends can be managed using an asset management system to maximize efficiency of overall equipment support. In addition, CONSOLIDATED has developed advanced diagnostic tools and services that also assist in the prevention of unexpected or unnecessary maintenance, repair, or overhaul. Available diagnostic tools include the Electronic Valve Tester (EVT®) for pressure relief valves. Diagnostic services include the on-site application of these highly advanced tools by fully trained technicians.

Consolidated® Operations

Call 1-800-245-VALV for service in the Americas, or contact the nearest Dresser Sales Office for international service and support.

Safety Relief Valve Maintenance Training

CONSOLIDATED Safety Relief Valves are called upon to open and relieve pressure automatically, even after they have been closed for long periods of time. Are you comfortable with the maintenance and repair as it is currently practiced in your shop? Does your inspection department know what to look for to determine if a pressure relief valve needs attention? You check to determine if the valves leak when installed. But, will your valves close after the system reaches overpressure? Will the Valve Disc reach full lift and relieve the required capacity?

CONSOLIDATED's three day ***Safety Relief Valve Maintenance Training Seminars*** are available in the Alexandria, Louisiana Training Center, or at your plant site.

Two-day ***Engineering Sizing and Selection Seminars*** are also available for CONSOLIDATED products.

For additional information concerning Training Seminars please contact the CONSOLIDATED Training Manager at (318) 640-6054 or by fax at (318) 640-6041.

The following codes and standards are applicable to the design, selection and use of pressure relief valves. Some of these are applicable to specific industries, such as those set up by the American Petroleum Institute (API), American Gas Association (AGA), American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME) and Manufacturers Standardization Society of the Valve and Fittings Industry (MSS). Other codes and standards may apply depending on the country in which pressure relief valves will be installed. When specifying pressure relief valves consideration must be given to local codes that apply to a specific industry and the application in question.

The following is a listing of organizations that supply standards that are applicable to pressure relief valves for product intended for installation within the United States and those countries that recognize these standards.

American National Standards Institute

11 West 42nd Street, New York, NY 10036
(212) 642-4900
(212) 764-3274
http://www.ansi.org

American Gas Association

1515 Wilson Boulevard Suite 100, Arlington, VA 22209
(703) 841-8400
http://www.aga.org

American Petroleum Institute

1220 L Street Northwest Suite 900, Washington, DC 20005
(202) 682-8000
http://api-ec.api.org

American Society of Mechanical Engineers

3 Park Avenue Fl 21, New York, NY 10016
(212) 591-7000
http://www.asme.org

Manufacturers Standardization Society of Valve and Fittings Industry

127 Park Street Northeast, Vienna, VA 22180
(703) 281-6613
http://www.mss-hq.com

NACE International - The Corrosion Society

1440 South Creek Drive
Houston, Texas 77084-4906
281-228-6200
http://nace.org

National Board of Boiler and Pressure Vessel Inspectors

1055 Crupper Avenue
Columbus, OH 43229
614-888-8320
http://www.nationalboard.org

NFPA (National Fire Protection Association)

1 Batterymarch Park Quincy, MA 02269-9101
Telephone: (617) 770-3000
http://www.nfpa.org

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Equivalents and Conversion Factors

Pressure (psi = pounds per square inch)

kPa x 0.145 = psi
bar x 14.504 = psi
Atmosphere x 14.7 = psi
Inches of mercury x 0.4912 = psi
Kilograms per square centimeter x 14.22 = psi
Atmosphere x 1.033 = kilograms per square centimeter
Inches of mercury x 0.0345 = kilograms per square centimeter

Weights

Pound x 0.4536 = kilogram
Kilograms x 35.27 = ounces
Pounds x 0.0005 = short tons (2000 lbs)
Pounds x 0.000454 = metric tons
Pounds x 16 = ounces
Tons (metric) x 1.102 = short tons (2000 lbs)
Short tons x 907.2 = kilograms

Dimensions

Centimeters x 0.3937 = inches
Centimeters x 0.01 = meters
Cubic inches x 16.39 = cubic centimeters
Feet x 0.3048 = meters
Inches x 25.4 = millimeters
Feet x 12 = inches
Meters x 100 = centimeters
Meters x 39.37 = inches
Yards x 0.9144 = meters
Square inches x 6.4516 = square centimeters
Square inches x 645.16 = square millimeters

Temperature

$$\frac{t_f - 32}{1.8} = t_c\text{, Celsius}$$

$$1.8\,t_c + 32 = t_f\text{, Fahrenheit}$$

Flowrate (All gallons are U.S. unless otherwise noted)

Pounds per hour x 0.4536 = kilogram per hour
Kilograms per minute x 132.3 = pounds per hour
Barrels per day x 0.0292 = gallons per minute
Cubic feet per second x 448.833 = gallons per minute
Cubic meters per hour x 4.4 = gallons per minute

Gallons of liquid per minute x 500 x specific gravity = pounds per hour of liquid (70°F)

Liters per hour x 0.0044 = gallons per minute
Pounds per hour x 6.32 / molecular weight = cubic feet per minute

Pounds per hour liquid x 0.002 / specific gravity = gallons per minute of liquid (70°F)

Tons (metric) per day x 91.8 = pounds per hour
Gallons per minute x 0.06309 = liters per second
Gallons per minute x 3.7854 = liters per minute
Gallons per minute x 0.2271 = cubic meters per hour
Gallons per minute x 500 = pounds per hour

SCFM (Standard Cubic Feet Per Minute) x 1.608 = normal cubic meter per hour (760 mmHG and 0°C)

SCFM x 0.02679 = normal cubic meter per minute (760 mmHG and 0°C)

SCFM x 1.699 = cubic meters per hour (101 kPa and 16°C)

SCFM x 1.725 = cubic meters per hour (1 ATM and 20°C)

Volumes (All gallons are U.S. unless otherwise noted)

Cubic centimeters x 0.06102 = cubic inches
Cubic feet x 7.48055 = gallons
Cubic meters x 264.17 = gallons
Gallons x 231 = cubic inches
Gallons (Imperial) x 277.4 = cubic inches
Gallons x 3785 = cubic centimeters
Gallons x 0.833 = gallons (Imperial)
Gallons x 3.785 = liters
Liters x 1000 = cubic centimeters
Liters x 0.2642 = gallons
Barrels (petroleum) x 42 = gallons

Other

Foot pounds x 0.001286 = BTU
Gallons of water x 8.345 = pounds (70°F)
Horsepower (boiler) x 34.5 = pounds water per hour evaporation
Specific Gravity (gas or vapor) x 28.97 = molecular weight

Use of SI Units

The ASME Code has adopted the following practice for the use of "English" and Metric Units. A reprint of that statement is given below:

It is the policy of ASME Council that SI units of measurement be included in all papers, publications, and revisions of ASME Codes and Standards. In accordance with this policy, each ASME Policy Board, Technical Division, or Committee has the option of giving preference to U.S. customary or SI Units.

When U.S. customary units are given preference, the SI equivalent shall be given in parentheses or in a supplementary table. When preference is given to SI units, the U.S. customary units may be omitted or given in parentheses. Each Transactions Journal has specific instructions as to which of these options to use. This manual illustrates use of the second option: SI (U.S. customary).

For complete details regarding SI usage, consult ASME Guide SI-1, "ASME Orientation and Guide for Use of SI (Metric) Units", available from the ASME Order Department.

Terminology For Safety Relief Valves

Accumulation

Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percentage of that pressure, or actual pressure units.

Back Pressure

Back pressure is the pressure on the discharge side of a safety relief valve. (Also see "Built-Up Back Pressure" and "Superimposed Back Pressure", below).

Blowdown

Blowdown is the difference between set pressure and reseating pressure of a pressure relief valve, expressed as a percentage of the set pressure, or actual pressure units.

Built-Up Back Pressure

Built-up back pressure is pressure which develops at the valve outlet as a result of flow, after the safety relief valve has been opened.

Chatter

Chatter is the abnormal, rapid reciprocating motion of the movable parts of a valve in which the disc contacts the seat.

Closing Pressure

Closing pressure is the point at which the valve re-closes. Closing pressure on a test stand may differ from the blowdown, which is the closing pressure under actual service conditions.

Cold Differential Test Pressure (CDTP)

Cold differential test pressure is the set pressure at which the valve is adjusted to open on the test stand. This pressure includes the corrections for back pressure and/or temperature service conditions. (CDPT replaces former term CDS. For Consolidated series 1900 setting instructions, refer to maintenance manual CON-2).

Differential Between Operating and Set Pressures

Valves in process service will generally give best results if the operating pressure does not exceed 90% of the set pressure. However, on pump and compressor discharge lines, the differential required between the operating and set pressures may be greater because of pressure pulsations coming from a reciprocating piston. It is recommended that the valve be set as high above the operating pressure as possible.

Flutter

Flutter is the abnormal, rapid reciprocating motion of the movable parts of a valve in which the disc does not contact the seat.

Lift

Lift is the actual travel of the disc away from the closed position when a valve is relieving.

Maximum Allowable Working Pressure

Maximum allowable working pressure is the maximum gauge pressure permissible in a vessel at a designated temperature. A vessel may not be operated above this pressure, or its equivalent, at any metal temperature other than that used in its design. Consequently, for that metal temperature, it is the highest pressure at which the primary safety relief valve is set to open.

Operating Pressure

The operating pressure is the gauge pressure to which the vessel is normally subjected in service.

Overpressure

Overpressure is a pressure increase over the set pressure of the primary relieving device. Overpressure is similar to accumulation when the relieving device is set at the maximum allowable working pressure of the vessel. Normally, overpressure is expressed as a percentage of set pressure.

Rated Capacity

Rated capacity is the percentage of measured flow at an authorized percent overpressure permitted by the applicable code. Rated capacity is generally expressed in pounds per hour (lb/hr), kilograms per hour (kg/hr) for vapors; standard cubic feet per minute (SCFM), normal cubic meters per minute (LNCM/min) or m^3/min for gasses; and in gallons per minute (GPM), or liters per minute (L/min) for liquids.

Relief Valve

A relief valve is an automatic pressure-relieving device, actuated by static pressure upstream from the valve. This type of valve is used primarily for liquid service.

Safety Relief Valve

A safety relief valve is an automatic pressure-relieving device which may be used as either a safety or relief valve, depending upon application.

Safety Valve

A safety valve is an automatic pressure-relieving device actuated by the static pressure upstream of the valve, and characterized by rapid opening or pop action. This type of valve is used for steam, gas or vapor service.

Seat Tightness Pressure

Seat tightness pressure is the specified inlet static pressure at which a quantitative seat leakage test is performed in accordance with a standard procedure.

Set Pressure

Set pressure is the gauge pressure at the valve inlet, for which the safety relief valve has been adjusted to open under service conditions. In liquid service, set pressure is determined by the inlet pressure at which the valve starts to discharge. In gas or vapor service, the set pressure is determined by the inlet pressure at which the valve pops.

Simmer

Simmer is characterized by the audible passage of a gas or vapor across the seating surfaces just prior to “pop”. The difference between this “start to open pressure” and the set pressure is simmer, and is generally expressed as a percentage of set pressure.

Superimposed Back Pressure

Superimposed back pressure is the pressure in the discharge header before the safety relief valve opens. This can be further defined as follows:

Constant Superimposed

This type of back pressure remains essentially at a fixed value (constant) and exists (superimposed) continuously prior to and during opening of the valve. (e.g., 20 psig/1.38 bar).

Variable Superimposed

This type of back pressure varies or changes over a range from a minimum to a maximum, or vice versa. (e.g., 0 to 20 psig/1.38 bar). The actual back pressure at any specific time depends on conditions in the piping system to which the outlet of the valve is connected.

Valve Trim

Valve trim includes the nozzle and disc.

Reaction Forces Due to Valve Discharge (Gases & Vapors)

A thrust is exerted on a pressure relief valve when it is discharging. This thrust is equal to the mass flow rate times exit velocity, plus outlet flange area, times the difference between exit pressure and atmospheric pressure. This thrust, acting opposite to the direction of flow, may be significant, particularly when relieving gases or vapors. Although CONSOLIDATED safety relief valves are designed to withstand this thrust, stresses developed in piping or equipment should be investigated. It is especially important when the valve is discharging to atmosphere through an unsupported stack.

CONSOLIDATED's sizing program SRVS provides valve specific calculation of reaction forces.

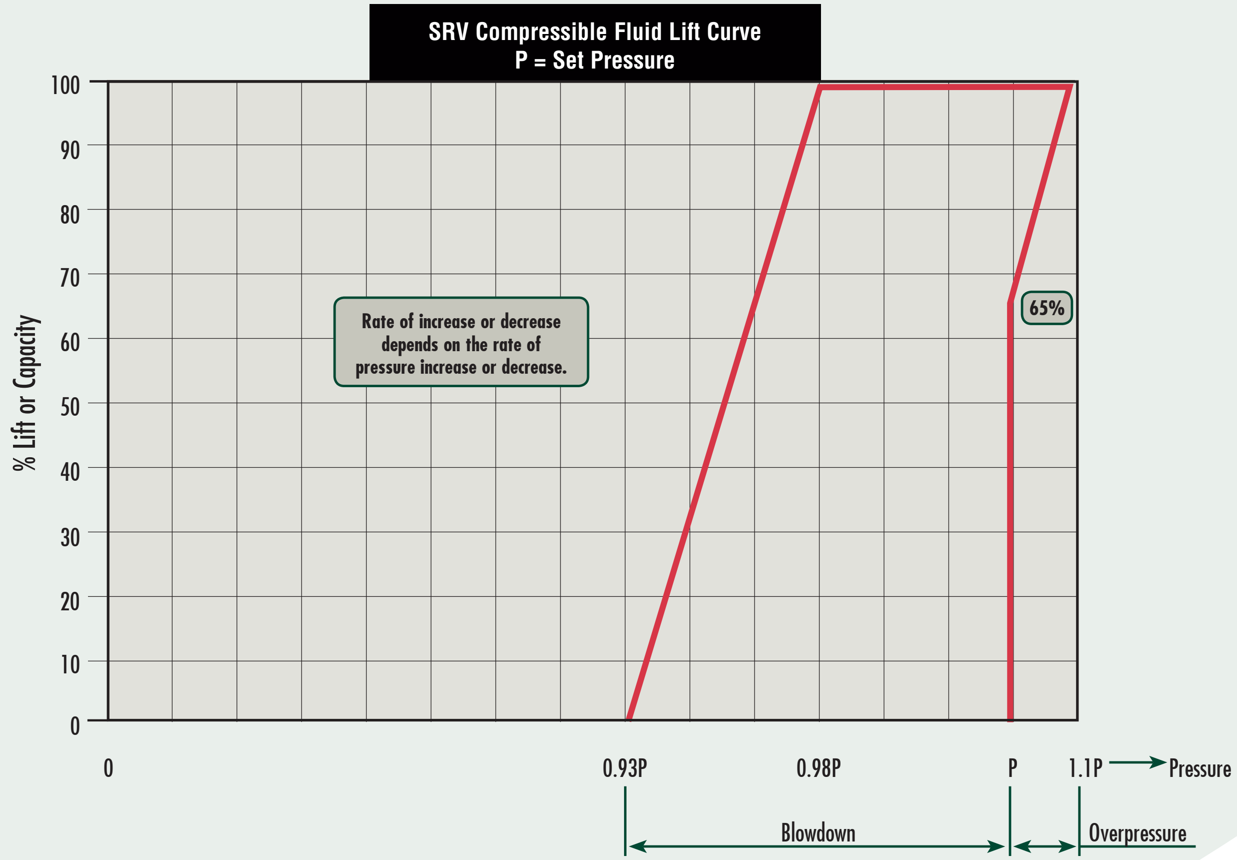
Determination of outlet reaction forces is the resposnsibility of the designer of vessel and/or piping.

