Designation: F1508 – 96 (Reapproved 2016)[ε1]

An American National Standard

Standard Specification for Angle Style, Pressure Relief Valves for Steam, Gas, and Liquid Services[1]

This standard is issued under the fixed designation F1508; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Corrected 6.2 editorially in September 2016.

1. Scope

1.1 This specification covers spring-loaded, angle style, pressure relief valves for steam, gas, and liquid system applications (excluding boiler safety and hydraulic system relief valves).

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A105/A105M Specification for Carbon Steel Forgings for Piping Applications
A125 Specification for Steel Springs, Helical, Heat-Treated
A182/A182M Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
A193/A193M Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
A217/A217M Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service
A227/A227M Specification for Steel Wire, Cold-Drawn for Mechanical Springs
A229/A229M Specification for Steel Wire, Quenched and Tempered for Mechanical Springs
A231/A231M Specification for Chromium-Vanadium Alloy Steel Spring Wire
A276 Specification for Stainless Steel Bars and Shapes
A313/A313M Specification for Stainless Steel Spring Wire
A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts
A479/A479M Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
A494/A494M Specification for Castings, Nickel and Nickel Alloy
A689 Specification for Carbon and Alloy Steel Bars for Springs
B21/B21M Specification for Naval Brass Rod, Bar, and Shapes
B61 Specification for Steam or Valve Bronze Castings
B62 Specification for Composition Bronze or Ounce Metal Castings
B148 Specification for Aluminum-Bronze Sand Castings
B164 Specification for Nickel-Copper Alloy Rod, Bar, and Wire
B637 Specification for Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service
D5204 Classification System for Polyamide-Imide (PAI) Molding and Extrusion Materials
F467 Specification for Nonferrous Nuts for General Use
F468 Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use

2.2 *ANSI Standards:*[3]

ANSI B1.1 Unified Screw Threads
ANSI B16.5 Pipe Flanges and Flanged Fittings
ANSI B16.34 Valves—Flanged, Threaded, and Welding End

2.3 *ASME Standard:*[4]

ASME Boiler and Pressure Vessel Code

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

Current edition approved Sept. 1, 2016. Published September 2016. Originally approved in 1996. Last previous edition approved in 2010 as F1508 – 96 (2010). DOI: 10.1520/F1508-96R16E01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

2.4 *API Standards:*[5]

API 526 Flanged Steel Safety-Relief Valves

API RP 520, Part 1 Recommended Practice for the Design and Installation of Pressure-Relieving Systems in Refineries

2.5 *Federal Specifications:*[6]

QQ-N-281 Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections

QQ-N-286 Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)

2.6 *Military Standards and Specifications:*[6]

MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I—Environmental and Type II—Internally Excited)

MIL-STD-1330 Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping Systems

MIL-F-1183 Fittings, Pipe, Cast Bronze, Silver Brazing, General Specification for

MIL-F-20042 Flanges, Pipe and Bulkhead, Bronze (Silver Brazing)

MIL-P-46122 Plastic Molding Material and Plastic Extrusion Material, Polyvinylidene Fluoride Polymer and Copolymer

MIL-R-17131 Rods, Welding, Surfacing

MIL-S-901 Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for

MS 16142 Boss, Gasket-Seal Straight Thread Tube Fitting, Standard Dimensions for

MS 51840 Plug, Machine Thread, O-ring

2.7 *Naval Sea Systems Command (NAVSEA) Drawings:*[6]

803-1385884 Unions, Fittings and Adapters, Butt and Socket Welding, 6000 PSI, WOG IPS

803-1385943 Unions, Silver Brazing, 3000 PSI, WOG IPS, for UT Inspection

803-1385946 Unions, Bronze Silver Brazing, WOG, for UT Inspection

3. Terminology

3.1 *Definitions:*

3.1.1 *accumulation*—the increase in static pressure above the set pressure during discharge through the valve, when the valve passes the rated flow. Accumulation is expressed in pound-force per square inch or as a percent of the set pressure.

3.1.2 *accumulation pressure*—the set pressure plus the accumulation. Accumulation pressure is expressed in pound-force per square inch gage.

3.1.3 *blowdown*—the difference between the set pressure and the reseating pressure. Blowdown is expressed in pound-force per square inch or a percent of the set pressure. The accumulation and blowdown establish the operating band of the pressure relief valve at a particular set pressure.

3.1.4 *blowdown pressure*—the set pressure minus the blowdown. Blowdown pressure is expressed in pound-force per square inch gage.

3.1.5 *built-up backpressure*—the static discharge pressure at the outlet of a pressure relief valve caused by the pressure drop in the discharge piping while the valve is discharging.

3.1.6 *gagging device*—a device, normally a screw (also called test gag), used to prevent the pressure relief valve from opening during a hydrostatic pressure test of the equipment on which it is installed.

3.1.7 *inlet piping—when used in this specification*, refers to all piping and fittings between the source and the inlet connection to the pressure relief valve.

3.1.8 *instability (chatter, flutter)*—an unstable operation of the pressure relief valve characterized by rapid seating and unseating of the disk during discharge. This hammering of the disk on the seat can cause high loading forces, which can lead to damage and rapid failure of the seating and sliding surfaces.

3.1.9 *maximum system operating pressure*—the highest pressure that can exist in a system, vessel, or component under normal (noncasualty) operating conditions. This is a normal (noncasualty) pressure that the pressure relief valve is not intended to protect against. This pressure can be the result of influences such as pump or compressor shutoff pressure, pressure regulating valve lockup (no flow) pressure, and so forth.

3.1.10 *opening pressure*—the value of increasing inlet static pressure of a pressure relief valve at which there is a measurable lift, or at which the discharge becomes continuous by seeing, feeling, or hearing.

3.1.11 *outlet piping (or discharge piping)—when used in this specification*, refers to all piping and fittings between the pressure relief valve outlet connection and the main, tank, or atmosphere to which the pressure relief valve relieves.

3.1.12 *popping pressure*—the value of increasing inlet static pressure at which the disk moves in the opening direction at a faster rate as compared with the corresponding movement at higher or lower pressures. It generally applies to valves with compressible fluid service such as steam, gas, and so forth.

3.1.13 *pressure relief valve*—an automatic pressure relieving device actuated by the static pressure upstream of the valve and characterized by either rapid opening (pop action for gas, vapor, or steam) or gradual opening (for liquids).

3.1.14 *primary and secondary pressure zones of pressure relief valve—primary pressure zone* refers to all portions of the pressure-containing envelope subject to inlet pressure; *secondary pressure zone* refers to all portions of the pressure-containing envelope subject to outlet or discharge pressure (includes spring housing of nonvented valves).

3.1.15 *relieving capacity (also called flow capacity)*—the pressure relief valve is defined as the quantity of pressure medium relieving through the pressure relief valve at the accumulation pressure, such as pound per hour of steam, gallon per minute of water at 70°F, or SCFM (standard cubic feet per minute at 60°F and 14.7 psia) of air, as applicable.

[5] Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://www.api.org.

[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.1.16 *set pressure*—the value of increasing inlet static pressure at which a pressure relief valve displays one of the operational characteristics as defined under *opening pressure*, or *start-to-leak* pressure. Set pressure is expressed in pound-force per square inch gage.

3.1.17 *set pressure range*—the range over which the set pressure can be adjusted with the installed spring.

3.1.18 *set pressure tolerance*—the permissible plus or minus deviation from the specified set pressure. Set pressure tolerance is expressed in pound-force per square inch or as a percent of the set pressure.

3.1.19 *source—when used in this specification*, refers to the pressure container being protected from overpressure by the pressure relief valve, for example, piping main, pressure vessel or tank, casing, and so forth.

3.1.20 *start-to-leak pressure*—the value of increasing inlet static pressure at which the first bubble occurs when a pressure relief valve for compressible fluid service of the resilient disk design is tested by means of air under a specified water seal on the outlet.

3.1.21 *superimposed backpressure*—the static pressure on the discharge side of a pressure relief valve prior to the opening of the pressure relief valve. This pressure exists where the pressure relief valve discharges into a common pipeline shared with other pressure sources such as pressure relief valves, or into a pressurized or closed system. This pressure may have the effect of changing the set pressure of the pressure relief valve.

3.1.22 *top-guided valve*—this type of valve has all the guiding, rubbing, or contacting surfaces on the discharge side of the seat.

4. Classification

4.1 Pressure relief valves shall be of the following types and material grades:

4.1.1 *Type I—For Steam Service:*

4.1.1.1 *Grade A*—Alloy steel construction (for steam service temperatures up to 1000°F) (see Table 8).

4.1.1.2 *Grade B*—Carbon steel construction (for steam service temperatures up to 775°F) (see Table 8).

4.1.2 *Type II—For Air, Gas Service:*

4.1.2.1 *Grade C*—Bronze or stainless steel construction (for air, gas service excluding oxygen) (see Table 9).

4.1.2.2 *Grade D*—Ni-Cu alloy construction (for oxygen) (see Table 9).

4.1.3 *Type III—For Liquid Service (except hydraulic oil):*

4.1.3.1 *Grade E*—Ferrous construction (for noncorrosive liquids, such as fuel oil, water, steam condensate, and so forth) (see Table 9).

4.1.3.2 *Grade F*—Nonferrous construction (for corrosive liquids, such as seawater, and so forth) (see Table 9).

5. Ordering Information

5.1 Ordering documentation for valves under this specification shall include the following information, as required, to describe the equipment adequately.

5.1.1 ASTM designation and year of issue.

5.1.2 Valve specification code (see 6.2).

5.1.3 Quantity of valves.

5.1.4 Maximum inlet temperature.

5.1.5 Set pressure.

5.1.6 Required relieving capacity (flow) at the accumulation pressure.

5.1.7 Installation limitations data, if different than specified in 7.9.

5.1.8 Blowdown limits, if different than specified in 7.7.

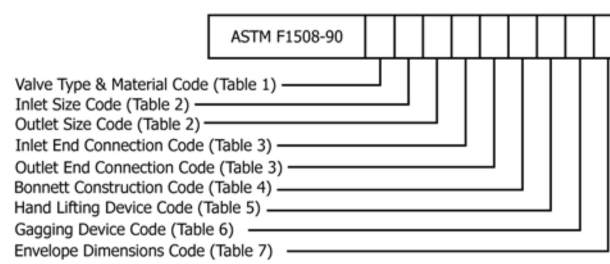
5.1.9 Envelope dimensions, if not covered in Table 13 and Table 14.

5.1.10 Supplementary requirements, if any (see S1 through S5).

6. Valve Coding and Construction

6.1 Valves shall incorporate the design features specified in 6.2 and 6.3.

6.2 *Valve Specification Coding*—Basic valve design features shall be specified and recorded using the following valve coding system. The valve specification code contains nine fields of information, which describe the construction features of the valve. Each of these nine fields are further assigned their respective codes in accordance with Tables 1-7.



6.3 *Construction*—Valve construction shall be in accordance with the requirements specified in 6.3.1 – 6.3.19.

6.3.1 The materials of construction for various valve components are detailed in Table 8 for Type I valves and Table 9 for Types II and III valves.

6.3.2 *General Requirements*—The valve shall be self-contained, single-seated, and spring-loaded where the inlet pressure is directly sensed under the spring-loaded disk. The valve shall incorporate only a single inlet and a single outlet connection.

6.3.3 *Pressure-Temperature Ratings*—The pressure-temperature ratings of a pressure relief valve consist of ratings for the primary and secondary pressure zones.

6.3.3.1 *Pressure-Temperature Rating of the Primary Pressure Zone*—This shall correspond to the rating of the inlet end connection, and is given in Table 10.

TABLE 1 Valve Type and Material Code

Valve Classification		Valve Type and Material Code
Valve Type	Material Grade	
I	A	1
I	B	2
II	C	3
II	D	4
III	E	5
III	F	6
As specified	as specified	9

TABLE 2 Codes for Valve Inlet/Outlet Pipe Size

Nominal valve inlet or outlet pipe size, in. (NPS)	0.25	0.38	0.50	0.75	1.00	1.25	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	8.0	10.0	As specified
Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	T	W

TABLE 3 End Connection Codes for Valve Inlet and Outlet Ports

NOTE 1—Unless otherwise specified in the purchase order (Code W), all ANSI flanges shall have raised faces.

NOTE 2—Unless otherwise specified in the purchased order (Code W), all Navy flanges shall be plain and without preinserted rings.

Type of End Connection	Codes for Valves				
	Type I	Type II Valves		For Type III	
	Grades A and B	Grade C	Grade D	Grade E	Grade F
ANSI Flanged per ANSI B16.5 Class 150	A			A	
ANSI Flanged per ANSI B16.5 Class 300	B			B	
ANSI Flanged per ANSI B16.5 Class 600	C			C	
ANSI Flanged per ANSI B16.5 Class 900	D				
ANSI Flanged per ANSI B16.5 Class 1500	E				
SBU, per MIL-F-1183 (400 psi)		F			F
Union-End, per Drawing 803-1385946 (1500 psi)		G			
Union-End, per Drawing 803-1385943 (3000 psi)		H			
Union-End, per Drawing 803-1385884 (6000 psi)		I			
6–in. Long nipple welded (400 psi)			K		
6–in. Long nipple welded (1500 psi)			L		
6–in. Long nipple welded (3000 psi)			M		
6–in. Long nipple welded (6000 psi)			N		
Navy flanged, per MIL-F-20042, 150 lb					P
Navy flanged, per MIL-F-20042, 250 lb					R
Navy flanged, per MIL-F-20042, 400 lb					T
As specified	W	W	W	W	W

6.3.3.2 *Pressure-Temperature Rating of the Secondary Pressure Zone*—The secondary pressure zone shall withstand the higher of the following:

(1) 150 % of maximum backpressure buildup specified in 7.9.

(2) 600 psig (for Type II, Grade C and Type III, Grade F valves only).

(3) ANSI B16.34, Class 150 pressure rating (for Type I, Grades A and B and Type III, Grade E valves only).

6.3.4 *Body Construction*—The valve shall be of the angle-body design. It shall be constructed so that the seat will not become distorted relative to the disk, and valve operation is not adversely affected by internal pressure and temperature.

6.3.5 *Bonnet Construction (Spring Housing):*

6.3.5.1 For Type I valves, the bonnet shall be attached to the body with bolted flanges. Type I, Grade A valves must have exposed spring bonnets—the discharge flow released through the open bonnet shall be minimal. For Type II and Type III valves, the bonnet shall be attached to the body with bolted flanges, or a threaded union connection.

6.3.5.2 For pressure-tight (nonvented) bonnet construction valves (for air/gas and liquid applications), there shall be no discharge of pressure medium into the atmosphere from the bonnet or from the body-to-bonnet joint.

6.3.5.3 Vented-bonnet construction valves shall incorporate a threaded vent hole in the bonnet for the discharge of pressure medium into the atmosphere. The discharge flow released through the vent hole shall be minimal. The vent hole shall be capable of attaching a pressure-tight MS straight-threaded tube fitting to divert the pressure relief to a distant location. The nominal tube fitting size shall be in accordance with Table 11. The vent hole shall be in accordance with MS 16142. Valves shall be furnished with a vent plug in accordance with MS 51840 to keep the dirt away and to allow hydro testing. A warning tag instructing the mandatory removal of the vent plug after valve installation must also be attached to the valve vent plug.

6.3.5.4 There shall be one bonnet for each valve body of a particular nominal inlet size and pressure-temperature rating. It shall be capable of housing any of the springs required to span the applicable set pressure ranges.

6.3.6 *Internal Trim:*

6.3.6.1 For Type I valves, valves shall be provided with a threaded seat ring, which shall be welded or nickel-brazed circumferentially to the body. The valve body shall have sufficient metal at the seat section to permit installation of a separate seat ring, if required as a service repair. When the seat ring is a part of the inlet flange raised face, such as in full nozzle valves, no welding or brazing is required.

6.3.6.2 For Types II and III valves, the valve shall have a replaceable seat ring. The seat ring shall be either threaded-in or retained by a cage construction and shall be easily replaceable, using hand tools, after extended service.