Reaction force information obtained from SRVS is for technical advice and assistance only. No obligation or liability for this advice and assistance is assumed. Use of the valve specific information is at the buyer's risk.

Lift and Closing Curves for Safety Relief Valves

For various reasons, information is needed concerning the response of the valve lift with respect to pressure beneath the valve. The following information supplies general data.

Chart 6, below, applies to 1900, 1982, and 19000 series valves on compressible fluids. These valves achieve approximately 65% of their total rated lift at opening pressure and achieve full rated lift at 10% overpressure.



Valves Used in Combination with Rupture Disks / Valves for Closed Water Heaters

Pressure Relief Valves Used in Combination with Rupture Disks

In all pressurized systems, the overpressure relief can be handled with a variety of mechanisms which include pressure relief valves, rupture disks or combinations of the two devices.

The following guidelines apply when pressure relief valves are used in combination with rupture disks.

ASME B & PVC, Section VIII Rules:

Paragraph UG-132 of the ASME Code ***does*** permit the use of rupture disks. The use of rupture disks at the valve inlet, in combination with pressure relief valves, will fall into one of the two following categories:

(1) The rupture disk is ***not*** capacity certified in combination with the pressure relief valve.

(a) In that case, the ASME stamped rated capacity of the pressure relief valve must be multiplied by 0.9 (reducing the valve's rated capacity). Therefore, only 90% of the valve capacity can be used as credit in determining available relieving capacity for the system.

(2) The rupture disk is capacity certified in combination with the pressure relief valve.

(a) It is permitted to use a combination capacity factor determined by tests conducted under ASME rules. The ASME stamped rated capacity of the pressure relief valve must be multiplied by this factor when determining allowable relieving capacity of the valve/rupture disk combination. The capacity calculated using the combination capacity factor is to be used in valve sizing requirements.

(b) Each rupture disk design must be tested in combination with each pressure relief valve design so that a combination capacity factor can be determined. Factors are valid for only the materials tested.

Other ASME B & PVC, Section VIII Guidelines:

(1) Pressure relief valves used in combination with rupture disks are to be marked with the capacity established under 2(a) above. The markings may be placed on the valve or the rupture disk device. The markings shall include the following:

(a) Name of the valve Manufacturer

(b) Design or type number of the valve

(c) Name of the rupture disk Manufacturer

(d) Design or type number of the rupture disk

(e) Capacity or combination capacity factor

(f) Name of the organization responsible for this marking (this could be the valve Manufacturer, rupture disk Manufacturer, vessel user, or vessel Manufacturer).

(2) The space between the rupture disk and pressure relief valve shall be provided with a pressure gauge, a try cock, free vent or suitable telltale indicator. This arrangement permits detection of disk rupture or leakage.

Safety Relief Valves for Closed Water Heaters

Heat exchangers, which utilize tubes as a method of transferring heat, present unique sizing problems. The tube side (flow through the tubes) is generally not a problem area, but the shell side sizing can be complicated by the fact that tube ruptures can occur.

The following techniques apply to valve sizing on shell sides of heat exchangers:

(1) When pressure, temperature and flow conditions are specified, valves will be sized in accordance with ASME B & PVC, Section VIII rules. For flashing water, valves will be sized on the basis of estimating back pressure due to flashing. That back pressure will be used in calculations for required orifice area calculations.

(2) When it is stated that valves are to be sized in accordance with the Heat Exchanger Institute Standard for Closed Feedwater Heaters, Section 6, specifications must supply all appropriate information to allow verification of sizing. If valve sizing under HEI guidelines results in valves smaller than that stated in (1), the sizing must be resolved before an ASME Code stamp is allowed on the valve nameplate.

(3) The following information is necessary to ensure proper sizing:

(a) Set pressure or shell design pressure

(b) Normal operating temperature

(c) Relieving temperature at the valve inlet in event of tube rupture

(d) Shell design temperature

(e) Relieving capacity required at relieving temperature (GPM or lb/hr)

(f) Back pressure condition
- at normal conditions
- at relieving conditions

(g) Specify percentage of flashing occurring

(h) Specify the valves to have "UV" symbols stamped on the nameplate and the capacity indicated in "GPM" at 70°F

(i) Liquid trim components to be installed in the valve

Seat Tightness of Pressure Relief Valves (Reprint of API RP 527)

Section 1 - Scope

This standard describes methods of determining the seat tightness of metal and soft seated pressure relief valves, including those of conventional, bellows, and pilot operating designs.

The maximum acceptable leakage rates are defined for pressure relief valves with set pressures from 15 pounds per square inch gauge (103 kilopascals gauge) to 6,000 pounds per square inch gauge (41,379 kilopascals gauge). If greater seat tightness is required, the purchaser shall specify it in the purchase order.

The test medium for determining the seat tightness - air, steam, or water shall be the same as that used for determining the set pressure of the valve.

For dual service valves, the test medium - air, steam, or water - shall be the same as the primary relieving medium.

To ensure safety, the procedures outlined in this standard shall be performed by persons experienced in the use and functions of pressure relief valves.

Section 2 - Testing with Air

2.1 Test Apparatus

A test arrangement for determining seat tightness with air is shown in Figure 1. Leakage shall be measured using a tube with an outside diameter 5⁄16 inch (7.9 millimeters) and a wall thickness of 0.035 inch (0.89 millimeter). The tube end shall be cut square and smooth. The tube opening shall be ½ inch (12.7 millimeters) below the surface of the water. The tube shall be perpendicular to the surface of the water.

Arrangement shall be made to safely relieve or contain body pressure in case the valve accidentally pops (see Figure 2).

2.2 Procedure

2.2.1 Test Medium

The test medium shall be air (or nitrogen) near ambient temperature.

2.2.2 Test Configuration

The valve shall be vertically mounted on the test stand, and the test apparatus shall be attached to the valve outlet, as shown in Figure 1. All openings - including but not limited to caps, drain holes, vents, and outlets shall be closed.

2.2.3 Test Pressure

For a valve whose set pressure is greater than 50 pounds per square inch gauge (345 kilopascals gauge), the leakage rate in bubbles per minute shall be determined with the test pressure at the valve inlet held at 90% of the set pressure. For a valve set at 50 pounds per square inch gauge (345 kilopascals gauge) or less, the test pressure shall be held at 5 pounds per square inch (34.5 kilopascals) less than the set pressure.

2.2.4 Leakage Test

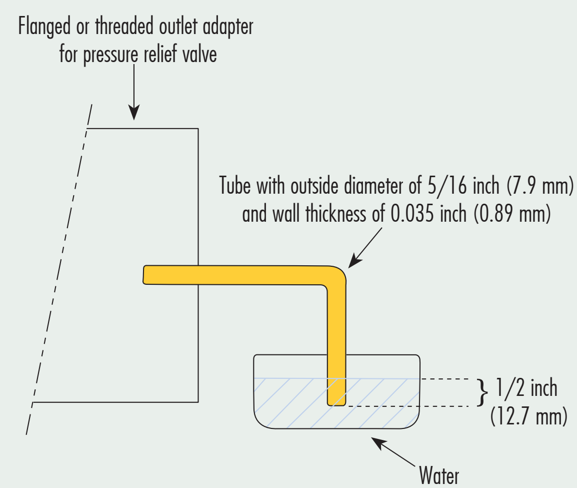
Before the leakage test, the set pressure shall be demonstrated, and all valve body joints and fittings should be checked with a suitable solution to ensure that all joints are tight.

Before the bubble count, the test pressure shall be applied for at least one minute for a valve whose nominal pipe size is two inches (50 millimeters) or smaller; two minutes for a valve whose nominal pipe size is 2½, 3 or 4 inches (65, 80, or 100 millimeters); and five minutes for a valve whose nominal pipe size is six inches (150 millimeters) or larger. The valve shall then be observed for leakage for at least one minute.

2.3 Acceptance Criteria

For a valve with a metal seat, the leakage rate in bubbles per minute shall not exceed the appropriate value in Table 1. For a soft seated valve, there shall be no leakage for one minute (zero bubbles per minute).

Fig. 1 - Apparatus to Test Seat Tightness with Air

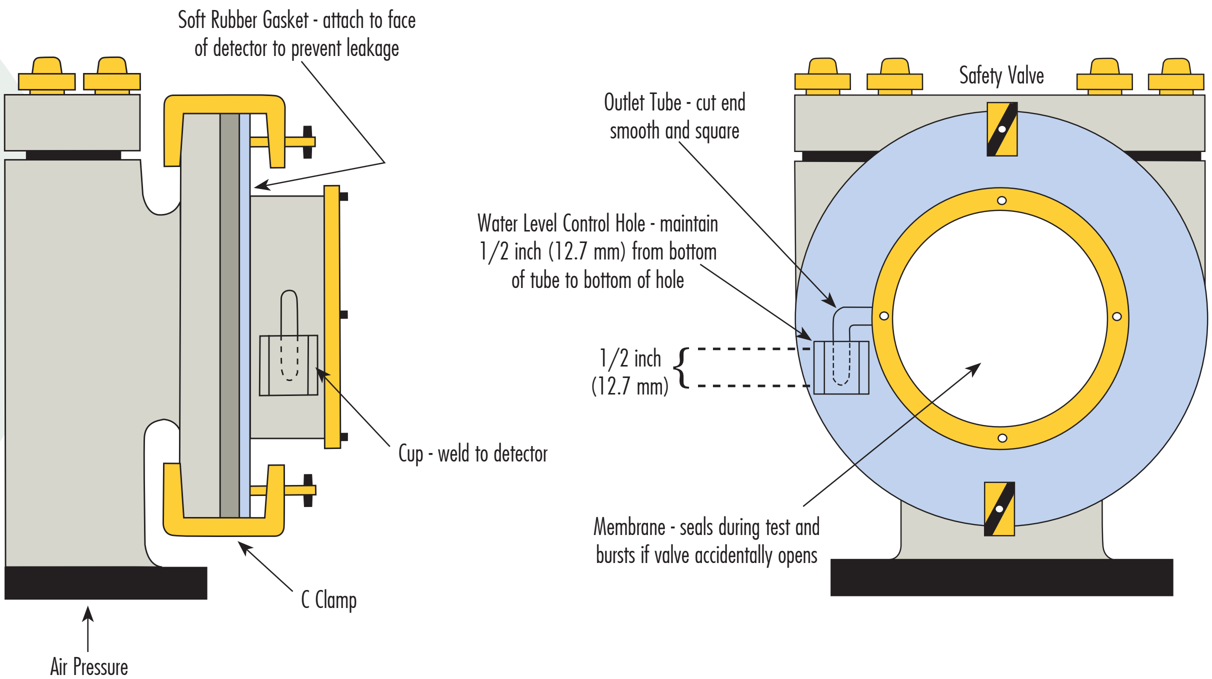


NOTE: See Figure 2 for an example of a device to relieve body pressure in case the valve accidentally pops.

Table 1 - Air Test - Maximum Seat Leakage Rates for Metal-Seated Pressure

Set Pressure at 60°F (15.6°C)		Effective Orifice Sizes 0.307 Inch and Smaller			Effective Orifice Sizes Larger than 0.307 Inch		
			Approximate Leakage per 24 Hours			Approximate Leakage per 24 Hours	
Pounds per Square Inch Gauge	Megapascals	Leakage Rate (bubbles per minute)	Standard Cubic Feet	Standard Cubic Meters	Leakage Rate (bubbles per minute)	Standard Cubic Feet	Standard Cubic Meters
15 - 1000	0.103 - 6.896	40	0.60	0.017	20	0.30	0.0085
1500	10.3	60	0.90	0.026	30	0.45	0.013
2000	13.0	80	1.20	0.034	40	0.60	0.017
2500	17.2	100	1.50	0.043	50	0.75	0.021
3000	20.7	100	1.50	0.043	60	0.90	0.026
4000	27.6	100	1.50	0.043	80	1.20	0.034
5000	38.5	100	1.50	0.043	100	1.50	0.043
6000	41.4	100	1.50	0.043	100	1.50	0.043

Fig. 2 - Air Test - Device to Relieve Body Pressure Caused by Accidental Popping of the Valve



Section 3 - Testing with Steam

3.1 Procedure

3.1.1 Test Medium
The test medium shall be saturated steam.

3.1.2 Test Configuration
The valve shall be vertically mounted on the steam test stand.

3.1.3 Test Pressure
For a valve whose set pressure is greater than 50 pounds per square inch gauge (345 kilopascals gauge), the seat tightness shall be determined with the test pressure at the valve inlet held at 90 percent of the set pressure. For a valve set at 50 pounds per square inch gauge (345 kilopascals gauge) or less, the test pressure shall be held at five pounds per square inch (34.5 kilopascals) less than set pressure.

3.1.4 Leakage Test
Before starting the seat tightness test, the set pressure shall be demonstrated, and the set pressure shall be held for at least three minutes. Any condensate in the body bowl shall be removed before the seat tightness test. Air (or nitrogen) may be used to dry condensate.

After any condensate has been removed, the inlet pressure shall be increased to the test pressure. Tightness shall then be checked visually using a black background. The valve shall then be observed for leakage for at least one minute.

3.2 Acceptance Criteria

For both metal and soft seated valves, there shall be no audible or visible leakage for one minute.

Section 4 - Testing with Water

4.1 Procedure

4.1.1 Test Medium
The test medium shall be water near ambient temperature.

4.1.2 Test Configuration
The valve shall be vertically mounted on the water test stand.

4.1.3 Test Pressure
For a valve whose set pressure is greater than 50 pounds per square inch gauge (345 kilopascals gauge), the seat tightness shall be determined with the test pressure at the valve inlet held at 90 percent of the set pressure. For a valve set at 50 pounds per square inch gauge (345 kilopascals gauge) or less, the test pressure shall be held at 5 pounds per square inch (34.5 kilopascals) less than the set pressure.

4.1.4 Leakage Test
Before starting the seat tightness test, the set pressure shall be demonstrated, and the outlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve outlet. The inlet pressure shall then be increased to the test pressure. The valve shall then be observed for one minute at the test pressure.

4.2 Acceptance Criteria

For a metal seated valve whose inlet has a nominal pipe size of one inch or larger, the leakage rate shall not exceed 10 cubic centimeters per hour per inch of nominal inlet size. For a metal seated valve whose inlet has a nominal pipe size of less than one inch, the leakage rate shall not exceed 10 cubic centimeters per hour. For soft seated valves, there shall be no leakage for one minute.

Section 5 - Testing with Air - Another Method

5.1 Type of Valve to be Tested

Valves with open bonnets - bonnets that cannot be readily sealed, as specified in 2.2.2 - may be tested in accordance with this section instead of Section 2.

This alternative method shall not be used to test valves in which air bubbles can travel to the open bonnet through any passageway inside the valve guide without being observed at the valve outlet.

5.2 Procedure

5.2.1 Test Medium
The test medium shall be air (or nitrogen)near ambient temperature.

5.2.2 Test Configuration
The valve shall be vertically mounted on the air test stand. The valve outlet shall be partially sealed with water to about ½ inch (12.7 millimeters) above the nozzle's seating surface.

5.2.3 Test Pressure
For a valve whose set pressure is greater than 50 pounds per square inch gauge (345 kilopascals gauge), the leakage rate in bubbles per minute shall be determined with the test pressure at the valve inlet held at 90 percent of the set pressure. For a valve set at 50 pounds per square inch gauge (345 kilopascals gauge) or less, the test pressure shall be held at five pounds per square inch (34.5 kilopascals) less than the set pressure.

5.2.4 Leakage Test
Before starting the seat tightness test, the set pressure shall be demonstrated, and the outlet body bowl shall be filled with water to the level of the partial seal. The inlet pressure shall then be increased to the test pressure and held at this pressure for one minute before the bubble count. The valve shall then be observed for leakage for at least one minute.

Caution: When looking for leakage, the observer shall use a mirror or some other indirect means of observation so that the observer's face is not in line with the outlet of the valve, in case the valve accidentally pops.

5.3 Acceptance Criteria

For a valve with a metal seat, the leakage rate in bubbles per minute shall not exceed 50% of the appropriate value in Table 1. For a soft-seated valve, there shall be no leakage for one minute (zero bubbles per minute).

Allowable Piping Loads for 1900 Flanged Safety Relief Valves

Exhaust piping loads on the valve outlet should be minimized and preferably be a value of zero.

Since most installations will include exhaust piping, we have tabulated allowable piping loads on our 1900 flanged safety relief valves in Table 2 (page TI.11). It is the user's responsibility to ensure that inlet piping to the valve and the attachment to a pressure vessel can adequately support the load (F_V) plus other effects of pressure and temperature.

The allowable load (F_V) is the vertical force shown in Figure 3. It is assumed that (F_V) acts through the centerline of the valve outlet and body. The limiting value of (F_V) is not based on the maximum allowable stresses of material in the valve body. (F_V) is based on the structural rigidity of the body which could cause the valve to leak if a given amount of strain is exceeded.

The allowable load (F_V) applies up to the limit of set pressure for each valve type.

The allowable load (F_V) is based on the valve maintaining API-527 tightness, i.e., leakage point is 90% of set pressure. If the leak tightness pressure required is higher than 90%, then allowable piping loads must be derated in accordance with the following:

Leak Tightness Pressure as a % of Set Pressure	Derating Factor for Value Given in Table 2
90%	1.0
91%	0.9
92%	0.8
93%	0.7
94%	0.6
95%	0.5

In addition to the above, the valve allowable load (F_V) must also be derated as a result of high temperature effects. The allowable piping loads must be derated in accordance with Figure 4.

The effects of required valve tightness and temperature are additive and must be included. Example:

(1) 1905K, set pressure 200 psig, 92% seat tightness, relieving temperature 500°F.

(2) Allowable load (F_V) = 500
Derating for tightness = 500 (0.8) = 400 lb.
Derating for temperature = 400 (.98) = 392 lb.

(3) That valve should not be subject to a force exceeding 392 lb. when installed under the stated conditions.

Fig. 3 - Vertical Force F_V

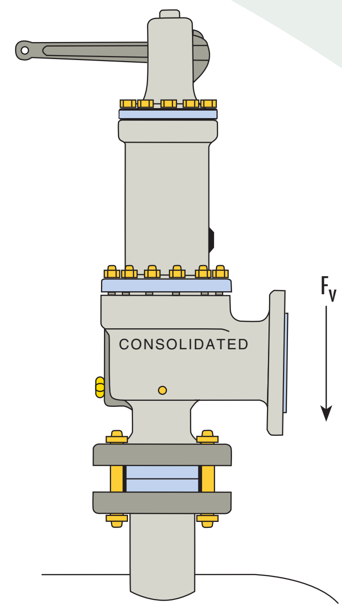
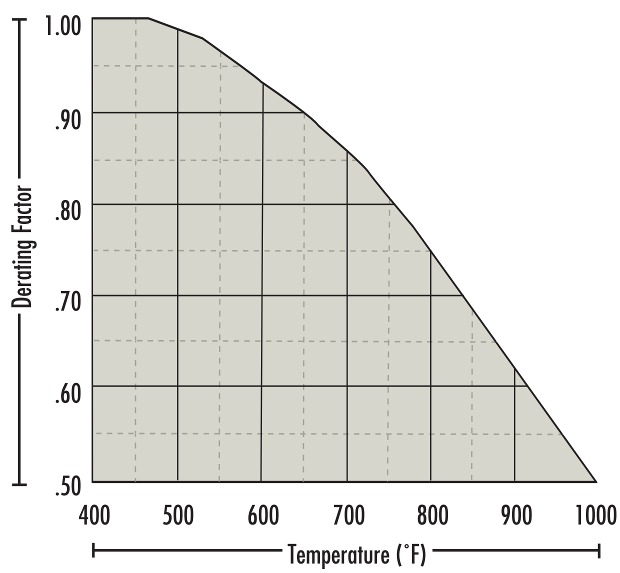


Fig. 4 - Temperature Derating Factor



Allowable Piping Loads for:
1900 Flanged Safety Relief Valves

Table 2

Orifice D		E		F		G		H		J		K		L	
Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load
1905	85	1905	85	1905	150	1905	150	1905	150	1905	250	1905	500	1905	500
1906	85	1906	85	1906	150	1906	150	1906	150	1906	250	1906	500	1906	500
1910	85	1910	85	1910	150	1910	150	1910	260	1910	500	1910	600	1910	800
1912	85	1912	85	1912	150	1912	150	1912	260	1912	500	1912	600	1912	800
1914	158	1914	158	1914	158	1914	158	1914	330	1914	800	1914	800	1914	1000
1916	158	1916	158	1916	158	1916	158	1916	330	1916	800	1916	800		
1918	230	1918	230	1918	230	1918	230								

Orifice M		N		P		Q		R		T		V		W	
Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load
1905	1000	1905	1000	1905	1000	1905	1200	1905	1200	1905	2400	1905	3300	1905	5300
1906	1000	1906	1000	1906	1000	1906	1200	1906	1200	1906	2400	1906	3300	1906	5300
1910	1200	1910	1200	1910	1200	1910	1500	1910	1500	1910	2400	1910	3300	1910	5300
1912	1500	1912	1500	1912	1500	1912	2000	1912	2000						

Allowable Piping Loads for:
19000 Threaded Safety Relief Valves

Valves with threaded base-to-bonnet joints should not have discharge piping installed that would induce a torsional load when the valve relieves. All discharge piping should be parallel to the vertical axis of the valve.

The maximum allowable vetical piping loads that can be applied at the outlet face and not adversely affect the performance of the 19000 series valve is as follows:

Valve Type	Maximum Load (lb)
19096L, M 19126L, M 19110L, M	411
19226L, M	427
19096H - 19110H	427
19126H - 19226H	4232
19357L, M	1072
19567L, M	1072

Allowable Piping Loads for:
Pilot Operated 3900 Flanged Safety Relief Valves

Exhaust piping loads on the valve outlet should be minimized, and preferably be a value of zero. This will be the total allowed load on the single outlet valves and the total allowable differential load between the two outlets on the dual outlet valves.

Since most installations will include exhaust piping, allowable piping loads are tabulated for the 3900 flanged safety relief valves in Table 3 and Table 4. It is the user's responsibility to ensure that inlet piping to the valve and the attachment to a pressure vessel can adequately support the load F_V.

The allowable load (F_V) is the vertical force at the valve outlet. It is assumed that F_V acts through the centerline of the valve outlet and body. The limiting value of F_V is not based on the maximum allowable stresses of material in the valve body. F_V is based on the structural rigidity of the body.

The allowable load (F_V) applies up to the limit of set pressure for each valve type.

Table 3 - Standard Bore Piping Loads

Orifice D		Orifice E		Orifice F		Orifice G		Orifice H		Orifice J		Orifice K	
Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load
3905	150	3905	150	3905	150	3905	150	3905	150	3905	250	3905	250
3910	150	3910	150	3910	150	3910	260	3910	260	3910	500	3910	500
3912	150	3912	150	3912	150	3912	260	3912	260	3912	500	3912	500
3914	158	3914	158	3914	158	3914	330	3914	330	3914	800	3914	800
3916	158	3916	158	3916	158	3916	330	3916	330	3916	800	3916	800

Orifice L		Orifice M		Orifice N		Orifice P		Orifice Q		Orifice R		Orifice T	
Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load
3905	500	3905	1000	3905	150	3905	150	3905	1200	3905	1200	3905	2400
3910	800	3910	1200	3910	150	3910	260	3910	1500	3910	1500	3910	2400
3912	800	3912	1500	3912	150	3912	260	3912	2000	3912	2000	3912	3000
3914	1100	3914	1800	3914	158	3914	330						
3916	1100	3916	1800	3916	158	3916	330						

Table 4 - Full Bore Piping Loads

Orifice 3 x 4		Orifice 4 x 6		Orifice 6 x 8 x 8		Orifice 8 x 10 x 10		Orifice 10 x 10 x 10	
Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load	Valve Type	F_V (lb) Max. Load
3905	500	3905	1000	3905	2400	3905	2400	3905	3600
3910	800	3910	1200	3910	2400	3910	2400	3910	3600
3912	800	3912	1500	3912	3000	3912	3000		

Temperatures Used in Selecting Pressure Relief Valves

In all safety relief valve protected pressurized systems, the possibility exists to have elevated temperatures present. Generally, temperatures in such situations can be categorized as stated below:

(1) Operating Temperature

This is the temperature normally found in the system and exists by virtue of the processes in the system. It is normally fairly constant when averaged over a period of time.

(2) Relieving Temperature

This is the temperature that exists in the system at the time that the pressure relief valve opens in response to a system pressure increase. It generally results from some type of system upset condition. This temperature is usually higher than operating temperature, but may be higher or lower than design temperature.

(3) Design Temperature

This is the specified temperature for which the structural components of the system must be designed. The value of this temperature level is based on several factors including the length of time at which various temperature levels are expected to occur. It may be higher or lower than relieving temperature.

In determining proper valve selection, temperature is one of the variables used both for structural considerations and valve sizing. The following guidelines are provided for use in temperature considerations and determining a valve selection.

(A) Capacities should be based upon the relieving temperature and flowing pressures.

If the relieving temperature is not given, the maximum of the temperatures given should be used.

(B) The CDTP (cold differential test pressure) should be based upon the operating temperature.

If the operating temperature is not given, the CDTP should be based on the lower of the temperatures given.

The nameplate should be stamped with the temperature used to calculate the CDTP.

(C) For the selection of springs, bellows and O-Ring materials, the most critical of the operating or relieving temperature is used, except in the case of fire-sizing. If only the design temperature is given, it should be used.

For fire-sizing, the operating temperature is used to select the materials for the bellows, springs and O-Rings. If the operating temperature is not given, the minimum of the temperatures given should be used.

This is the temperature which is used to select the “t” or “c” design valve.

(D) The flange rating should be based upon the design temperature (reference ASME Section VIII, UG-20, UG-21). If the design temperature is not given, the most critical of the temperatures given should be used.

When conditions are not clear about which temperatures are to be used, additional guidance should be requested.

Flange Finishes and Natural Frequency

Flange Finishes

Standard Raised Face Flange Finish

(a) CONSOLIDATED's standard flange face finish is 125 to 250 micro inch roughness (Ra). A spiral finish having 24 to 40 grooves per inch is machined using a cutting tool with a minimum radius of .062". The resultant finish is 125 to 250 Ra with a minimum of torn surface when compared with the visual comparison standard.

(b) Acceptance of finish is based on use (visual and tactile) of the Rubert 119 comparator. In accordance with ASME/ANSI B16.5, the finish of contact faces of valves will be judged by visual comparison with Ra standards (see ANSI B46.1) and not by instruments having stylus tracers and electronic amplification.

NOTE: Ra, AARH, AA and CLA are the same.

Nonstandard Designations

(a) When a finish other than **CONSOLIDATED**'s standard is desired, the customer should supply the following information:

- **(1)** Finish: serrated or smooth
- **(2)** Serrations: spiral or concentric
- **(3)** For smooth finish specify roughness, e.g., 63 Ra
- **(4)** Acceptance standard, e.g., Rubert 119 comparator

References

(a) ASME/ANSI B16.5 - 1996, Pipe Flanges and Flanged Fittings

(b) ASME/ANSI B16.34 - 1996, Valves - Flanged, Threaded, and Buttwelding End

(c) ASME/ANSI B46.1 - 1985, Surface Texture

Natural Frequency of Pressure Relief Valves

All piping and mechanical systems exhibit a characteristic known as a natural frequency. This natural frequency is determined in many ways, but actually subjecting the valve to a test on a vibrating table is the most reliable.

In general, valves with lower natural frequencies indicate a relatively flexible product in its structural design. Valves which have a high natural frequency are indicative of valves with a stiff structural design.

It is not advisable to install a valve on a system header where the valve and the piping system both have the same natural frequency. This would eventually lead to major vibration problems causing the valve to open at a very low set pressure and leak continuously. Usually, valve natural frequencies are much higher than the natural frequency of the piping system on which they are installed, so problems related to natural frequency of the valve are not common.

Valve Installation

General

Valve Connections

1900 flanged valves are equipped with ANSI B16.5 flanges and comply with ANSI/API STD 526. For other standards, contact CONSOLIDATED for your needs.

The facing on raised flanges is a spiral finish, 125 to 250 micro inch roughness (Ra).

All flange drillings straddle the centerlines of the valve.

19000 valves are supplied with threaded, socket weld or flanged connections. Centerline to face dimensions are consistent with good installation practices. These flanges also comply with B16.5.

Handling and Storage

The internal parts of safety relief valves are precision machined and fitted together to maintain perfect alignment. Rough handling may damage the seats or cause misalignment sufficient to incur leakage or erratic operation. Safety relief valves should be handled carefully. Safety relief valves are shipped with a protective covering over the inlet and the outlet to prevent damage to the flanged surfaces and to prevent entry of foreign material into the valve. If the valves are to be stored before installation, the protective covering should be left intact until installation. Furthermore, clean, dry covered storage is recommended. If this is not practical, valves should at least be protected with a suitable covering to prevent entry of foreign material.

Inlet Piping

The safety relief valve should be installed in a vertical upright position. The inlet piping to the valve should be short and direct from the vessel or equipment being protected. The connection to the vessel should be provided with a radius to permit smooth flow to the valve. Sharp corners should be avoided. Should this not be practical, then the inlet should be wedged out at least one additional pipe diameter.

In any event, the pressure drop from the vessel to the valve should not exceed 3% when the valve is flowing full capacity. In no event should the inlet piping be smaller in diameter than the inlet connection of the valve.

Outlet Piping

Alignment of the internal parts of a safety relief valve is important to ensure proper operation. Although the valve body will withstand a considerable mechanical load, unsupported discharge piping should not involve loads any higher than that stated in the Piping Loads section of this catalog. They should also avoid loads consisting of more than a companion flange, long radius elbow and a short vertical pipe. Care should be taken to ensure thermal expansion of piping and support does not produce strains in a valve. Spring supports are recommended where this may be the case. The discharge piping should be designed to allow for vessel expansion as well as expansion of the discharge pipe itself. This is particularly important on long discharge lines.

Consideration should be given to discharge pipe movement resulting from wind loads. A continual oscillation of the discharge piping introduces stress distortion in the valve body. The resultant movement of the internal parts may cause leakage.