6.3.6.3 The valve disk to valve seat sealing must be metal to metal for Type I valves and metal to nonmetal for Type II and Type III valves.

6.3.6.4 The disk or the disk holder assembly shall be top-guided. Bottom-guided valves (also known as wing-guided valves), or other construction valves where all or part of the guiding surfaces are under the disk, are not permitted. Guiding surfaces (bushings and posts) shall have the proper hardness, finish, concentricity, parallelism, clearances, length, and rigidity to prevent binding or seizing and to ensure proper seating under all operating conditions. These alignment requirements shall be maintained with interchangeable parts and under any tolerance stackup.

6.3.7 *Interchangeability*—In no case shall the parts be physically interchangeable in a valve unless such parts are also interchangeable with regard to function, performance, and strength. Where machining is required after installation of a

TABLE 4 Bonnet Construction Codes

Type of Bonnet Construction	Code for Type I Valve		Code for Type II Valve		Code for Type III Valve	
	Grade A	Grade B	Grade C	Grade D	Grade E	Grade F
Vented bonnet	not applicable	A	A	A	A	A
Pressure-tight bonnet	not applicable	B	B	B	B	B
Open bonnet (exposed spring)	C	not applicable	not applicable	not applicable	not applicable	not applicable

TABLE 5 Hand-Lifting Device Codes

Is Hand-Lifting Device Required With the Valve?	Code for Type I Valves	Code for Type II Valves	Code for Type III Valves
Yes	1	1	1
No	not applicable	2	not applicable

TABLE 6 Gagging Device Codes

Is Gagging Device Required With the Valve?	Code for Type I Valves	Code for Type II Valves	Code for Type III Valves
Yes	1	1	1
No	2	2	2

TABLE 7 Valve Envelope Dimensions Code

Requirement to Meet Listed Envelope Dimensions	Code
The valve meets the envelope dimensions listed in Table 12 and Table 13.	1
The valve does not meet the envelope dimensions listed in Table 12 and Table 13.	2

TABLE 8 Materials of Construction for Type I Valves

Name of Part	Grade A	Grade B
Body, bonnet, and yoke	Specification A182/A182M Grade F11, F22 Specification A217/A217M Grade WC6, WC9	Specification A105/A105M Specification A182/A182M Grade F11, F22 Specification A216/A216M Grade WCB Specification A217/A217M Grade WC1, WC6 Specification A351/A351M Grade CF3, CF3M, CF8, CF8M
Metallic disk and seat ring	Haynes 25 or Stellite (wrought Stellite 6B, cast) Stellite 6 or an inlay of Stellite not less than 3⁄32 in. thick. Where inlays are used, welding rod shall be in accordance with Type MIL-RCoCr-A of MIL-R-17131 and base materials shall be one of the following: Specification A351/A351M Grade CF3, CF3M, CF8, CF8M Specification A276 Types 302, 304, 316, 347	Specifications A276, A479/A479M Types 302, 304, 316, 410, 430 Specification A351/A351M Grades CF3, CF3M, CF8, CF8M QQ-N-281, QQ-N-286 Specification A494/A494M
Stem	Specifications A276, A479/A479M Types 302, 304, 316, 410, 430	Specifications A276, A479/A479M Types 302, 304, 316, 410, 430
Springs	Specification B637 (Inconel X750)	Specification A125[A] Specification A227/A227M[A] Specification A229/A229M[A] Specification A231/A231M[A] Specification A276 Specification A689[A] Specification A313/A313M Specification B637 (Inconel X750)
Body bolts and nuts	Specification A193/A193M Grade B16 Specification A194/A194M Grade 4	Specification A193/A193M Grade B7, B16 Specification A194/A194M Grade 2H, 4

[A] Electroless nickel plated (ENP) or zinc plated.

seat ring or guide to maintain critical concentricity or alignment dimensions, detailed instructions must be provided with each repair part.

6.3.8 *Spring*—The spring shall be designed so that the full lift spring compression shall be no greater than 80 % of the nominal solid deflection. The permanent set of the spring (defined as the difference between the free height and height measured 10 min after the spring has been compressed solid four times at room temperature) shall not exceed 0.5 % of the free height. Spring ends shall be squared and ground.

6.3.9 *Threads*—Threads shall conform to ANSI B1.1. Provisions shall be incorporated to prevent the accidental loosening of threaded parts. Pipe threads and lock-washers shall not be used.

6.3.10 *Bearing Surfaces*—Nut- and bolt-bearing surfaces and their respective mating surfaces on the valves shall be machine finished.

6.3.11 *Stem Packing*—A stuffing box, O-rings, or any other nonmetallic materials shall not be permitted on the stem/disk guiding surfaces.

6.3.12 *Hand-Lifting Device*—When specified (see 6.2), valves shall be provided with a hand-lifting device so that they may be operated by hand for testing purposes with an inlet pressure of 75 % of the set pressure. Type I and Type III valves must be furnished with a hand-lifting device. The necessary lever or tool shall be furnished as part of the valve. For valves requiring pressure-tight (nonvented) bonnets, a stuffing box or a seal on the shaft of the hand-lifting device which will have no effect on the valve set pressure and the valve lift, shall be required.

6.3.13 *Gagging Device*—When specified for system test purposes (see 6.2), a gagging device shall be supplied with the valve. Valves shall be constructed to be gagged without alteration of the set point. The gagging screw shall be provided with a knurled or wing nut-type head to discourage the use of wrenches when gagging the valve. The gagging device shall be constructed to minimize the possibility of overlooking its removal after test and shall include a tag or other warning to

TABLE 9 Materials of Construction for Types II and III Valves

Name of Part	Type II, Grade C	Type II, Grade D	Type III, Grade E	Type III, Grade F
Body, bonnet, and yoke	Specification B61, B62 Specifications A276/A479/A479M Types 302, 304, 316, 410, 430 Specification A351/A351M Grade CF3, CF3M, CF8, CF8M	QQ-N-281, Specification A494/A494M	Specification A105/A105M Specification A216/A216M Grade WCB Specifications A276/A479/A479M Types 302, 304, 316, 410, 430 Specification A351/A351M Grade CF3, CF3M, CF8, CF8M	Specification B61, B62 Specification B148 Grade 958 QQ-N-281, Specification A494/A494M
Metallic disk and seat ring	Specifications B61, B62 QQ-N-281, QQ-N-286, Specification A494/A494M Specifications A276/A479/A479M Types 302, 304, 316, 410, 430 Specification A351/A351M Grade CF3, CF3M, CF8, CF8M	QQ-N-281, QQ-N-286 Specification A494/A494M	Specifications A276/A479/A479M Types 302, 304, 316, 410, 430 Specification A351/A351M Grade CF3, CF3M, CF8, CF8M	QQ-N-281, QQ-N-286 Specification A494/A494M
Stem	QQ-N-281, QQ-N-286 Specification B21/B21M Specifications A276/A479/A479M Types 302, 304, 316, 410, 430	QQ-N-281, QQ-N-286	Specifications A276/A479/A479M Types 302, 304, 316, 410, 430	QQ-N-281, QQ-N-286 Specification B21/B21M
Springs	Specification A125[A] Specification A227/A227M[A] Specification A229/A229M[A] Specification A231/A231M[A] Specifications A276, A313/A313M Specification A689[A]	QQ-N-281, QQ-N-286	Specification A125[A] Specification A227/A227M[A] Specification A229/A229M[A] Specification A231/A231M[A] Specifications A276, A313/A313M Specification A689[A]	QQ-N-281, QQ-N-286
Body bolts and nuts	Specifications A193/A193M, A194/A194M, B164 Specifications F467, F468	QQ-N-281, QQ-N-286 Specification B164	Specification A193/A193M Specification A194/A194M	QQ-N-281, QQ-N-286 Specifications B164, F467, F468
Diaphragm, gasket, and so forth	TFE or reinforced TFE, nitrile (Buna-N), fluorocarbon-rubber (viton)	TFE or reinforced TFE	TFE or reinforced TFE, nitrile (Buna-N), fluorocarbon-rubber	TFE or reinforced TFE, nitrile (Buna-N), fluorocarbon-rubber
Nonmetallic disk insert	TFE or reinforced TFE Plastic in accordance with MIL-P-46122 Plastic in accordance with Classification System D5204	TFE or reinforced TFE Plastic in accordance with MIL-P-46122 Plastic in accordance with Classification System D5204	TFE or reinforced TFE Plastic in accordance with MIL-P-46122 Plastic in accordance with Classification System D5204	TFE or reinforced TFE Plastic in accordance with MIL-P-46122 Plastic in accordance with Classification System D5204

[A] Electroless nickel plated (ENP).