Where possible, drains should be piped away to prevent the collection of water or corrosive liquid in the valve body. Attention should be given to the support of the drainage piping.

When two or more valves are piped to discharge into a common header, the built-up back pressure resulting from the opening of one (or more) valve(s) may cause a superimposed back pressure in the remaining valves connected to the header. This back pressure will increase the set pressure of the remaining valves by the amount of the back pressure, unless the bonnet is vented. Under these conditions, use of bellows valves is recommended. Bellows valves may also permit use of a smaller size manifold.

It is recommended that the smaller orifice valve be set at the lower set pressure and that it be installed upstream of other valves.

API Recommended Practice for the Design and Installation of Pressure Relieving Systems in Refineries

(Excerpts from API RP 520 Part II)

1. General

1.1 Scope

This recommended practice is intended to cover methods of installation for pressure relieving devices. Pressure relief valves or rupture disks may be used independently or in combination with each other to provide the required protection against excessive overpressure. As used in this recommended practice, the term *pressure relief valve* includes safety relief valves used in compressible fluid service and relief valves used in liquid service. This recommended practice covers gas, vapor, and liquid service; it does not cover special applications that require unusual installation considerations.

2. Inlet Piping

2.1 General Requirements

For general requirements of inlet piping, see Fig. 5 and Fig. 6.

2.1.1 Flow and Stress Considerations

The valve inlet piping should be designed to provide for proper valve performance. This requires design consideration of the flow induced pressure drop in the inlet piping. Excessive pressure losses in the piping system between the protected vessel and the pressure relief valve will adversely affect the valve performance. In addition, the effect of stresses derived from both valve operation and externally applied loads must be considered. For more complete piping design guidelines, see ASME B31.1 or B31.3.

2.1.2 Vibration Considerations

Vibrations in inlet piping systems may cause leakage in the seats of pressure relief valves or fatigue failure of the piping; under certain conditions, both results may occur.

Most vibrations that occur in inlet piping systems are random and complex. These vibrations may cause the seat on the valve disc to slide back and forth across the seat on the valve nozzle, resulting in damage to the seating surfaces; they may cause actual separation of the seating surfaces; or they may cause premature fatigue failure of certain valve parts.

Regardless of the amplitude, high-frequency vibrations are more detrimental to the tightness of the pressure relief valve than are low-frequency movements. This effect can be minimized by providing greater pressure differentials between the operating pressure and the set pressure, particularly under high-frequency conditions.

2.2 Pressure Drop Limitations and Piping Configurations

For pressure drop limitations and piping configurations, see Figures 5 - 8.

Fig.5 - Typical Pressure Relief Valve Without a Stop

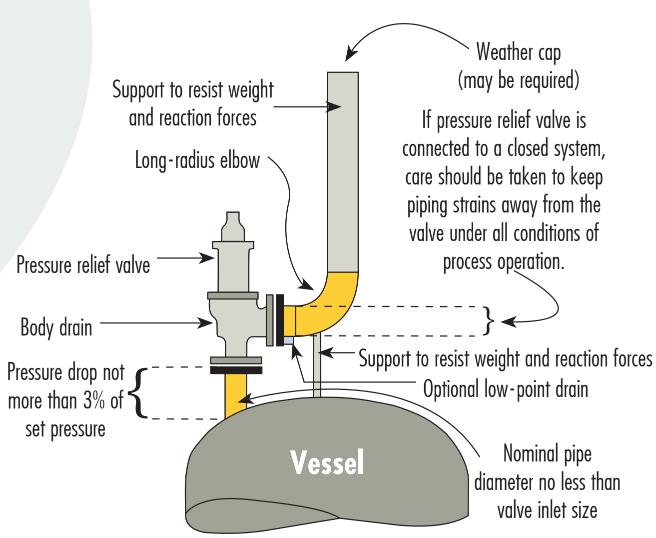
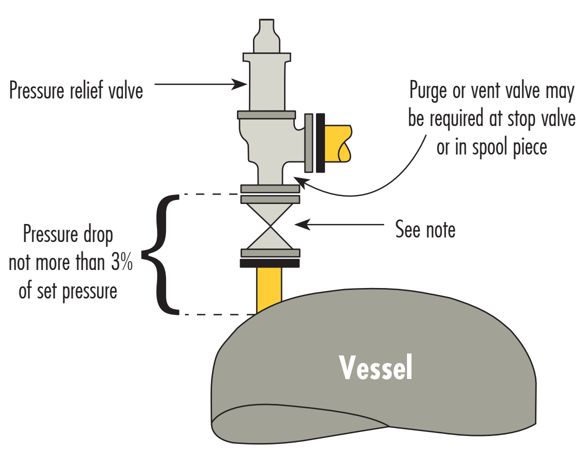


Fig. 6 - Typical Pressure Relief Valve With a Stop Valve



NOTE: The stop valve must have a full port area greater than or equal to the inlet size of the pressure relief valve. The stop valve should be used only as permitted by the applicable codes.

2.2.1 Pressure Loss at the Valve Inlet

Excessive pressure loss due to friction at the inlet of a pressure relief valve will cause rapid opening and closing of the valve, or chattering. Chattering may result in lowered capacity and damage to the seating surfaces. Pressure loss is caused by friction within, or entering into, the inlet piping of the pressure relief valve.

2.2.2 Size and Length of Inlet Piping

The inlet piping between the protected equipment and the inlet flange of the pressure relief valve should be designed so that the total pressure loss does not exceed 3% of the set pressure of the valve. The pressure loss should be calculated using the maximum rated capacity of the pressure relief valve. Pressure losses can be reduced materially by rounding the entrance to the inlet piping or by using larger inlet piping.

The nominal size of the inlet piping must be the same as or larger than the nominal size of the valve inlet flange.

When a rupture disk device is used in combination with a pressure relief valve, the pressure drop calculation must include the additional pressure drop developed by the disk.

Pilot operated valves can tolerate higher inlet pipe pressure losses when the pilot senses the system's pressure at a point that is not affected by the inlet pipe pressure drop (see Figure 9). The reduced capacity of the main valve, caused by the increased pressure drop, should not be reduced below the capacity required to protect the equipment or system.

2.2.3 Configuration of Inlet Piping

The installation of a pressure relief valve at the end of a long horizontal inlet pipe through which there is normally no flow should be avoided. Foreign matter may accumulate, or liquid may be trapped, creating interference with the valve's operation or requiring more frequent valve maintenance.

2.3 Inlet Stresses that Originate from Discharge Piping

Improper design or construction of the discharge piping from a pressure relief valve can set up stresses that will be transferred to the valve and its inlet piping. These stresses may cause the valve to leak or malfunction. The valve Manufacturer should be consulted about permissible loads and moments.

2.3.1 Thermal Stresses

Fluid flowing from the discharge of a pressure relieving device may cause a change in the temperature of the discharge piping. A change in temperature may also be caused by prolonged exposure to the sun or to heat radiated from nearby equipment. Any change in the temperature of the discharge piping will cause a change in the length of the piping and may cause stresses that will be transmitted to the pressure relieving device and its inlet piping. The pressure relieving device should be isolated from piping stresses through proper support, anchoring, or flexibility of the discharge piping. Fixed supports should not be used because they may cause stresses in the pressure relief valve as a result of thermal changes.

2.3.2 Mechanical Stresses

Discharge piping should be independently supported and carefully aligned. Discharge piping that is supported by only the pressure relief valve will induce stresses in the pressure relief valve and the inlet piping. Forced alignment of the discharge piping will also induce such stresses.

Fig. 7 - Typical Pressure Relief Valve Mounted on a Process

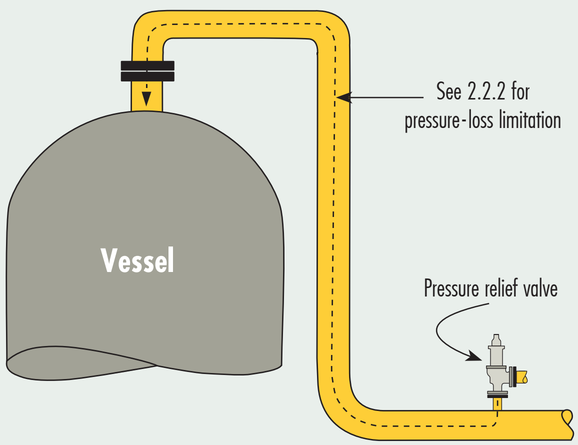
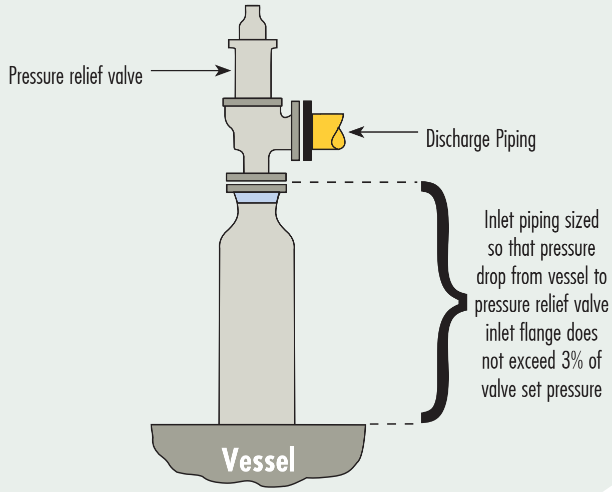


Fig. 8 - Typical Pressure Relief Valve Mounted on a Long Inlet



2.6 Rupture Disks

A rupture disk device may be used as the sole pressure relieving device, or it may be installed between the pressure relief valve and the vessel or on the outlet side of the valve. For ASME Code applications, the capacity of a pressure relief valve used in combination with a rupture disk mounted as shown in Figure 10 must be derated by 20% unless that particular combination has a capacity factor derived from testing and certified by ASME.

When a rupture disk device is used downstream from the valve or between the pressure relief valve and the protected vessel, a pressure gauge, try cock, free vent, or suitable telltale indicator should be provided to permit detection of disk rupture or leakage. Unless this requirement is complied with, the user is cautioned that any pressure buildup between the rupture disk and the pressure relief valve will increase the opening pressure of the device (see Figure 10).

Only rupture disks that have a non-fragmenting design may be used beneath a pressure relief valve.

When reverse buckling disks are used in liquid service, some Manufacturers recommend a vapor space that is required to provide the dynamic energy necessary to ensure complete rupture and full opening of the disk.

2.7 Process Laterals

Process laterals should generally not be connected to the inlet piping of pressure relief valves. Exceptions should be analyzed carefully to ensure that the allowable pressure drop at the inlet of the pressure relief valve is not exceeded under simultaneous conditions of rated flow through the pressure relief valve and maximum possible flow through the process lateral (see Figure 11).

2.8 Pressure Relief Valve Inlets

Inlets of pressure relief valves should not be located where excessive turbulence is present (see Figure 12). The branch entrance where the lateral outlet nozzle joins the main run should have a well rounded, smooth corner that minimizes turbulence and resistance to flow.

3. Discharge Piping

3.1 General Requirements

The discharge piping installation must provide for proper valve performance and adequate drainage, with consideration given to the effect of back pressure on the particular design of the valve. Consideration should be given to the type of discharge system used, the design of the pressure relief valve, and the set pressure relationship of the valves in the system.

Auto-refrigeration during discharge can severely cool the outlet of the valve and the discharge piping. Materials must be selected to avoid sensitivity to brittle fracture.

3.2 Safe Disposal of Relieving Fluids

For a comprehensive source of information about the safe disposal of various relieving fluids, see API RP 521.

3.3 Back Pressure Limitations and Sizing of Pipe

When discharging piping is designed, the combined effect of superimposed and built-up back pressure on the operating characteristics of the valves should be considered. The discharge piping system should be designed so that the amount of back pressure does not exceed the value established by the pressure relief valve that has the lowest back pressure limitation in the system.

Fig.9 - Typical Pilot Operated Pressure Relief Valve Installation

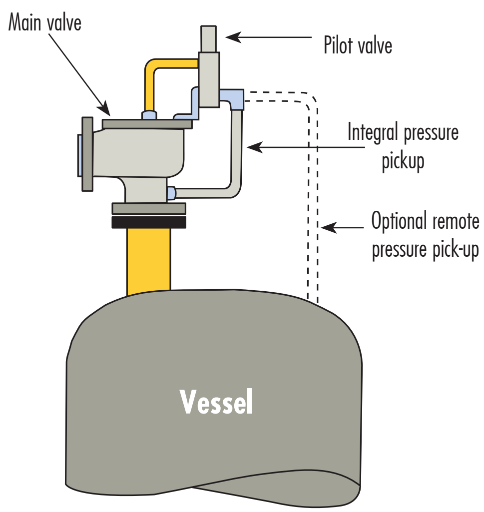
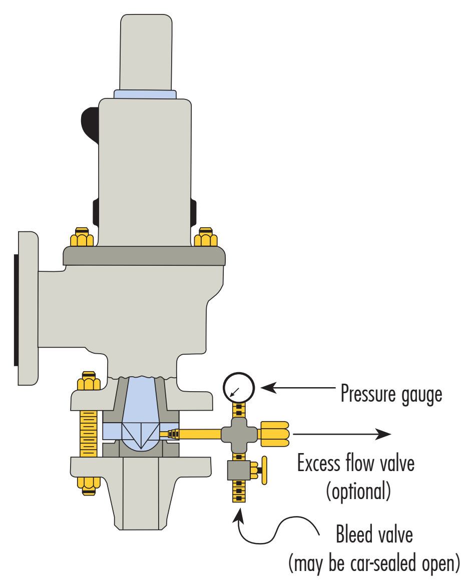


Fig. 10 - Typical Rupture Disk Assembly Installed in Combination with a Pressure Relief Valve



In every case, the nominal discharge pipe should be as large as or larger than the nominal size of the pressure relief valve outlet flange; in the case of long discharge piping, the pipe size must sometimes be much larger.

Sizing of discharge piping for vapor or gas service is covered in API RP 521.

3.4 Stresses that Originate from Discharge Piping

The effects of stresses that originate from discharge piping are discussed in 2.3.1 and 2.3.2.

4. Bonnet or Pilot Vent Piping

4.1 Conventional Valves

Following are two types of conventional valves:

a) Closed Bonnet. The normal closed bonnet valve requires no special precautions except that it should be properly chosen for the particular conditions of installation.

b) Vented Bonnet. The location of the valve and the design of the discharge piping system are the main considerations in venting the valve bonnets into the atmosphere.

Considerations must be given to the qualities of the fluids that are discharged to the atmosphere through the bonnet vents, since some fluids may have hazardous properties.

4.2 Balanced Bellows Valves

The bonnets of bellows seal valves should always be vented to ensure proper functioning of the valve and to provide a telltale in the event of a bellows failure. The vent must be designed to avoid plugging caused by ice, insects, or other obstructions. When the fluid is flammable, toxic, or corrosive, the bonnet vent should be piped to a safe location.

4.3 Balanced Piston Valves

The bonnets of balanced piston seal valves should always be vented because of the flow past the piston. Under conditions of normally low back pressure, the flow is small and may possibly be safely discharged to the atmosphere; however, when the valve is operating, the flow will increase as a result of the higher body pressure. This factor must be considered in the design of the bonnet venting.

4.4 Pilot Operated Valves

The pilot is normally vented to the atmosphere under operating conditions, since the discharge during operation is slight. When vent discharge to the atmosphere is not permissible, the pilot should be vented through a supplementary piping system to a safe location. When vent piping is designed, precautions should be taken to avoid the possibility of back pressure on the pilot unless the pilot is of the balanced design.

6. Valve Location and Position

6.1 Inspection and Maintenance

For optimum performance, pressure relief valves must be serviced and maintained regularly. Details for the care and servicing of specific valves are provided in the Manufacturer's maintenance bulletins and in Chapter XVI of the *API Guide for Inspection of Refinery Equipment.*

Pressure relief valves should be located for easy access and removal so that servicing can be properly handled. Sufficient working space should be provided around the valve.

Fig. 11 - Recommended Typical Installation to Avoid Process Laterals Connected to Pressure Relief Valve Inlet

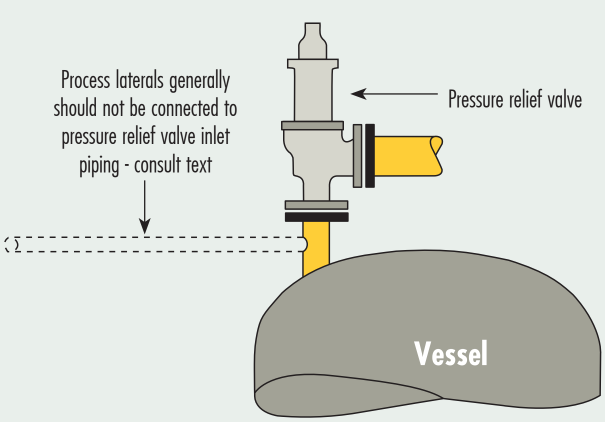
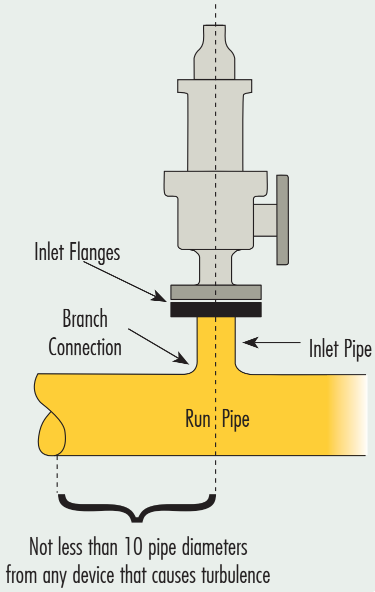


Fig. 12 - Typical Installation Avoiding Excessive Turbulence at Pressure Relief Valve Inlet



6.2 Proximity to Pressure Source

The Pressure relieving device should normally be placed close to the protected equipment so that the valve will be "fed" properly under flowing conditions. For example, where protection of a pressure vessel is involved, mounting the pressure relieving device directly on a nozzle on top of the vessel is strongly recommended; however, on installations that have pressure fluctuations at the pressure source (as with valves on the compressor discharge) that peak close to the set pressure of the valve, the pressure relief valve should be located farther from the source and in a more stable pressure region.

6.3 Proximity to Other Valve Equipment

The valves should be mounted downstream from any of the devices in 6.3.1 through 6.3.3 at a distance sufficient to avoid turbulence (see Figure 12).

6.3.1 Reducing Stations

Pressure relief valves are often used to protect piping downstream from pressure reducing valves, where turbulence usually occurs. Other valves and appurtenances in the system may also be effective in disturbing the flow. This condition cannot be evaluated readily, but turbulence at valve inlets tends to generate instability.

6.3.2 Orifice Plate and Flow Nozzle

Proximity to orifice plates and flow nozzles may cause adverse operation of the pressure relief valves.

6.3.3 Other Valves and Fittings

The use of other fittings, such as elbows, may create turbulent areas that could result in adverse performance of pressure relief valves.

6.4 Mounting Position

Pressure relief valves should be mounted in a vertical upright position. Installing a pressure relief valve in other than a vertical upright position will adversely affect its operation. The valve Manufacturer should be consulted about any other mounting position, since mounting a pressure relief valve in other positions may cause a shift in the set pressure and a reduction in the degree of seat tightness.

6.5 Test or Lifting Levers

Test or lifting levers should be provided on pressure relief valves as required by the applicable code. Where simple levers are provided, they should hang down, and the lifting fork must not contact the lifting nuts on the valve spindle (see Figure 13, Panel A). Uploads caused by the lifting mechanism bearing on the spindle will cause the valve to open below the set pressure.

7. Bolting and Gasketing

7.1 Care in Installation

Before a pressure relief valve is installed, the flanges on the valve and the mounting nozzle should be thoroughly cleaned to remove any foreign material that may cause leakage. Where valves are too heavy for ready lifting by hand, the use of proper handling devices will avoid damage to the flange gasket facing. Ring joint and tongue and groove facing should be handled with extreme care so that the mating sections are not damaged.

7.2 Proper Gasketing and Bolting for Service Requirements

The gasket used must be dimensionally correct for the specific flange, and must fully clear the valve's inlet and outlet openings.

Gaskets, flange facings, and bolting should meet the service requirements for the pressure and temperature involved. This information can be obtained by referring to other national standards and to Manufacturers' technical catalogs.

When a rupture disk device is installed in the pressure relieving system, the flange gasket material and bolting loads may be critical. The disk Manufacturer's instructions should be followed for proper performance.

8. Multiple Pressure Relief Valves with Staggered Settings

8.1 Advantages of Multiple Valves

In many instances, valves are sized to handle the total quantity of fluid that results from a maximum emergency condition; however, during mild system upsets, only a fraction of that amount is discharged through the valve. If the fluid volume under the valve is insufficient to sustain the flow, the valve operation will be cyclic and will result in poor performance. The valve's ability to reseat tightly may be affected. This type of service condition can exist in a pressure reducing station where the requirement for a pressure relief valve is based on the wide open failure of a reducing valve, but under conditions of lesser flow, the pressure relief valve works only at partial capacity.

When capacity variations of the foregoing types are frequently encountered in normal operation, the use of multiple smaller pressure relief devices with staggered settings is recommended. With this arrangement, the pressure relief valve with the lowest setting will be capable of handling minor upsets, and additional valves will be put in operation as the capacity requirement increases.

8.2 Code Requirements for Staggered Settings

For ASME Code applications, one pressure relief device must be set at or below the maximum allowable working pressure of the protected vessel. Additional devices may be set to open at higher pressures, but in no case except under fire conditions should the setting be more than 105% of the maximum allowable working pressure.

When a pressure vessel is exposed to fire or another unexpected source of external heat, any supplemental pressure relieving devices may be set to open at a pressure not more than 110% of the maximum allowable working pressure of that vessel.

9. Preinstallation, Handling, and Inspection

9.1 Storage and Handling of Pressure Relief Valves

Because cleanliness is essential to the satisfactory operation and tightness of a pressure relief valve, precautions should be taken to keep out all foreign materials. Valves should be closed off properly at both inlet and outlet flanges. Particular care should be taken to keep the valve inlet absolutely clean. Valves should preferably be stored indoors or in a location where dirt and other forms of contamination are at a minimum. Valves should not be thrown on a pile or placed on the bare ground while they await installation.

Valves should be handled carefully and should not be subjected to shocks. If attention is not paid to this point, considerable internal damage or misalignment can result, and seat tightness may be adversely affected.

9.2 Inspection and Testing of Pressure Relief Valves

The conditions of all pressure relief valves should be visually inspected before installation. The Manufacturer's instruction manuals should be consulted for details relating to the specific valve. Caution should be taken to ensure that all protective material on the valve flanges and any extraneous materials inside the valve body and nozzle are completely removed. Bonnet shipping plugs must be removed from balanced pressure relief valves. The inlet surface must be cleaned, since foreign materials clinging to the inside of the nozzle will be blown across the seats when the valve is operated. Some of these materials may damage the seats or get trapped between the seats in such a way that they cause leakage. Valves should be tested before installation to confirm their opening pressure setting.

9.3 Inspection of Rupture Disk Devices

All rupture disk devices should be thoroughly inspected before installation. The Manufacturer's instruction manuals should be followed with respect to the specific disk. The seating surfaces of the rupture disk holder must be clean, smooth, and undamaged.

Rupture disks should be checked for physical damage to the seating surfaces or the prebulged disk area. Damaged or dented disks should not be used. The safety heads of bolted construction should be checked for proper torque as recommended by the Manufacturer.

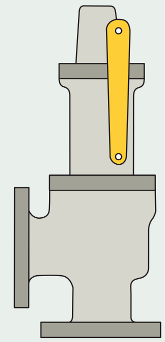
On reverse buckling disks that have knife blade assemblies, the knife blades should be checked for physical damage and sharpness. Nicked or dull blades must not be refurbished or replaced.

9.4 Inspection and Cleaning of Systems Before Installation

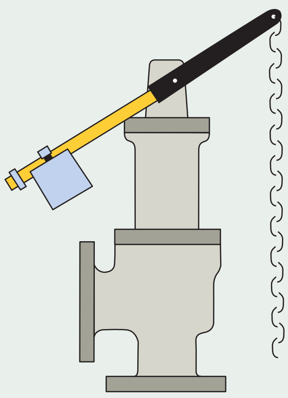
Because foreign materials that pass into and through pressure relief valves are damaging, the systems on which the valves are tested and finally installed must also be inspected and cleaned. New systems in particular are prone to contain welding beads, pipe scale, and other foreign objects that inadvertently get trapped during construction and will destroy the seating surface when the valve opens. Wherever possible, the system should be thoroughly purged before the valve is installed.

The valve should be isolated during pressure testing of the system, either by blanking or closing a stop valve.