TABLE 10 Pressure Temperature Ratings of Valve

End Connection Code (see Table 3)	Type of End Connection	Pressure-Temperature Rating (see 6.3.3)			
A thru E	ANSI Flanged	Refer to ANSI B16.5			
F	SBU, MIL-F-1183 (400 psi)				
G	Union-End, Drawing 803-1385946 (1500 psi)	Nominal Pressure, psi	Design Pressure, psig	Design Temperature, °F	Shell Test Pressure, psig
H	Union-End, Drawing 803-1385943 (3000 psi)				
I	Union-End, Drawing 803-1385884 (6000 psi)				
K	6-in. long nipple welded (400 psi)				
L	6-in. long nipple welded (1500 psi)	400	480	165	800
M	6-in. long nipple welded (3000 psi)	1500	1800	165	2250
N	6-in. long nipple welded (6000 psi)	3000	3600	165	4500
		6000	7200	165	9000
P, R, T	Navy flanged, MIL-F-20042	refer to MIL-F-20042			
W	as specified	as specified			

this effect. The gagging device shall be designed to prevent the installation of a valve cap over the gagging device.

6.3.14 *Accessibility*—Valves shall permit adjustment and repair without removal from the line.

6.3.15 *Valve Adjustment:*

6.3.15.1 Means shall be provided for adjusting the set pressure setting with the valve under pressure. The adjusting screw shall have right-hand threads so that clockwise rotation

TABLE 11 Nominal Tube Sizes (Inches) for Vented-Bonnet Valves

Valve Inlet Size	Nominal Tube Size
0.250	0.375
0.375	0.375
0.500	0.375
0.750	0.375
1.000	0.500
1.250	0.500
1.500	0.625
2.000	0.625
2.500	0.750
3.000	0.750
4.000	1.000
5.000	1.000
6.000	1.250
8.000	1.250

increases the set pressure. The adjusting device shall be provided with a locknut and cap, or other suitable means, to prevent accidental change of adjustment.

6.3.15.2 Valves shall have adjustable blowdown using blowdown ring(s). Positive means shall be used to lock the adjusting ring(s) in place by use of adjustable ring pins(s). The pin(s) shall be installed through the penetration hole in the lower valve body.

6.3.16 *Valve Envelope Dimensions*—Unless otherwise specified in the ordering data, valves must meet the overall envelope dimensions shown in Table 12 for Type I valves and Table 13 for Types II and III valves.

6.3.17 *Cleaning*—Type II, Grade D valve parts (for oxygen service) shall be cleaned in accordance with MIL-STD-1330 and maintained oxygen clean.

6.3.18 *Sealing*—Means shall be provided in the design of all valves for sealing all external adjustments such as set pressure. Seals shall be installed by the manufacturer or assembler at the time of initial shipment and after field adjustment or repair of the valves by either the manufacturer, his authorized representative repairer, or the user. Seals shall be installed in such a manner as to prevent changing the adjustment without breaking the seal and, in addition, shall serve as a means of identifying the manufacturer, assembler, repairer, or user making the adjustment.

6.3.19 Asbestos material is not permitted in the valve construction.

7. Performance Requirements

7.1 All valves shall meet the requirements of 7.2 – 7.10.

7.2 *Range of Set Pressure Adjustment*—For Type I and Type III valves, the set pressure shall be adjustable over a range of at least ±10 % of the specified set pressure, for set pressures up to 250 psig; and when the specified set pressure exceeds 250 psig, this range shall be ±5 %. For Type II valves, the set pressure shall be adjustable over the set pressure range specified in Table 14. If required, more than one spring may be used to accomplish this.

7.3 *Operation*—Valves shall operate without instability throughout their full range of capacity. Types I and II valves shall open with a clear, sharp pop. Valve closure shall be clear and sharp when the inlet pressure is reduced to the blowdown pressure. Type III valves shall open/close gradually, without instability, in response to the increase/decrease in pressure over the opening pressure.

TABLE 12 Valve Envelope Dimensions (Inches) for Type I Valves (See Fig. 1)

NOTE 1—Variations for A and B dimensions are ±0.06 in. C is the maximum dimension shown.

NOTE 2—Dimensions not shown in the table shall be in accordance with API 526. If dimensions are not shown in Table 12, or are not listed in API 526, they should be agreed upon between the buyer and the valve supplier.

		Type of Inlet × Outlet End Connections																							
Inlet Size	Outlet Size	ANSI 300 × ANSI 150			ANSI 600 × ANSI 150																				
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
0.25	0.25																								
0.25	0.50																								
0.50	0.50	3.2	3.2	3.2	3.5																				
0.50	1.00																								
0.75	0.75	3.2	3.2	3.2	3.5																				
1.00	1.00	3.5	3.5	3.4	3.7																				
1.00	2.00																								
1.25	1.25	3.7	3.7	3.7	4.0																				
1.50	1.50	4.7	4.7	4.7	5.0																				
1.50	2.00																								
1.50	2.50																								
2.00	2.00	4.7	4.7	4.7	5.0																				
2.00	3.00																								
2.50	2.50	5.5	5.5	5.5	5.7																				
3.00	3.00	6.4	6.0	6.4	6.2																				
3.00	4.00																								
3.50	3.50																								
4.00	4.00	7.0	7.0	7.0	7.2																				
4.00	5.00																								
4.00	6.00																								
5.00	5.00																								
6.00	8.00																								
8.00	10.0																								

TABLE 13 Valve Envelope Dimensions (Inches) for Type II, Grade C, and Type III Valves (see Fig. 1) (Without Tailpieces and Nuts)

NOTE 1—Variations for A and B dimensions are ±0.06 in. C is the maximum dimension shown.

NOTE 2—Dimensions do not include length of nut or tailpiece.

NOTE 3—Dimensions not shown in the table should be agreed upon between the buyer and the valve supplier.

		Type of Inlet and Outlet End Connections																							
Inlet Size	Outlet Size	MIL-F-1183 SBU-400 PSI			803–1385946 Union 1500 PSI			803–1385943 Union 3000 PSI			803–1385884 Union 6000 PSI			MIL-F-20042 Flanged, 150#			MIL-F-20042 Flanged, 250#			ANSI Class 150 Flanged			ANSI Class 300 Flanged		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
0.25	0.25	2.6	2.6	12.0	2.6	2.6	12.0	2.6	2.6	13.0	2.6	2.6	13.0	3.0	3.0	13.0	3.0	3.0	13.0	3.0	3.0	13.0			
0.37	0.37	2.6	2.6	12.0	2.6	2.6	12.0	2.6	2.6	13.0	2.6	2.6	13.0	3.0	3.0	13.0	3.0	3.0	13.0	3.0	3.0	13.0			
0.50	0.50	2.6	2.6	12.0	2.6	2.6	12.0	2.6	2.6	13.0	2.6	2.6	13.0	3.0	3.0	13.0	3.0	3.0	13.0	3.0	3.0	13.0			
0.50	1.00													3.0	3.5	13.0	3.0	3.5	13.0	3.0	3.5	13.0			
0.75	0.75	2.6	2.6	12.0	2.6	2.5	12.0	2.6	2.6	13.0	2.6	2.5	13.0	3.0	3.0	13.0	3.0	3.0	13.0	3.0	3.0	13.0			
1.00	1.00	3.1	3.1	15.0	3.1	3.1	15.0	3.1	3.1	16.0	3.1	3.1	16.0	3.5	3.5	15.0	3.5	3.5	15.0	3.5	3.5	15.0			
1.00	2.00																								
1.25	1.25	3.2	3.2	15.5	3.2	3.2	15.5	3.2	3.2	16.5	3.2	3.2	16.5	3.8	3.8	16.0	3.8	3.8	16.0	3.8	3.8	16.0			
1.50	1.50	4.0	4.0	17.0	4.0	4.0	17.0	4.0	4.0	18.0	4.0	4.0	18.0	4.7	4.7	17.0	4.7	4.7	17.0	4.7	4.7	17.0			
1.50	2.00	4.5	4.0	19.0	4.5	4.0	19.0	4.5	4.0	20.0	4.5	4.0	20.0	4.7	4.7	18.0	4.7	4.7	18.0	4.7	4.7	18.0			
1.50	2.50													5.5	4.7	18.5	5.5	4.7	18.5	5.5	4.7	18.5			
2.00	2.00	4.5	4.5	18.5	4.5	4.5	18.5	4.5	4.5	19.5	4.5	4.5	19.5	4.7	4.7	18.0	4.7	4.7	18.0	4.7	4.7	18.0			
2.00	3.00																								
2.50	2.50	5.5	5.5	21.0	5.5	5.5	21.0	5.5	5.5	22.0	5.5	5.5	22.0	5.5	5.5	19.0	5.5	5.5	19.0	5.5	5.5	19.0			
3.00	3.00													6.0	5.5	19.5	6.0	5.5	19.5	6.0	5.5	19.5			
3.00	4.00																								
3.50	3.50													6.0	5.5	19.5	6.0	5.5	19.5	6.0	5.5	19.5			
4.00	4.00													6.5	6.5	24.0	7.0	7.0	24.5	7.0	7.0	24.5			
4.00	5.00																								
4.00	6.00													9.0	6.5	30.0	9.0	6.5	30.0	9.0	6.5	30.0			
5.00	5.00													6.5	6.5	24.0	7.0	7.0	24.5	7.0	7.0	24.5			
6.00	8.00													10.0	9.5	28.0	10.0	9.6	28.0	10.0	9.6	28.0			
8.00	8.00													10.0	10.0	28.0	10.0	10.0	28.0	10.0	10.0	28.0			

TABLE 14 Range of Set Pressure Adjustment for Type II Valves

Nominal Pressure Rating, lb/in. ^{2} gage	Minimum Required Set Pressure, lb/in.^{2} gage	Maximum Required Set Pressure, lb/in.^{2} gage
400	. . .	460
1500	460	1725
3000	1725	3450
6000	3450	6875

7.4 *Hydrostatic Shell Test Pressure*—The valve shall show no signs of external leakage, permanent deformation, or structural failure when subjected to the hydrostatic shell test pressure specified in 8.2.

7.5 *Set Pressure Tolerance*—For all types of valves, the set pressure tolerance, plus or minus, shall not exceed the following: 2 psi for set pressures up to 70 psig, 3 % for set pressures over 70 psig up to 300 psig, 10 psi for set pressures over 300 psig up to 1000 psig, and 2 % for set pressures over 1000 psig.

7.6 *Accumulation*—Valves shall be sized to pass the specified flow (see 5.1.6) without permitting the inlet pressure (source static pressure) to rise beyond the accumulation pressure. The accumulation (overpressure) shall not exceed 10 % of set pressure, or 3 psi, whichever is greater. The valve shall show no signs of instability.

7.7 *Blowdown Limits*—Unless otherwise specified in the ordering data (see 5.1.8), valves shall operate satisfactorily with the following blowdown pressure setting:

7.7.1 For Type I and Type II valves, the maximum blowdown limit shall be 3 psi or 7 % of the set pressure, whichever is greater.

7.7.2 For Type III valves, the maximum blowdown limit shall not exceed 15 % of the set pressure or 3 psi, whichever is greater.

7.8 *Seat Tightness*—With an inlet pressure at or above the minimum allowable blowdown pressure setting, the valve shall seat tightly. No through seat leakage under this condition shall be allowed (see Table 15).

7.9 *Installation Limitation*—Valve operation shall not be adversely affected (loss of capacity or instability) by an inlet piping pressure loss of up to 25 % of the relief valve maximum permitted blowdown or an outlet piping breakpressure buildup of up to 10 % of the set pressure, or both. Where the installation will subject the valve to more severe piping restrictions, this information shall be noted in the ordering data (see 5.1.7).

7.10 *Effective Discharge Area (A)*—Valves shall meet the effective discharge areas (A) specified in Table 16 based on

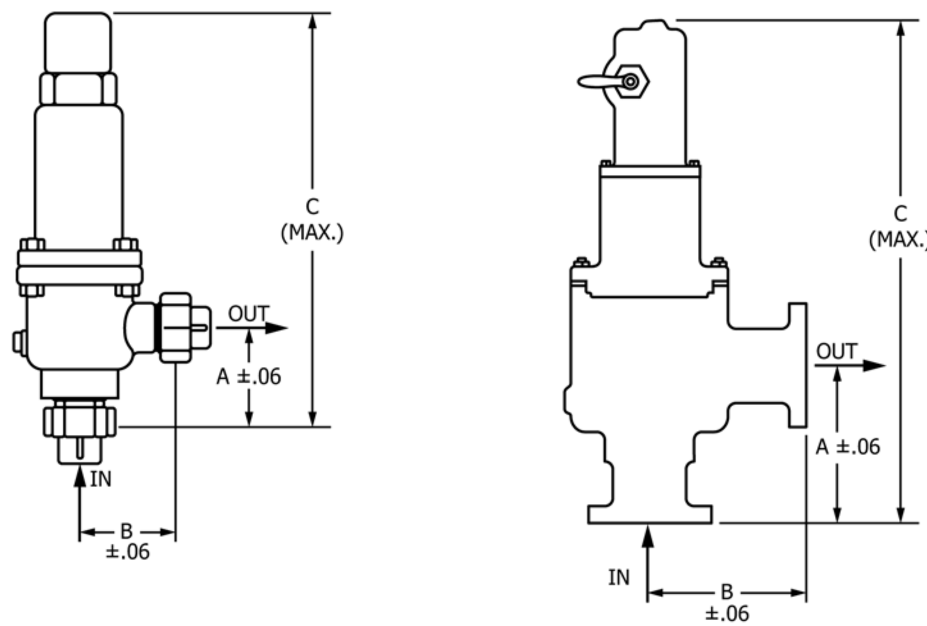
TABLE 15 Allowable Seat Leakage Rates

Valve Type	Test Medium	Type of Seat	Maximum Allowable Seat Leakage Over a Period of Minimum 3 min
I	steam	metallic	no visible evidence of steam leakage when the valve outlet is viewed against a dark background
II	air or nitrogen gas	nonmetallic	no visible leakage as indicated by a submerged underwater or a soap bubble test
III	water	nonmetallic	no visible leakage

TABLE 16 Effective Discharge Areas (A),[A] in.²

Valve Inlet Size	(A) for Steam Valves	(A) for Air/Gas Valves	(A) for Liquid Valves
0.250	0.018	0.016	0.011
0.375	0.041	0.035	0.024
0.500	0.132	0.141	0.096
0.750	0.162	0.141	0.096
1.000	0.285	0.249	0.160
1.250	0.444	0.389	0.280
1.500	0.638	0.559	0.432
2.000	1.140	0.998	0.834
2.500	1.780	1.560	1.372
3.000	2.560	2.250	2.000
4.000	4.550	3.990	3.727

[A] Variation allowed on the discharge areas is +15 %, −0 %.



(a) SBU End Connections

(b) Flanged End Connections

NOTE—Pictorial representations are for illustrative purposes only, and do not imply design. Dimensions for SBU end valves do not include length of nut or tailpiece.

FIG. 1 Typical End Connections

flow tests and neglecting any inlet/outlet losses (in accordance with API RP 520, Part 1, Appendix C).

NOTE 1—To calculate the required effective discharge area for a given relief capacity requirement, see the following examples for steam, gas, and liquid services (for additional details, refer to API RP 520, Part 1, Appendix C):

NOTE 2—The formulae shown in Examples 1, 2, and 3 are for valves with vented/exposed spring construction bonnets. Nonvented bonnet valves generally have much lower capacity and the valve manufacturer should be consulted to obtain their capacities. Also, the calculated effective discharge area does not include impact as a result of installation limitation in accordance with 7.9.