Fig. 13 - Typical Positions for Pressure Relief Valve Lifting Lever



Panel A: Remote operation not required



Panel B: Counterbalanced for remote operation

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Acetaldehyde		X			X	X
Acetamide	X	X	X	X	X	X
Acetic acid		X				X
Acetic anhydride		X		X	X	X
Acetone		X				X
Acetophenone		X				X
Acetyl acetone		X				X
Acetyl chloride			X			X
Acetylene	X	X	X	X	X	X
Acetylene tetrabromide		X	X	X		X
Air	X	X	X	X	X	X
Alkazene			X			X
Amines-mixed		X		X		X
Ammonia, gas	X	X		X	X	X
Ammonia, liquid (anhydrous)	X	X		X	X	X
Ammonium hydroxide	X	X		X	X	X
Amyl alcohol	X	X	X	X		X
Amyl borate	X		X	X		X
Amyl chloride			X			X
Amyl chloronaphthalene			X			X
Amyl naphthalene			X			X
Anhydrous ammonia	X	X		X	X	X
Anhydrous hydrazine		X		X		X
Anilene		X				X
Argon	X	X	X	X	X	X
Asphalt	X		X	X		X
ASTM oil	X		X			X
Automatic transmission fluid	X		X	X		X
Beer	X	X	X	X	X	X
Beet sugar liquors	X	X	X	X	X	X
Benzaldehyde		X			X	X
Benzene			X			X
Benzochloride		X	X			X
Benzoic acid		X	X			X
Benzophenone		X	X			X
Benzyl alcohol		X	X	X	X	X
Benzyl benzoate			X			X
Benzyl chloride			X			X
Bleach liquor		X	X	X	X	X
Boric acid	X	X	X	X	X	X
Brake fluid (non-petroleum)		X		X		X
Bromine			X			X
Bromobenzene			X			X
Bromochloro trifluoroethane			X		X	X
Bunker oil	X		X		X	X
Butadiene (monomer)			X			X
Butane	X		X	X		X
Butane, 2, 2-dimethyl	X		X	X		X
Butane, 2, 3-dimethyl	X		X	X		X
Butanol (butyl alcohol)	X	X	X	X	X	X
1-Butene, 2-ethyl	X		X			X
N-butyl acetate		X				X
Butyl alcohol	X	X	X	X	X	X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Butyl amine or N-butyl amine		X				X
N-butyl benzoate		X	X			X
N-butyl butyrate		X	X			X
Butylene	X		X			X
Butyraldehyde		X				X
Butyric acid		X	X			X
Calcium acetate	X	X		X		X
Calcium bisulfite	X	X	X	X		X
Calcium carbonate	X	X	X	X	X	X
Calcium chloride	X	X	X	X	X	X
Calcium cyanide	X	X		X	X	X
Calcium hydroxide	X	X	X	X	X	X
Calcium hypochlorite	X	X	X	X	X	X
Calcium nitrate	X	X	X	X	X	X
Calcium phosphate	X	X	X	X	X	X
Cane sugar liquors	X	X	X	X	X	X
Carbolic acid phenol		X	X			X
Carbon bisulfide			X	X		X
Carbon dioxide	X	X	X	X	X	X
Carbon disulfide			X			X
Carbon monoxide	X	X	X	X	X	X
Carbon tetrachloride	X		X			X
Carbonic acid	X	X	X	X	X	X
Castor oil	X	X	X	X	X	X
Cetane (hexadecane)	X		X	X		X
Chloracetic acid		X				X
Chlorinated salt brine			X			X
Chlorine, dry			X	X		X
Chlorine dioxide			X			X
Chloroacetone		X				X
Chlorobenzene			X			X
Chlorobromo methane		X	X			X
Chlorobutadiene			X			X
Chlorododecane			X			X
Chloroform			X			X
O-chloronaphthalene		X				X
Chlorotoluene		X				X
Chlorox™	X	X	X	X		X
O-chlorphenol			X			X
Chrome plating solutions		X	X		X	X
Citric acid	X	X	X	X	X	X
Corn oil	X		X		X	X
Cottonseed oil	X	X	X	X	X	X
Crude oil	X		X			X
Cyclohexane	X		X			X
Cyclohexanol	X		X	X		X
Cyclohexanone		X				X
Decalin			X			X
Decane	X		X		X	X
Denatured alcohol	X	X	X	X	X	X
Detergent, water solution	X	X	X	X	X	X
Dexron™	X		X	X		X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Diacetone		X		X		X
Diacetone alcohol		X		X		X
Dibenzyl ether		X				X
Dibenzyl sebacate		X	X			X
Dibromoethyl benzene			X			X
Dibutyl phthalate		X			X	X
Dibutyl sebacate		X	X		X	X
O-dichlorobenzene			X			X
P-dichlorobenzene			X			X
Dichloro-butane	X		X			X
Diesel oil	X		X			X
Di-ester synthetic lubricants	X		X			X
Diethylamine	X	X		X		X
Diethyl sebacate	X	X	X		X	X
Diethylene glycol	X	X	X	X	X	X
Diisobutylene	X		X			X
Diisopropyl ketone		X		X	X	X
Dimethyl formamide (DMF)	X	X				X
Dimethyl phthalate		X	X			X
Dioctyl phthalate		X	X			X
Dioctyl sebacate		X	X			X
Dioxane		X				X
Dioxolane		X				X
Dipentene	X		X			X
Diphenyl	X	X	X	X	X	X
Diphenyl oxides	X	X	X	X	X	X
Dowtherm, A			X			X
Dowtherm, E			X			X
Epichlorohydrin			X			X
Ethane	X		X	X		X
Ethanol		X		X	X	X
Ethanol amine	X	X		X	X	X
Ethyl acetate-organic ester		X			X	X
Ethyl acetoacetate		X			X	X
Ethyl acrylate		X			X	X
Ethyl alcohol	X	X		X	X	X
Ethyl benzene			X			X
Ethyl benzoate			X			X
Ethyl bromide	X		X			X
Ethyl cellosolve		X				X
Ethyl cellulose	X	X		X	X	X
Ethyl chloride	X		X			X
Ethyl chlorocarbonate		X	X			X
Ethyl chloroform, ATE		X				X
Ethycyclopentane	X		X			X
Ethylene chloride			X			X
Ethylene chlorohydrin		X	X	X		X
Ethylene diamine	X	X		X	X	X
Ethylene dibromide			X			X
Ethylene dichloride			X			X
Ethyl formate		X	X	X		X
Ethylene glycol	X	X	X	X	X	X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Ethylene trichloride			X			X
Ethyl hexanol	X	X	X	X	X	X
Ethyl mercaptan			X			X
Ethyl oxalate		X	X			X
Ethyl pentachlorobenzene		X				X
Ethyl silicate	X	X	X	X		X
Fatty acids	X		X	X		X
Ferric chloride	X	X	X	X	X	X
Ferric nitrate	X	X	X	X	X	X
Formaldehyde		X			X	X
Freon, 11™	X		X			X
Freon, 12™	X		X	X		X
Freon, 13™	X	X	X	X		X
Freon, 13B1™	X	X	X	X		X
Freon, 14™	X	X	X	X		X
Freon, 22™	X	X		X		X
Freon, 31™				X		X
Freon, 32™				X		X
Freon, 112™	X		X	X		X
Freon, 113™	X		X	X		X
Freon, 114™	X	X	X	X		X
Fuel oil	X		X	X		X
Fuel oil, acidic	X		X	X	X	X
Fuel oil, #6	X		X		X	X
Fumaric acid	X	X	X	X	X	X
Furfural		X				X
Furfuraldehyde		X				X
Furfurl alcohol		X				X
Furyl carbinol		X				X
Gallic acid	X	X	X	X		X
Gasoline	X		X	X		X
Gelatin	X	X	X	X	X	X
Glucose	X	X	X	X	X	X
Glycerine-glycerol	X	X	X	X	X	X
Glycols	X	X	X	X		X
Halothane			X			X
Halowax oil			X			X
Helium	X	X	X	X	X	X
N-Heptane	X		X	X		X
N-Hexaldehyde		X		X	X	X
N-Hexane	X		X	X		X
N-Hexane-1	X		X	X		X
Hexyl alcohol	X		X	X		X
Hydraulic oil, petroleum base	X		X	X	X	X
Hydrazine	X	X		X	X	X
Hydrobromic acid		X	X			X
Hydrocarbons	X		X	X		X
Hydrochloric acid to 158°F	X	X	X	X		X
Hydrocyanic acid	X	X	X	X		X
Hydrofluosilicic acid	X	X	X	X		X
Hydrogen gas	X	X	X	X		X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Hydrogen peroxide (1)			X			X
Hydrogen sulfide		X		X		X
Hydyne	X	X		X		X
Hypochlorous acid		X	X	X		X
Iodine	X	X	X	X		X
Isobutyl alcohol	X	X	X	X	X	X
Iso-butyl N-butyrate		X	X			X
Isododecane	X		X	X		X
Isooctane	X		X	X		X
Isophorone (ketone)		X				X
Isopropanol	X	X	X	X	X	X
Isopropyl acetate		X				X
Isopropyl alcohol	X	X	X	X	X	X
Isopropyl chloride			X			X
Isopropyl ether	X					X
JP-3 to JP-10			X			X
Kerosene	X		X	X		X
Lactic acid			X			X
Lactones		X				X
Linoleic acid	X		X	X	X	X
Linseed oil	X		X		X	X
Liquid petroleum gas (LPG)	X		X	X		X
Lubricating oils	X		X			X
Lye solutions	X	X	X	X	X	X
Magnesium hydroxide	X	X	X	X		X
Malathion™	X		X			X
Maleic acid			X			X
Maleic anhydride		X				X
Malic acid	X	X	X	X	X	X
Mesityl oxide (ketone)		X				X
Methane	X		X	X		X
Methanol	X	X		X		X
Methyl acetate		X		X		X
Methyl acetoacetate		X			X	X
Methyl acrylate		X		X		X
Methylacrylic acid		X		X		X
Methyl alcohol	X	X		X	X	X
Methyl benzoate			X			X
Methyl bromide	X		X			X
Methyl butyl ketone		X				X
Methyl carbonate			X			X
Methyl chloride			X			X
Methyl chloroformate			X			X
Methylcyclopentane			X			X
Methylene chloride			X			X
Methyl ether	X		X		X	X
Methyl ethyl ketone (MEK)		X				X
Methyl formate		X		X		X
Methyl isopropyl ketone		X				X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Methyl mercaptan		X				X
N-methyl-2-pyrrolidone		X				X
Methyl oleate		X				X
Methyl salicylate		X				X
Milk	X	X	X	X	X	X
Mineral oils	X		X	X	X	X
Mono bromobenzene			X	X		X
Monochlorobenzene			X			X
Mono ethanolamine		X			X	X
Monomethylaniline		X	X	X		X
Monomethyl hydrazine	X	X		X		X
Monovinyl acetylene	X	X	X	X	X	X
Naptha	X		X			X
Napthalene				X		X
Napthenic acid	X		X			X
Natural gas	X		X	X		X
Neon	X	X	X	X	X	X
Nickel acetate	X	X		X		X
Nickel chloride	X	X	X	X	X	X
Nickel salts	X	X	X	X	X	X
Nickel sulfate	X	X	X	X	X	X
Nitrobenzene		X	X			X
Nitroethane		X		X		X
Nitrogen	X	X	X	X	X	X
Nitromethane		X				X
Nitropropane		X				X
Nitrous oxide	X					X
Octadecane	X		X	X		X
N-octane	X		X			X
Octyl alcohol	X		X	X	X	X
Oleic acid			X			X
Olive oil	X	X	X	X		X
Orthochloro ethylbenzene			X			X
Ortho-dichlorobenzene			X			X
Oxalic acid	X	X	X	X	X	X
Oxygen	X	X	X	X	X	X
Palmitic acid	X	X	X	X		X
Para-dichlorobenzene			X			X
Peanut oil	X	X	X	X	X	X
Pentane	X		X	X		X
N-pentane	X		X	X		X
Perchloroethylene	X		X			X
Petrolatum	X		X	X		X
Petroleum oil			X	X		X
Phenol			X			X
Phenylbenzene			X			X
Phenylhydrazine		X	X			X
Phosphoric acid to 158°F		X	X			X
Phosphorous trichloride		X	X			X
Pinene	X		X			X
Pine oil	X		X			X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Plating solutions		X	X			X
Potassium acetate	X	X		X		X
Potassuim chloride	X	X	X	X	X	X
Potassium cupro cyanide	X	X	X	X	X	X
Potassium cyanide	X	X	X	X	X	X
Potassium dichromate	X	X	X	X	X	X
Potassium nitrate	X	X	X	X	X	X
Potassium salts	X	X	X	X	X	X
Potassium sulphate	X	X	X	X	X	X
Potassium sulphite	X	X	X	X	X	X
Propane	X		X	X		X
Propane propionitrile	X		X	X		X
Propyl acetate		X		X		X
N-propyl acetone		X				X
Propyl alcohol	X	X	X	X	X	X
Propylene			X			X
Propylene oxide		X				X
Propyl nitrate		X		X		X
Rapeseed oil	X	X	X	X		X
Salicylic acid	X	X	X	X	X	X
Sea (salt) water	X	X	X	X	X	X
Silicone oils	X	X	X	X		X
Silver nitrate	X	X	X	X	X	X
Soap solutions	X	X	X	X	X	X
Sodium acetate	X	X		X		X
Sodium bicarbonate	X	X	X	X	X	X
Sodium borate	X	X	X	X	X	X
Sodium carbonate	X	X	X	X	X	X
Sodium bisulfate or bisulfite	X	X	X	X	X	X
Sodium chloride	X	X	X	X	X	X
Sodium cyanide	X	X		X	X	X
Sodium hydroxide, 3 molar	X	X	X	X	X	X
Sodium hypochlorite	X	X	X	X	X	X
Sodium metaphosphate	X	X	X	X		X
Sodium nitrate	X	X		X		X
Sodium perborate	X	X	X	X	X	X
Sodium peroxide	X	X	X	X		X
Sodium phosphate	X	X	X	X		X
Sodium silicate	X	X	X	X		X
Sodium sulphate	X	X	X	X	X	X
Sodium sulphide and sulfite	X	X	X	X	X	X
Sodium thiosulfate	X	X	X	X	X	X
Soybean oil	X	X	X	X	X	X
Stannic chloride	X	X	X		X	X
Steam		X				X
Stearic acid	X	X		X	X	X
Stoddard solvent	X		X	X		X
Styrene			X			X
Sucrose solutions	X	X	X	X	X	X

O-Ring Selection

O-Ring Selection Tables - Media

Fluid	Nitrile	Ethylene Propylene	Fluorocarbon	Neoprene	Silicone	Teflon
Sulfur			X	X		X
Sulfur chloride			X			X
Sulfur dioxide		X			X	X
Sulfuric acid to 158°F	X	X	X	X	X	X
Sulfurous acid	X	X	X	X		X
Sulfur trioxide, dry		X	X	X	X	X
Tar, bituminous	X	X	X	X	X	X
Tartaric acid	X	X	X	X	X	X
Terpineol	X		X			X
Tertiary butyl alcohol	X	X	X	X	X	X
P-tertiary butyl catechol		X	X	X		X
Tertiary butyl mercaptan			X			X
Tetrabromoethane			X			X
Tetrabutyl titaniate	X	X	X	X		X
Tetrachoroethane			X			X
Tetrachloroethylene			X			X
Tetrahydrofuran		X				X
Tetralin			X			X
Therminol VP-1, 44, 55, 60, 66			X			X
Toluene			X			X
Toluene diisocyanate		X				X
Triacetin	X	X		X		X
Triaryl phosphate		X	X			X
Tributoxyethyl phosphate		X	X			X
Tributyl mercaptan			X			X
Tributyl phosphate		X				X
Trichloroacetic acid	X	X				X
Trichloroethane			X			X
Trichloroethylene			X			X
Tricresyl phosphate		X	X			X
Triethanol amine		X		X		X
Trifluoroethane			X			X
Trioctyl phosphate		X	X			X
Tripoly phosphate		X	X			X
Tung oil, china wood oil	X		X	X		X
Turpentine	X		X			X
Varnish	X		X			X
Vegetable oil	X		X			X
Vinegar	X	X		X		X
Water	X	X	X	X	X	X
Whiskey and wines	X	X	X	X	X	X
Xylene			X			X
Xylol			X			X
Xenon	X	X	X	X	X	X
Zinc acetate	X	X		X		X
Zinc chloride	X	X	X	X		X
Zinc salts	X	X	X	X	X	X
Zinc sulfate	X	X	X	X	X	X

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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 K_d 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 VS.5 are in agreement with those published in API RP 520 for determining the required **Consolidated** valve series. On page VS.7, the equations of page VS.6 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 back pressure 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 K_d 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.

Computer Sizing Program Information

Dresser Measurement has a computer sizing program 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.

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 back pressure on conventional and balanced bellows valves. See Figure 3 for balanced bellows valve corrections and Figure 2 for non-bellows valves. Types 1900-30D-1 and E-1 are unbalanced bellows valves and should not be used for any back pressure applications.

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 back pressure for balanced bellows valves (only when used on liquid applications, see Figure 3.) Types 1900-30D-1 and E-1 are unbalanced bellows valves and should not be used for any back pressure applications (no correction for liquid conventional valves.)

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 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, K_n = 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 of 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	P_1 = 1.16(MAWP) + 14.7
MAWP higher than 1.72 barg	P_1 = 1.16(MAWP) + 1.01
MAWP higher than 1.75 kg/cm^{2}g	P_1 = 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)

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

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

$$A_c = \frac{W}{51.5 \; K_d P_1 \; K_b}$$

VAPORS OR GASES
Volumetric Flow Rate Sizing

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

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

(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)

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

AIR
Volumetric Flow Rate Sizing

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

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

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 VIII 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)

$$A_c = \frac{W}{51.5 \; K \; P_1 \; K_b}$$

VAPORS OR GASES
Volumetric Flow Rate Sizing

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

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

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

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

K Factors (K 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 in^2)	.877	N/A
13900 (201 in^2 only)	.850	N/A
19000	.878	.673

ASME Sizing Formulas - Metric

ASME Section VIII 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/cm²a, K_u = 134.26

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

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

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 m^3/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/cm²a, 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/cm^2a and Q = liters/min, K_u = 0.841
If P_1 & P_2 = bara and Q = m^3/hr, K_u = 0.0509
If P_1 & P_2 = ka/cm^2a and Q = m^3/hr, K_u = 0.0504

AIR
Volumetric Flow Rate Sizing

(Q = Normal m^3/hr Flow Rate at 760 mm Hg at 0°C)

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

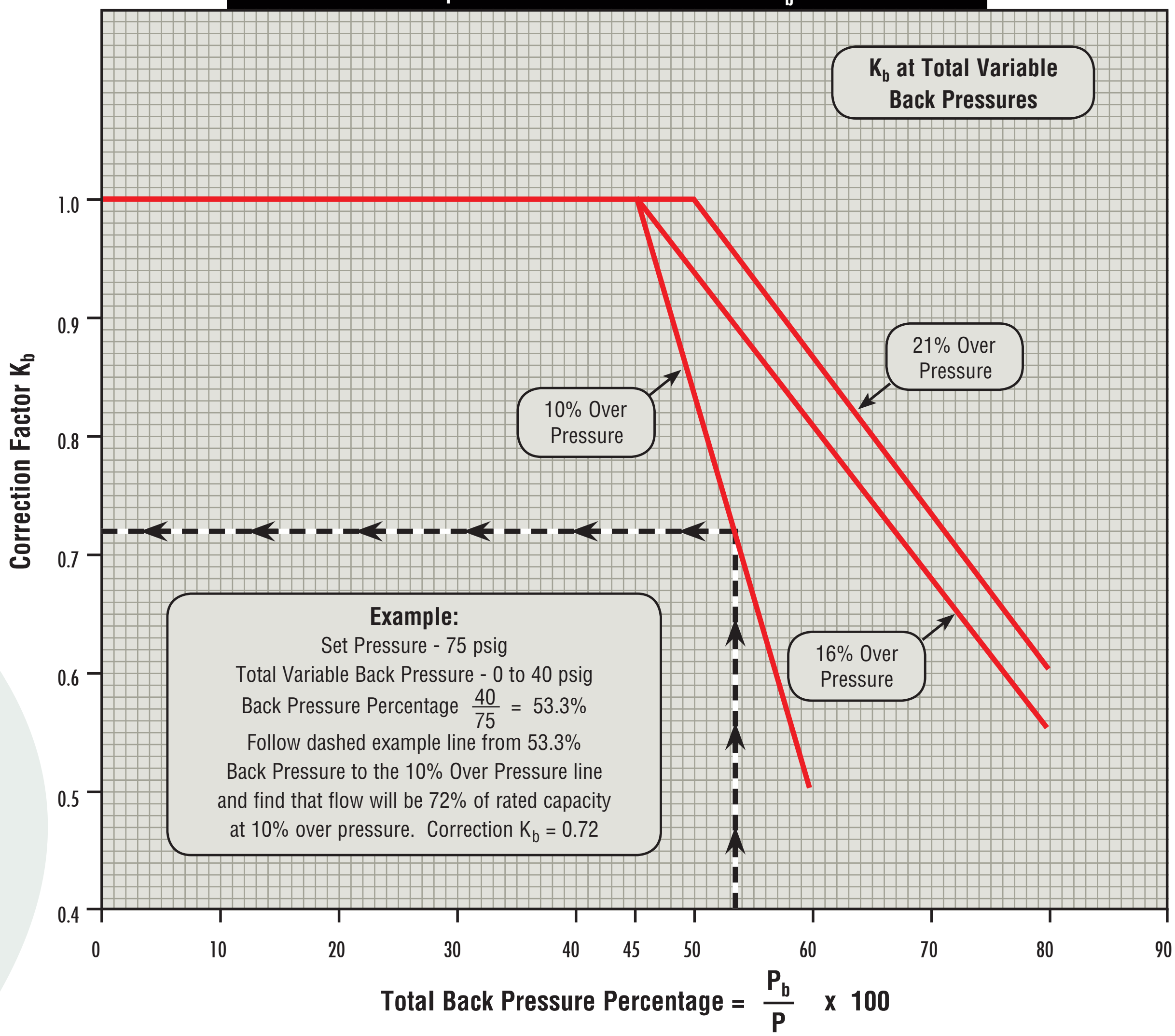
If P_1 = bara, K_u = 131.71
If P_1 = kg/cm²a, K_u = 134.26