Example 1, Steam Service:
Given: Flow medium = saturated steam
Upstream pressure = 100 psig
Accumulation = 10 %
Required flow through valve = 1774 lb/h
Calculate: *A* (effective discharge area of valve)
For steam service, use formula "C-10" in API RP 520, Part 1, Appendix C

$$A = \frac{W}{50P_1K_{SH}} \quad (1)$$

where:

A = effective discharge area of valve, in.²;
W = required flow through valve, lb/h;
P_1 = upstream relieving pressure, psia = 124.7 at 100-psig set pressure; and
K_{SH} = correction factor as a result of amount of superheat in steam = 1.0 for saturated steam.

Then substituting these values in Eq 1,

$$A = \frac{1774}{50 \times 124.7 \times 1.0} = 0.285 \text{ in.}^2 \quad (2)$$

Example 2, Air Service:
Given: Flow medium = air
Upstream pressure = 100 psig
Accumulation = 10 %
Temperature = 60°F
Required flow through valve = 556 SCFM
Calculate: *A* (effective discharge area of valve)
For air service, use formula "C-3" in API RP 520, Part 1, Appendix C

$$A = \frac{V\sqrt{TZG}}{1.175\ CKP_1K_b} \quad (3)$$

where:

A = effective discharge area of valve, in.²;
C = coefficient determined by ratio of specific heats, for air C = 356;
K = effective coefficient of discharge = 0.975 for formula "C-3;"
V = required flow through valve, standard cubic feet per min at 14.7 psia and 60°F;

P_1 = upstream relieving pressure, psia = 124.7 at 100-psig set pressure;
K_b = correction factor as a result of back pressure = 1.0 from "Figure C-1;"
T = absolute temperature of the inlet air, °F + 460 = 520°F for given data;
Z = compressibility factor, assume Z = 1.0 for air; and
G = specific gravity of gas referred to air = 1.0 for rated data.

Then substituting these values in the formula,

$$A = \frac{556\sqrt{520 \times 1.0 \times 1.0}}{1.175 \times 356 \times 0.975 \times 124.7 \times 1.0} = 0.249 \text{ in.}^2 \quad (4)$$

Example 3, Liquid Service:
Given: Flow medium = water
Upstream pressure = 100 psig
Accumulation = 10 %
Required flow through valve = 25.2 gpm
Calculate: *A* (effective discharge area of valve)
For liquid (water), use formula "C-7" in API RP 520, Part 1, Appendix C

$$A = \frac{\text{gpm}\sqrt{G}}{38.0KK_pK_wK_v\sqrt{1.25\,P - P_b}} \quad (5)$$

where:
A = effective discharge area of valve, in.^{2};
gpm = flow rate required through the valve, gal/min;
G = specific gravity of the liquid at flowing temperature = 1.0 for water at rated conditions;
K = coefficient of discharge = 0.62;
K_p = capacity correction factor because of 10 % overpressure = 0.6 at 10 % accumulation, see "Figure C-4;"
K_w = capacity for correction factor as a result of back pressure = 1.0, see "Figure C-5;"
K_v = capacity correction factor as a result of viscosity = 1.0, see "Figure C-6;"
P = set pressure, psig = 100; and
P_b = back pressure, psig = 0.0 for given data.

Then substituting these values in the formula,

$$A = \frac{25.2 \times \sqrt{1.0}}{38.0 \times 0.62 \times 0.6 \times 1.0 \times 1.0 \times \sqrt{1.25 \times 100 - 0.0}} \quad (6)$$

$$= 0.160 \text{ in.}^2$$

8. Tests Required

8.1 Each production valve must pass the tests outlined in 8.2 and 8.3.

8.2 *Hydrostatic Shell Test*—Valve shall be gagged shut or disk and spring assembly removed and seat blanked off. The following two separate hydrostatic shell tests for a minimum of 3 min shall be performed: (*a*) Water or air/nitrogen at a test pressure (see Table 10) shall be applied to the valve inlet (primary pressure zone) to verify conformance to 7.4. (*b*) For valves with pressure-tight bonnet construction only, water or air/nitrogen at a test pressure specified in 6.3.3.2 shall be applied to the valve outlet (secondary pressure zone) to verify conformance to 7.4.

8.3 *Set Pressure, Blowdown, and Seat Tightness Test*—Inlet pressure (see Table 15 for test medium) shall be increased until the valve opens. Inlet pressure shall be reduced until the valve reseats. Leakage shall be checked over a 3-min period at an inlet pressure equal to the minimum allowable blowdown pressure setting. There shall be no damage to seating surfaces and no instability (chatter). The valve shall conform to the requirements in accordance with 7.5, 7.7, and 7.8.

9. Marking

9.1 Each valve shall be plainly and permanently marked by the manufacturer with the required data in such a way that the marking will not be obliterated in service. The marking may be placed on the valve or on a corrosion-resistant plate permanently attached to the valve. The following data is required:

9.1.1 Name of the manufacturer,
9.1.2 Manufacturer's design or type number,
9.1.3 Valve specification code,
9.1.4 Size _____in. (nominal pipe size of the valve inlet),
9.1.5 Set pressure _____psi,
9.1.6 Rated relieving capacity (as applicable):

NOTE 3—The information listed in 9.1.5 and 9.1.6 must be placed on a corrosion-resistant plate permanently attached to the valve.

9.1.6.1 Pounds per hour of saturated steam at an overpressure of 10 % of set pressure or 3 psi, whichever is greater, for valves used in steam service; or
9.1.6.2 Gallon per minute of water at 70°F at an overpressure of 10 % of set pressure or 3 psi, whichever is greater, for valves used in water service; or
9.1.6.3 SCFM (standard cubic feet per minute at 60°F and 14.7 psia) of air at an overpressure of 10 % of set pressure or 3 psi, whichever is greater, for valves used in air or gas service.
9.1.6.4 For Type I valves (where the outlet size is larger than the inlet size), the effective orifice area letter designation in accordance with API 526 must be stamped.
9.1.7 Service fluid (line medium),
9.1.8 Manufacturers' serial number identifying the valve. The serial number should be stamped on the body and placed adjacent to the nameplate, and
9.1.9 Range of set pressure adjustment.

9.2 All connections (inlet, outlet, drain, and so forth) shall be permanently marked to aid in correct installation of the pressure relief valve.

10. Quality Assurance System

10.1 The manufacturer shall establish and maintain a quality assurance system which will ensure that all the requirements of this specification are satisfied. This system shall also ensure that all valves will perform in a similar manner to those representative valves subjected to original testing for determination of the operating and flow characteristics.

10.2 A written description of the system the manufacturer will use shall be available for review and acceptance by the purchaser or his designee.

NOTE 4—If supplementary requirement S4 is specified in 5.1.10, an outline of subjects described in S4 shall be provided by the manufacturer.

10.3 The purchaser or his designee reserves the right to witness the production tests and inspect the valves in the manufacturer's plant to the extent specified on the purchase order.

11. Keywords

11.1 angle style valves; pressure relief valves; spring-loaded valves; valves

SUPPLEMENTARY REQUIREMENTS

One or more of the following supplementary requirements S1, S2, S3, S4, or S5 shall be applied only when specified by the purchaser in the inquiry, contract, or order. Details of those supplementary requirements shall be agreed upon in writing between the manufacturer and the purchaser. Supplementary requirements shall in no way negate any requirement of the specification itself.

S1. Examinations

S1.1 *Examination of Materials*—Materials used in the manufacture of valves shall be examined to determine conformance to 6.3.1. Contracting agencies or their representatives shall normally accept certifications that the material complies with the specification; however, testing to demonstrate compliance may be required.

S1.2 *Visual and Dimensional Examination*—Visual and dimensional examination on sample valves shall be conducted to determine conformance with the ordering data, interface dimensions, and workmanship without disassembly.

S1.3 *Nondestructive Tests*—When nondestructive tests such as radiography, magnetic particle, or dye penetrant tests are required, they shall be specified in the ordering information (see 5.1.10).

S2. Initial Qualification Testing

S2.1 *Rated Relieving Capacity Test*—The valve-rated relieving capacity data shall be obtained and certified by the manufacturer by following the procedures outlined in Section VIII of the ASME Boiler and Pressure Vessel Code.

S2.2 *Endurance Test*—The valve shall be cycled with the pressurized test medium (see Table 15 for the test medium) 50 times. After each ten cycles, the set pressure and the leakage shall be checked. Valve shall conform to the requirements specified in 7.5 and 7.8. There shall be no signs of instability or damage to the seating surface.

S2.3 *Mechanical Shock Test*—The valve shall be tested in accordance with the requirements of Grade A, Class I of MIL-S-901. The valve shall be pressurized during test. There shall be no structural damage or degradation to performance capability.

S2.4 *Vibration Test*—The valve shall be tested in accordance with Type I of MIL-STD-167-1. At frequencies up to and including 33 Hz (unless otherwise specified in the ordering information, see Section 5), there shall be no structural damage or degradation to performance.

S2.5 *Stuck Valve Test*—With the valve set at the specified set pressure, and not subjected to any inlet pressure, the valve shall be left in the closed position for a minimum of 72 h. After this 72-h period, the inlet pressure (see Table 15 for test medium) shall be increased until the valve opens. Valve shall conform to the requirement specified in 7.5.

S3. Valve Testing With Imposed Installation Limitations

S3.1 The test set up shall impose an inlet piping pressure loss of 25 % of the blowdown (or the maximum inlet piping pressure loss, when specified in 5.1.7), and an outlet piping pressure buildup of 10 % of set pressure (or the maximum outlet piping pressure buildup, when specified in 5.1.7). Tests outlined in 8.3 and S2.1 should be conducted to verify conformance to 7.5 – 7.9.

S4. Quality Assurance

S4.1 *Scope of Work*—The written description of the quality assurance system shall include the scope and locations of the work to which the system is applicable.

S4.2 *Authority and Responsibility*—The authority and responsibility of those in charge of the quality assurance system shall be clearly established.

S4.3 *Organization* —An organization chart showing the relationship between management and the engineering, purchasing, manufacturing, construction, inspection, and quality control groups is required. The purpose of this chart is to identify and associate the various organizational groups with the particular functions for which they are responsible. These requirements are not intended to encroach on the manufacturer's right to establish, and from time to time to alter, whatever form of organization the manufacturer considers appropriate for its work. Persons performing quality control functions shall have a sufficiently well-defined responsibility, the authority, and the organizational freedom to identify quality control problems, and to initiate, recommend, and provide solutions.

S4.4 *Review of Quality Assurance System*—The manufacturer shall ensure and demonstrate the continuous effectiveness of the quality assurance system.

S4.5 *Drawings, Design Calculations, and Specification Control*—The manufacturer's quality assurance system shall include provisions to ensure that the latest applicable drawings, design calculations, specifications, and instructions, including all authorized changes, are used for manufacture, examination, inspection, and testing.

S4.6 *Purchase Control*—The manufacturer shall ensure that all purchased material and services conform to specified requirements and that all purchase orders give full details of the material and services ordered.

S4.7 *Material Control*—The manufacturer shall include a system for material control which ensures that the material received is properly identified and that any required documentation is present, identified to the material, and verifies compliance to the specified requirements. The material control system shall ensure that only the intended material is used in manufacture. The manufacturer shall maintain control of material during the manufacturing process by a system that identifies inspection status of material throughout all stages of manufacture.

S4.8 *Manufacturing Control*—The manufacturer shall ensure that manufacturing operations are carried out under controlled conditions using documented work instructions. The manufacturer shall provide for inspection, where appropriate, for each operation that affects quality or shall arrange an appropriate monitoring operation.

S4.9 *Quality Control Plan*—The manufacturer's quality control plan shall describe the fabrication operations, including examinations and inspections.

S4.10 *Welding*—The quality control system shall include provisions for ensuring that welding is in accordance with specified requirements. Welders shall be qualified to the appropriate standards and the qualification records shall be made available to the inspection authority if required.

S4.11 *Nondestructive Examination*—Provisions shall be made to use nondestructive examination as necessary to ensure that material and components comply with the specified requirements. Nondestructive examination operations shall be conducted by a recognized national body, and their qualification records shall be made available to the inspection authority if required.

S4.12 *Nonconforming Items*—The manufacturer shall establish procedures for controlling items not in accordance with the specified requirements.

S4.13 *Heat Treatment*—The manufacturer shall provide controls to ensure that all required heat treatments have been applied. Means should be provided by which heat treatment requirements can be verified.

S4.14 *Inspection Status*—The manufacturer shall maintain a system for identifying the inspection status of material during all stages of manufacture and shall be able to distinguish between inspected and noninspected material.

S4.15 *Calibration of Measurement and Test Equipment*—The manufacturer shall provide, control, calibrate, and maintain inspection, measuring, and test equipment to be used in verifying accordance with the specified requirements. Such calibration shall be traceable to a national standard and calibration records shall be maintained.

S4.16 *Records Maintenance*—The manufacturer shall have a system for the maintenance of inspection records, radiographs, and manufacturer's data reports that describe the achievement of the required quality and the effective operation of the quality system.

S4.17 *Sample Forms*—The forms used in the quality control system and any detailed procedures for their use shall be available for review. The written description of the quality assurance system shall make reference to these forms.

S4.18 *Inspection Authority*—The manufacturer shall make available to the inspection authority at the manufacturer's plant a current copy of the written description of the quality assurance system. The manufacturer's quality assurance system shall provide for the inspection authority at the manufacturer's plant to have access to all drawings, calculations, specifications, procedures, process sheets, repair procedures, records, test results, and any other documents as necessary for the inspection authority to perform its duties in accordance with this supplementary requirement. The manufacturer may provide for such access by furnishing the inspection authority with originals or copies of such documents.

S5. High-Integrity Body Valves

S5.1 These valves shall meet all the requirements of Type III construction. In addition, they shall have pressure-tight bonnet construction and not have any penetrations in the valve body. An accumulation of 25 % is permissible. The maximum blowdown limit shall not exceed 15 % of the set pressure or 8 psi, whichever is greater. These valves need not have the adjustable blowdown feature.

APPENDIX

(Nonmandatory Information)

X1. GUIDELINES FOR SELECTION AND INSTALLATION OF PRESSURE RELIEF VALVES

X1.1 *Scope*—This appendix provides general guidance for the selection and installation of pressure relief valves for shipboard use, and therefore, its use does not in any way relieve a shipbuilder of the final responsibility in the selection and installation of pressure relief valves. This appendix does not apply to boiler safety valves or hydraulic system relief valves.

X1.2 *General*—A properly designed, applied, and installed pressure relief valve will begin to lift at a definite pressure (set pressure), attain rated lift at a definite overpressure (accumulation pressure), and subsequently reseat at a definite lower pressure (blowdown pressure) once the overpressure condition at the source is corrected. For the pressure relief valve to function properly, the pressure at the source and the pressure differential that tends to hold the pressure relief valve disk in the open position must be the same (within certain limits) under all flowing conditions. Unstable operation (chatter) of a properly designed but improperly installed relief valve will occur when the pressure differential across the valve is not maintained during flowing conditions. This can result from any one of the following (or a combination of the following) causes:

X1.2.1 *Restricted Inlet Piping*—The inlet piping restricts flow to the pressure relief valve, and sufficient flow from the source to the pressure relief valve cannot be sustained.

X1.2.2 *Restricted Source*—The flow generated by the source because of a particular failure is not sufficient to sustain the required pressure at the pressure relief valve inlet.

X1.2.3 *Restricted Discharge*—The outlet piping restriction results in a high backpressure buildup in the pressure relief valve outlet section to affect valve operation.