K Factors (K 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 in^2)	.877	Not applicable
13900 (201 in^2 only)	.850	Not applicable
19000	.878	.673

Correction Factors

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



Correction Factors

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

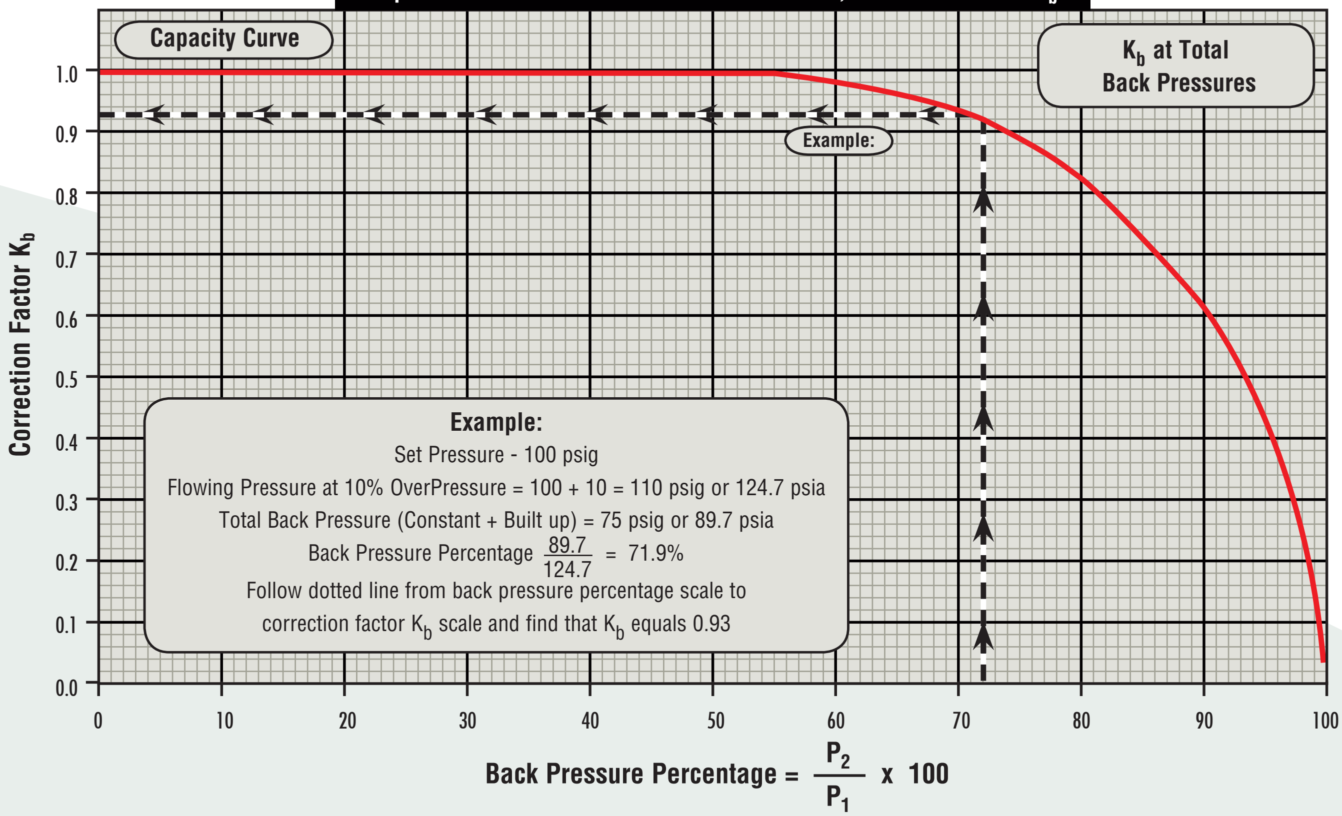
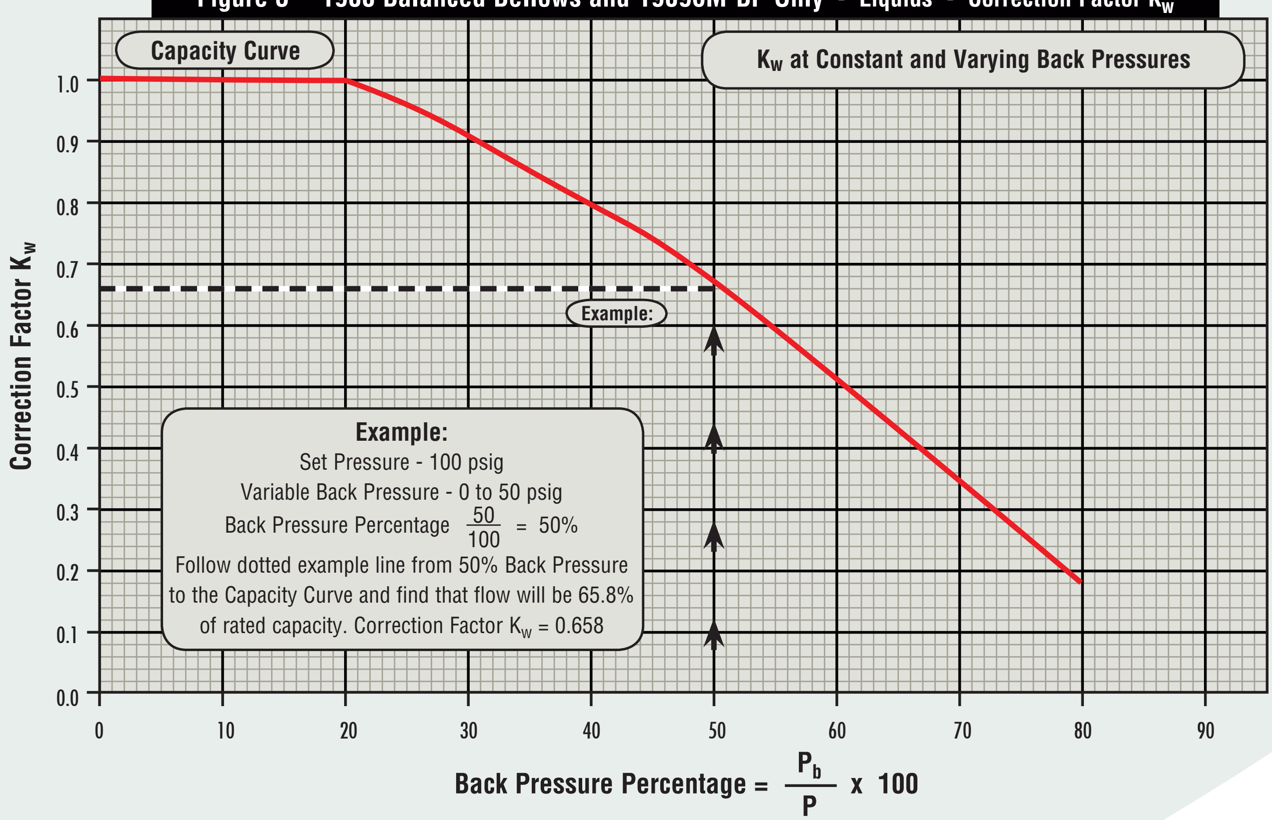


Figure 3 - 1900 Balanced Bellows and 19096M-BP Only - Liquids - Correction Factor K_w



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

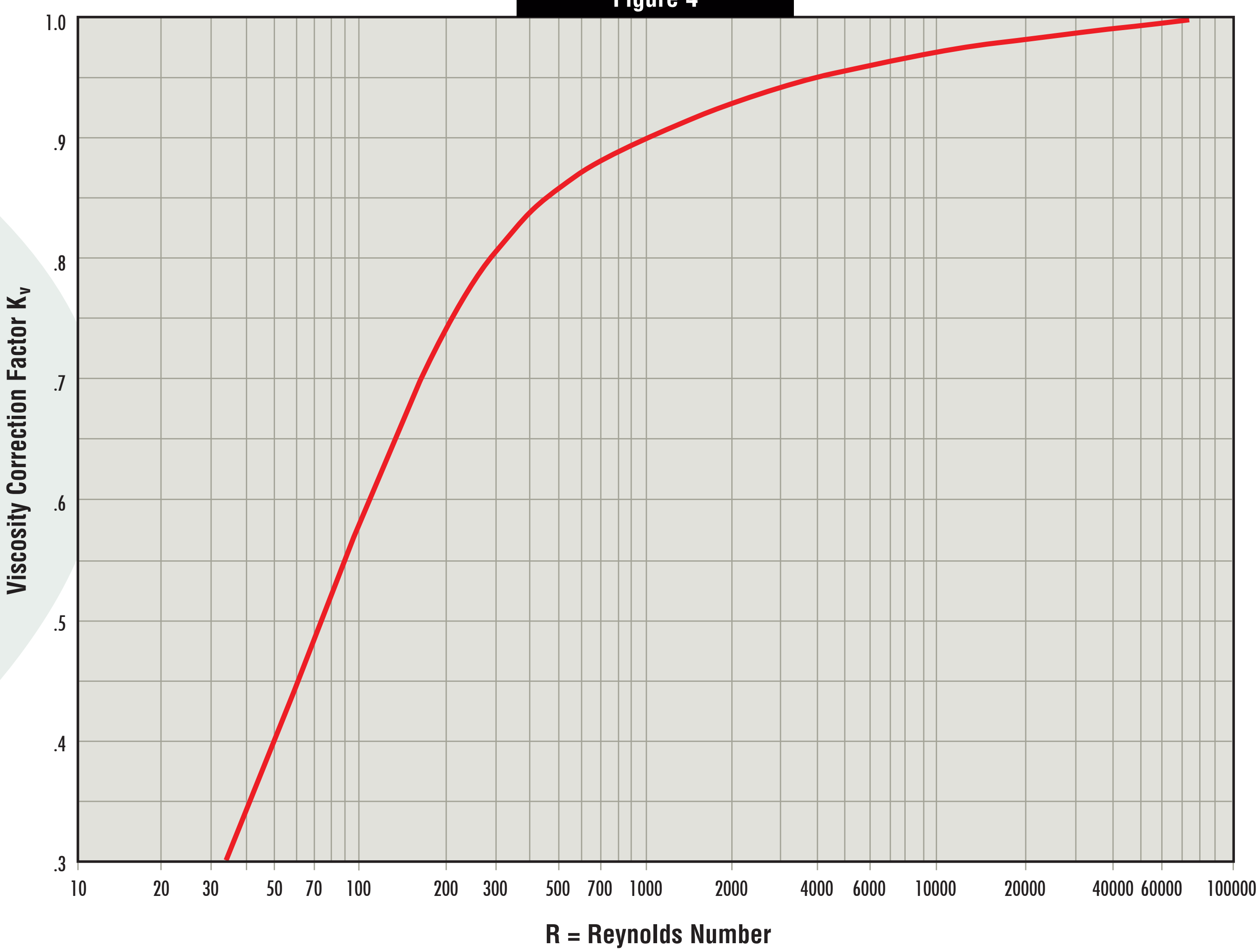
$$R = \frac{12{,}700 \times Q}{SSU \times \sqrt{A}}$$

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
- **Cp** = absolute viscosity at the flowing temperature (in centipoises)
- **A** = valve orifice discharge area (square inches)
- **SSU** = Saybolt 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	297	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*	MW	G* AIR = 1	G WATER = 1	G TEMP °F	BOILING POINT* °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

* 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 **	(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*	9 - 300	9 - 300
N/A	V	50.26	N/A	15 - 300
N/A	W	78.996	N/A	15 - 300

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

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

API Standard Orifice Areas - 2900

Table 7 - 2900 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 - 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

* 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*	15 - 900	15 - 1500

* 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) Actual (ASME) 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
1-1/2	19357L	.357	5 - 290
2	19567L	.567	5 - 290
1/2, 3/4, 1	19096M	.096	291 - 2000
3/4, 1	19126M	.126	291 - 2000
1	19226M	.226	291 - 2000
1-1/2	19357M	.357	291 - 1500
2	19567M	.567	291 - 1500
3/4	19096H	.096	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
1-1/2	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 Saturated Water Valve Sizing / Rupture Disk Combinations

Below is a copy of Appendix 11, Para. 11-2 and Flow Capacity Curve Fig. 11-2 from the ASME Code, Section VIII, which is used in determining valve relieving orifice areas required for saturated water service.

(a) Since it is realized that the saturated water capacity is configuration sensitive, the following applies only to those safety valves that have a nozzle type construction (throat to inlet area ration of 0.25 to 0.80 with a continuously contoured change) and have exhibited a coefficient K_d in excess of 0.90. No saturated water rating shall apply to other types of construction.

NOTE: The manufacturer, user and Inspector are all cautioned that for the following rating to apply, the valve shall be continuously subjected to saturated water. If, after initial relief the flow media changes to quality steam, the valve shall be rated as per dry saturated steam. Valves installed on vessels or lines containing steam-water mixture shall be rated on dry saturated steam.

(b) To determine the saturated water capacity of a valve currently rated under UG-131 and meeting the requirement of (a) above, refer to Fig. 5. Enter the graph at the set pressure of the valve, move vertically upward to the saturated water line and read horizontally the relieving capacity. This capacity is the theoretical, isentropic value arrived at by assuming equilibrium flow and calculated values for the critical pressure ratio.

Example of the method for sizing safety relief valves using this curve:

Fluid .... Saturated Water
Required Capacity..... 183,795 lb/Hr
Allowable Overpressure 10%
Set Pressure.............. 600 psig
Relieving Temperature .... 470°F

Calculations:

1. Consult Saturated Water Capacity Curve (Fig. 5) for capacity of one square inch of orifice area at given set pressure.

Capacity of one square inch = 84,000 lb/hr (at 600 psig set pressure)

2. Divide required capacity by the capacity of one square inch to get the required orifice area:

$$\frac{183{,}795}{84{,}000} = 2.188 \text{ sq. in.}$$

3. Therefore, in this case, an "L" orifice valve is required that has a relieving orifice (ASME) area of 3.317 square inches.