X1.3 *Restricted Inlet Piping*—The pressure relief valve is intended to control or limit the source pressure; however, the only pressure that it actually senses, and therefore, reacts to at any given instant, is the pressure immediately under the disk. Actually, it responds to the pressure differential between the valve inlet and valve outlet acting across the unbalanced disk area. The effect of any valve outlet pressure will be considered in X1.5. Therefore, for the pressure relief valve to function properly in response to a source condition, the pressure under the pressure relief valve disk must accurately reflect the pressure at the source at all times and under all flowing conditions. Before lift, the source pressure and the pressure under the disk are identical, since there is no flow of pressure medium. However, once the valve lifts and begins to relieve (discharge) fluid, there will be a pressure differential or pressure drop between the source pressure and the pressure under the disk, caused by the head loss through the inlet piping. If this pressure drop is small relative to the blowdown of the valve, the valve will remain open and continuously discharge fluid until the pressure at the source is reduced below the set pressure and normal and stable valve operation should result.

X1.3.1 However, where the relief operation is limited by the inlet piping, the pressure drop during discharge may exceed the valve blowdown. If the pressure under the disk drops below the blowdown setting, the valve will immediately reseat as soon as it opens, even though the source pressure may still be above the set pressure or continuing to rise. Once the valve reseats, the valve stops relieving the fluid, and the pressure under the disk will immediately rise to match the source pressure. Assuming that the quantity of fluid discharged during this brief opening was not sufficient to bring the source pressure down below the set pressure, the valve will immediately reopen and a rapid chattering cycle will begin. The chattering will continue until the pressure at the source is reduced, in stages, to a value below the set pressure. Note that the rated capacity of the pressure relief valve, and not the available source supply, is critical since the pressure relief valve actually establishes the instantaneous or transient flow rate. Therefore, if the installation of a pressure relief valve results in a pressure drop in the inlet piping at the rated flow of the valve which approaches or exceeds the blowdown value of the valve, and the valve responds to an overpressure condition of any duration, chattering may occur. A chattering operation of a pressure relief valve will have the following detrimental effects:

X1.3.1.1 Damage to the valve (particularly the seating surfaces) and the attached piping.

X1.3.1.2 *Lowered Capacity*—The actual effective relieving capacity of a chattering pressure relief valve will be far below its rated capacity, which is based on a continuous open valve.

X1.3.2 To prevent instability, the following criteria for pressure relief valve inlet piping installation should be followed: The inlet piping connecting a pressure vessel, tank, pipe main, and other equipment being protected to the pressure relief valve inlet should have a streamlined entrance and should be as large in diameter, short in length, and direct as possible. Any changes in direction (elbows, bends, and so forth) should be avoided. The inlet piping should be arranged and sized so that the total pressure drop in the inlet piping does not exceed 25 % of the blowdown of the pressure relief valve with a flow rate equal to the rated capacity of the pressure relief valve. For example, if a pressure relief valve is set at 100 psig and has a 10 % blowdown and a capacity rating of 50 gpm at 10 % accumulation, then the inlet piping should be arranged and sized so that it will pass a flow of 50 gpm with a pressure drop not exceeding 2.5 psi.

X1.3.3 From the above, it can be seen that a pressure relief valve with very precise or narrow blowdown characteristics generally requires an installation with a very short and direct connection to the source. On the other hand, in existing installations in which the inlet connection is restrictive, a wide blowdown setting (where practical, based on other considerations) can improve stability. Another solution, in cases in which existing restrictive inlet piping cannot be replaced, would be the installation of a pilot-operated valve sensing directly to the source pressure. Since such a sensing line is always a very low-flow system, the valve will normally respond to the actual system pressure. As such, the pressure under the valve disk should have little effect on operating stability.

X1.3.4 Another possible solution to a chattering problem in an existing installation is the substitution of a smaller size pressure relief valve, where permissible, based on other considerations. From a pressure drop standpoint, decreasing the capacity of the pressure relief valve has the same relative effect as increasing the size of the inlet piping. Where such a substitution results in a stable operating pressure relief valve, it can actually increase rather than decrease the effective protective capacity of a pressure relief valve installation.

X1.4 *Restricted Source*—Chatter or unstable operation can occur when the rate of excess flow generated by the source is insufficient to sustain the valve in the open position during an overpressure condition. The mechanics and effects of this condition are the same as those resulting from restricted inlet piping, the only difference being the basic cause. This condition of insufficiency can be the result of oversizing the pressure relief valve in error or by deliberately oversizing the pressure relief valve in an effort to be on the "safe side." This condition can also result from applications in which the pressure relief valve size is based on some maximum excess flow condition (for example, wide open failure of an upstream regulating valve) and the overpressure condition in most cases is caused by a lesser failure (for example, damage to the regulating valve seat) which results in far less excess flow requiring discharge. When the pressure relief valve is merely oversized, it should be replaced with a valve of the correct capacity. As noted earlier, if such a substitution results in the elimination of a chattering condition, the result could be an increase in the effective relief protection capacity. In cases in which a variety of failures can require widely differing relief capacities, consideration should be given to installing two or more smaller size pressure relief valves with staggered settings.

X1.5 *Restricted Discharge*—The backpressure at the outlet section of a pressure relief valve can have a detrimental effect on valve operation. Under backpressure conditions, the pressure relief valve capacity is reduced because the valve lift is reduced by the increased pressure over the valve disk. Ideally, a pressure relief valve should only respond to the inlet (or source) pressure. However in valves that do not have a special balanced construction, any increase in the backpressure (which will have the effect of decreasing the pressure differential available to hold the disk in the open position) can have a similar effect on valve operation as a drop in the valve inlet pressure. Also, superimposed backpressure can shift the effective set pressure of a pressure relief valve. The following criteria for pressure relief valve discharge piping installation should be followed: The discharge piping should be arranged and sized so that the built-up backpressure does not cause unsatisfactory pressure relief valve operation, either from a stability or capacity standpoint. In cases in which a built-up backpressure in excess of 10 % of the set pressure, or where a superimposed backpressure can exist in the discharge line, a pressure relief valve of balanced design should be used.

X1.6 *Pressure Relief Valve Setting*—To ensure good valve operation, the spread between the maximum system operating pressure and the pressure relief valve set pressure should always be as wide as possible, consistent with economical and safe system design. Pressure relief valves are generally set to open at 10 % above the operating pressure. This margin will improve seat tightness (by permitting a greater normal seating load), decrease the number of times the valve is required to operate, and decrease valve maintenance. It will permit using a wider blowdown band, which can result in a more stable valve operation.

X1.6.1 The two critical performance points in any pressure relief valve installation are the accumulation pressure and the blowdown pressure. The accumulation pressure (the maximum overpressure which the pressure relief valve will permit the source to reach) establishes the required design rating of the equipment being protected. Therefore, the accumulation pressure must be compatible with economical and practical system and component design or with the ratings of systems and components already designed or installed. The blowdown pressure (the pressure, below the set pressure, to which the source must drop before the pressure relief valve will reseat) must always be above the maximum system operating pressure.

X1.6.2 From an economical point of view, the blowdown should be as short as possible. However, from the point of stable valve operation, a high blowdown is desirable. A compromise may therefore have to be accepted.

X1.6.3 If the blowdown pressure and the maximum system operating pressure are too close together, or if they can cross over, there is the possibility that a condition can be set up where, after responding to an overpressure, the system must be secured to stop the discharging of the pressure medium before the pressure relief valve will reseat. The higher the valve set pressure can be set above the maximum system operating pressure, the wider (or less precise) the spread between the accumulation and blowdown limits which can be permitted, and therefore, the less critical pressure relief valve operation becomes.

X1.6.4 Therefore, the selection and installation of pressure relief valve protection always involves compromises between system design considerations and pressure relief valve design considerations. As stated previously, the blowdown and accumulation are the only critical pressure relief valve performance points from a system standpoint. The actual set pressure is of little importance aside from providing a reference for setting and checking the valve. If the blowdown pressure and accumulation pressure meet system requirements, the set pressure can fall anywhere in between.

X1.7 *Installation Forces*—Forces transmitted to a pressure relief valve by thermal stresses, forced alignment of piping, and inadequate supports tend to distort the valve body. These forces should be avoided since the operation of pressure relief valves is particularly sensitive to such influences. The piping must also be designed and adequately supported to withstand the reactive forces associated with pressure relief valve discharge.