Two possibilities exist for sizing safety relief valves in conjunction with rupture disks at their inlet. First, the rupture disk has not been ASME certified in combination with the safety relief valve; second, the rupture disk has been ASME certified in combination with the safety relief valve.

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.

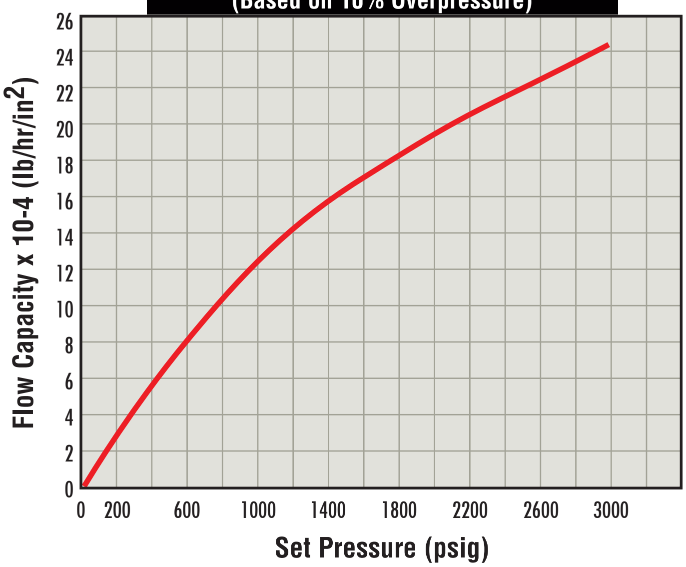
B) Rupture Disk is certified with the Safety Relief Valve K_c

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 VIII, paragraph UG-127.

Figure 5
Flow Capacity Curve for Rating Nozzle Type Safety Valves on Saturated Water (Based on 10% Overpressure)



Thermal Expansion / API Fire Sizing

Sizing Formula for Thermal Expansion of Trapped Liquids*

Flow rates for relieving devices protecting heat exchangers, condensers and coolers against thermal expansion of trapped liquids can be approximated by use of the following:

$$GPM = \frac{BH}{500\ GC}$$

Where:

GPM = Flow rate in U.S. gallons per minute at the flowing temperature.

B = Cubical expansion coefficient per degree Fahrenheit for the liquid at the expected temperature differential. It is best to obtain this information from the process design data: however, shown here are typical values for hydrocarbon liquids and for water:

	B
3° to 35° API gravity	0.0004
35° to 51° API gravity	0.0005
51° to 64° API gravity	0.0006
64° to 79° API gravity	0.0007
79° to 89° API gravity	0.0008
89° to 94° API gravity	0.00085
94° to 100° API gravity& lighter	0.0009
Water	0.0001

H = Total heat transfer rate, in BTU/hr. This should be taken as the maximum exchanger duty during operation.

G = Specific gravity referred to water = 1.00 at 60˚. Compressibility of liquid is usually ignored.

C = Specific heat in BTU/lb/˚F of the trapped fluid.

*Extracted from API RP 520 Part 1 - Design

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[a]

Bare vessel	1.0
Insulated vessel[b] (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[c]	1.0
Depressurizing and emptying facilities[d]	1.0

[a] 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.

[b] 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-ft^2-°F per inch at 1600°F and correspond to various thicknesses of insulation between 1 and 12 inches.

[c] No reduction is given due to the inherent variables present, e.g. freezing weather, high winds clogged systems, etc.

[d] No reduction is given due to the inherent variables present, e.g. inaccessibility of manual controls, timing of depressurization, direction of automated controls, etc.

API Fire Sizing

2) Determine Heat Absorption

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

Where:

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

F = Environment Factor (see Table A1)

A = Total wetted surface area in square feet

When adequate draining and fire fighting equipment do not exist,

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

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 A2 and Figure 6. For vertical vessels, use Table A2 and Figure 7.

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.

Table A2 - Total Surface Area Formulas*

SPHERE	$A = \pi D^2$
Vertical cylinder with flat ends	$A = \pi(DL + D^2/2)$
Vertical cylinder with elliptical ends	$A = \pi\ DL + 2.61D^2$
Vertical cylinder with hemispherical ends	$A = \pi(DL + D^2)$
Horizontal cylinder with flat ends	$A = \pi(DL + D^2/2)$
Horizontal cylinder with elliptical ends	$A = \pi\ DL + 2.61D^2$
Horizontal cylinder with hemispherical ends	$A = \pi(DL+D^2)$
$\pi = 3.1416$	

* 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.

4) Determination of orifice area requirements

Valves are to be sized in accordance with previously defined methods given in "Sizing Formulas" (see pages VS.5 - VS.7.)

API Fire Sizing Example (for vessels containing liquid hydrocarbons)

a) Sample Vessel Information

- Tank size: 6' dia. x 12' long, seam to seam, elliptical ends
- Mounting: Horizontal and 3' above ground
- Fluid: Propane
- Normal liquid level: 80% filled
- F factor: 1 (no insulation) (from Table A1)
- Operating Pressure: 100 psig
- Set Pressure: 250 psig
- Operating Pressure: 80°F
- Saturation Temperature: 142°F
- K: 1.13
- M (molecular weight): 44.09
- Z (compressibility factor): 1
- Latent Heat of vaporization: 110 BTU/lb

b) Solution

Wetted surface area:

Enter 80% filled on Figure 6 to determine that $F_{wp} = .67$

Select total surface area formula from Table A2 for a horizontal cylinder with elliptical ends.

$A = F_{wp} \times [\ \pi\ DL + 2.61\ D^2]$

$A = .67 \times (\pi \times 6 \times 12 + 2.61 \times 6 \times 6) = 214.5$ sq. ft.

Heat absorbed:

$Q = 21000\ FA^{0.82}$

$Q = 21000\ (1)\ 214.5^{0.82} = 1{,}713{,}940$ BTU/hr

Vapor generated:

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

$$W = \frac{1{,}713{,}940}{110} = 15{,}581 \text{ lb/hr}$$

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° (psia)
- Set pressure, P (psig)
- Operating temperature: T° (°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
$P_\circ$ = Normal Operating pressure, psia
$T_\circ$ = Normal operating temperature absolute (°R)
T_1 = Relieving temperature = T_1 - 460

NOTE: Use caution when T_1 exceeds 1100°F 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.

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

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

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

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:

$$T_1 = \frac{P_1 \times T_O}{P_O}$$

Where:

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

T_η = normal operating gas temperature, in degrees Rankine.

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

API Fire Sizing Example (for vessels containing gases)

a) Information required

- Tank size: 5' dia. x 12' long seam-to-seam, flat ends.
- Mounting: Horizontal and 2" above grade
- Fluid: ISOBUTANE VAPOR
- k: for isobutane = 1.094
- C: 327
- Operating pressure: 110 psig
- Set pressure: 150 psig
- Operating temperature: 160°F
- Relieving temperature: Not known
- T_ω: 1025°F

b) Solution

Calculate flowing pressure:

P_1 = 150 x 1.21 + 14.7 = 196.2 psia
$P_\circ$ = 110 + 14.7 = 124.7 psia
$T_\circ$ = 160 + 460 = 620° R absolute

Calculate flowing temperature:

$$T_1 = \frac{196.2 \times 620}{124.7} = 975^\circ \text{ R absolute}$$

Fahrenheit flowing temperature or gas temperature at P_1:

$$T_1 = 975 - 460 = 515^\circ\text{F}$$

API Fire Sizing

Determination of Relief Valve Factor F[1] :

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

$$F' = \frac{0.1406\,(1485 - 975)^{1.25}}{(327)\,(.95)\,(975)^{0.6506}}$$

$$F' = 0.012$$

Determination of exposed vessel surface area:

Select wetted surface area formula from Table A2 for "horizontal cylinder with flat ends":

$$A_S = \pi\,(DL + \frac{D^2}{2})$$

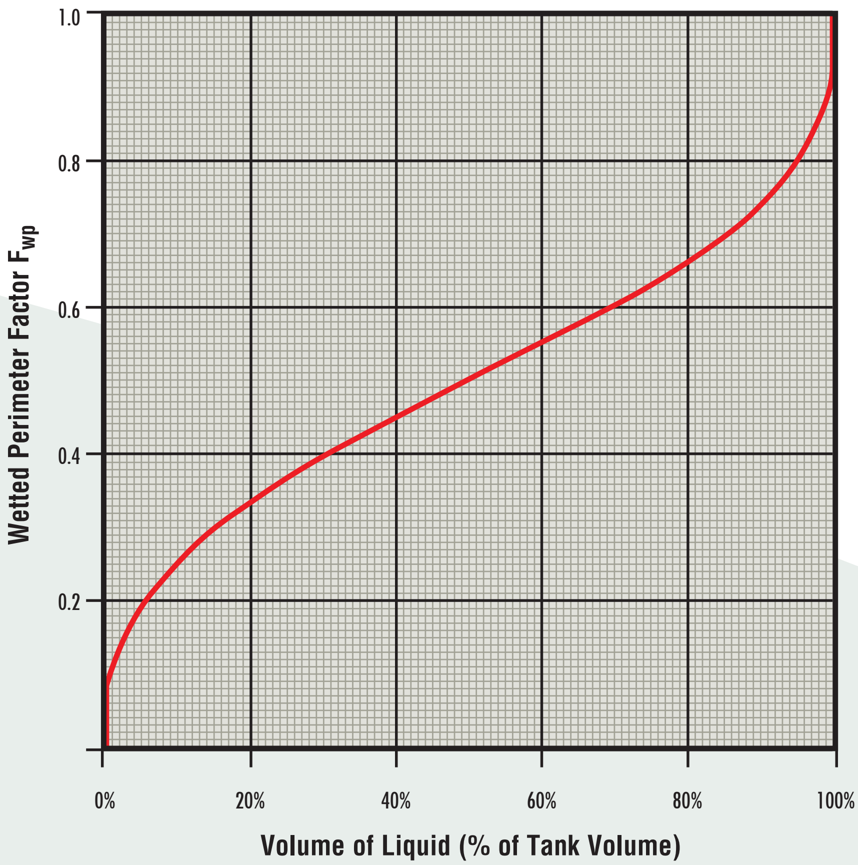
$$A_S = \pi\,(5 \times 12 + \frac{25}{2}) = 227.8 \text{ sq. ft.}$$

Now put values in the formula as follows:

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

$$A_C = \frac{.012 \times 227.8}{\sqrt{196.2}} = .1952 \text{ sq. in.}$$

API Fire Sizing



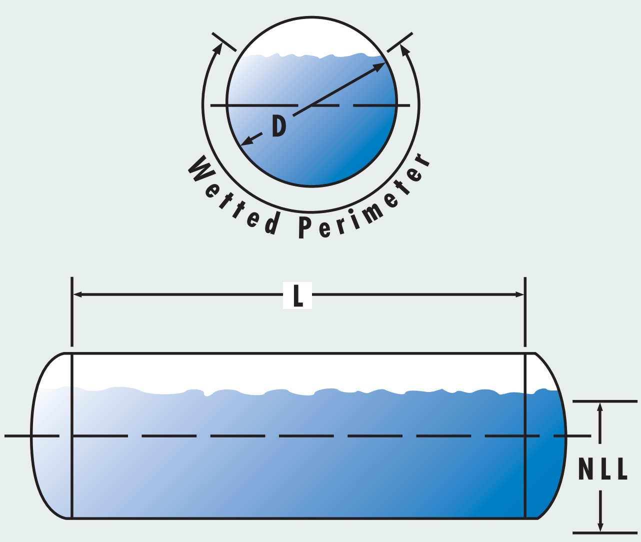


Figure 6 - Horizontal Tank

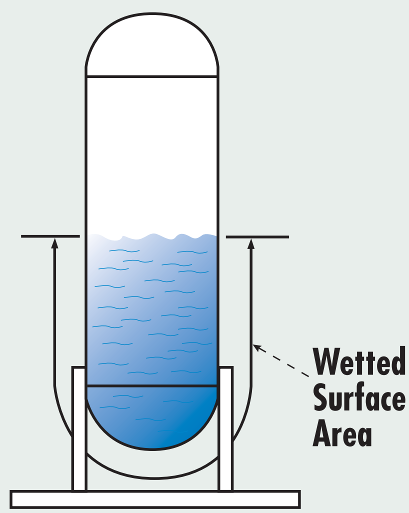


Figure 7 - Vertical Tank

Sizing for Multiple Fluids (Gas / Liquid) Per API (not a Diers Methodology)

To properly size for a mixed flow application per API guidelines, the following steps are required:

1. Determine the quantity of gas flow required.
2. Determine the quantity of liquid flow required.

NOTE: Refer to Page VS.3 for definition of formula symbols.

3. Use the applicable flow equations for each media to determine the orifice area required to flow each media.
4. The orifice area of valve selected must equal or exceed the sum of the flow area required for the gas and the flow area required for the liquid.
5. The proper selection would be an H orifice, which has an orifice area of 0.785 sq. in.
6. Due to the calculated orifice area required in the example, additional calculations should be considered utilizing the 1982 or 19000 Series formulas. This may allow a less expensive valve selection.

Example:

Given:

Set Pressure: 100 psig
Overpressure: 10%
Specific Gravity: 1 for Water
Rel. Temp: 68°F
Required Capacity: Air - 800 SCFM
Water - 35 GPM
Back Pressure: 0 psig

A. Solve for orifice area required for air capacity

$Q = 800$ SCFM
$P_1 = 100\,(1.1) + 14.7 = 124.7$
$T_a = 68 + 460 = 528$
$Z = 1$
$K_b = 1$
$K_d = .95$

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

$$A_c = \frac{60\,(800)\,0.0763)\,(22.978)\,(1)}{356\,(.95)\,(124.7)\,(5.3824)\,(1)}$$

$$A_c = 0.37$$

B. Solve for orifice area required for water capacity.

$Q = 35$ gpm
$G = 1$
$P = 100$
$P_b = 0$
$K_d = .62$
$K_v = 1$
$K_w = 1$

NOTE: Formula used in ASME - Liquid Trim

$$A_c = \frac{Q\,\sqrt{G}}{38\,K_d\,\sqrt{1.25\,P - P_b}\,K_v\,K_w}$$

$$A_c = \frac{35\,(1)}{38\,(.62)\,\sqrt{1.25\,(100) - 0\,(1)\,(1)}}$$

$$A_c = 0.132$$

C. Total orifice required = .37 sq. in. (air) + 0.132 sq. in. (water) or .502 sq. in.

Organic Fluid Systems

The use of Organic Fluid Systems falls under special rules for sizing and valve selection. Organic fluids are known under a variety of trade names as noted below:

TRADE NAME	COMPANY
Thermia	Shell Oil Co.
Dowtherm	Dow Chemical Co.
Therminol	Monsanto Chemical Co.
Caloria	Exxon Corp.
Mobiltherm	Mobil Corp.
Ucon	Union Carbide Corp.

Depending on the type of system in which the fluid is used, valve selection may be affected. The following criteria should be used in valve selections:

Vapors

Organic vapor pressure relief valve requirements are specified in ASME Section I PVG. See the 1900P section in this catalog.

Liquids

In cases where the fluid is not vaporized, as would be the case when heat transfer is involved, the valve must be sized on the basis of liquid. The LA liquid trim valves must be supplied and applicable sizing equations used.

The pressure relief valve requirements for these applications are contained in ASME Section VIII.

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