FLOWSERVE

Edward
Forged Steel Valves

Experience In Motion

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Maintenance

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• These valves can be constructed for nuclear service.

Note: See "References to Related Brochures" chart in the Table of Contents to locate figures that do not appear in this brochure.

Edward Valves Availability Chart

Edward Forged Steel, Globe, Angle, and Check Valves

Description	Pressure Rating[1,2]	Size[2]	Ends	Page
Globe Stop Valves	ASME 600(110)*	½(15) thru 2(50)	Flanged	28
	ASME 800(130)	¼(6) thru 2(50)	Threaded, Socket	31
	Series 1500	½(15) thru 2(50)	Threaded, Socket, Flanged	36,37
Univalve Globe Stop Valves	ASME 1690(290)* ASME 2680(460)* ASME 4500(760)	½(15) thru 4(100)	Threaded, Socket, Buttwelding	42,48,54
Hermavalve Globe Stop Valves	ASME to 1690(290)*	½(15) thru 2-½(65)	Socket, Buttwelding	64-67
Blow Off Stop Valves	ASME 300(50), 400(68) & 600(110)	1-½(40) thru 2-½(65)	Socket, Flanged, Buttwelding	22-25
	ASME 1500(250) & 2500(420)		Socket, Buttwelding	26
Hydraulic Stop Valves	5,000 PSI CWP 10,000 PSI CWP	¼(6) thru 2(50)	Threaded, Socket, Flanged	57
Globe Stop-Check Valves	ASME 600(110)*	½(15) thru 2(50)	Flanged	29
	ASME 800(130)	¼(6) thru 2(50)	Threaded, Socket	32
	Series 1500	½(15) thru 2(50)	Threaded, Socket, Flanged	38,39
Univalve Globe Stop-Check Valves	ASME 1690(290)* ASME 2680(460)* ASME 4500(760)	½(15) thru 4(100)	Threaded, Socket, Buttwelding	43,49,55
Piston Check Valves	ASME 600(110)*	½(15) thru 2(50)	Flanged	30
	ASME 800(130)	¼(6) thru 2(50)	Threaded, Socket	33
	Series 1500	¼(6) thru 2(50)	Threaded, Socket, Flanged	40
PressurCombo	ASME 1690*, 2680* & 4500	½(15) thru 4(100)	Socket, Buttwelding	59-62
Univalve Piston Check Valves	ASME 1690(290)* ASME 2680(460)* ASME 4500(760)	½(15) thru 4(100)	Threaded, Socket, Buttwelding	44,50,56
Hydraulic Check Valves	5,000 PSI CWP & 10,000 PSI CWP	¼(6) thru 2(50)	Threaded, Socket, Flanged	58
Ball Check Valves	ASME 800(130)	¼(6) thru 2(50)	Threaded, Socket	34
	Series 1500			41
Strainers	ASME 800(130) & Series 1500	¼(6) thru 2(50)	Threaded, Socket	63
Flanged Univalve	Class 1500(260)	½(15) thru 2(50)	Flanged	35
Univalve Angle Stop, Stop-Check and Check Valves	ASME 1690(290)	½(15) thru 4(50)	Socket, Buttwelding	45-47
	ASME 2680(460)			51-53
Continuous Blowdown Valves	ASME 1925	1(25) thru 4(100)	Socket, Buttwelding	27
Nuclear Valves	Thru ASME 2500(420)*	to Size 32(800)	Buttwelding	See Nuclear Catalog

Note: See "References to Related Brochures" chart in the Table of Contents to locate valves that do not appear in this brochure.
1. See 3.2 Pressure Ratings in the Technical Information section of this brochure for definition of various pressure ratings available.
2. Metric equivalent values for ratings and sizes are in parentheses.
*These valves can be constructed and supplied for nuclear service.

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Edward Valves Availability Chart

Edward Cast Steel Gate, Globe, Angle and Check Valves

See Edward Cast Steel Valve Catalog for detailed information (EVENCT0002)

Description	Pressure Rating[1,2]	Size[2]	Ends	Page
Bolted Bonnet Globe and Angle Valves, Stop and Stop-Check (Non-Return) and Bolted Cover Piston Check	ASME 300(50)	2-½(65) thru 12(300)	Buttwelding or Flanged	26, 28, 30
	ASME 600(110)*	2-½(65) thru 69(150)		35, 38, 41
Pressure Seal Bonnet Globe and Angle Valves Stop and Stop-Check (Non-Return)	ASME 600(110)*	8(200) thru 14(350)	Buttwelding or Flanged	35, 38
	ASME 900(150)*	3(80) thru 24(600)		46, 47, 50, 51
	ASME 1500(260)* & 2500(420)	2-½(65) thru 24(600)		59, 60, 63, 75, 79, 80, 81, 82
Pressure Seal Cover, Piston Check Valves	ASME 600(110)*	8(200) thru 14(350)	Buttwelding or Flanged	42
	ASME 900(150)*	8(200) thru 24(600)		52
	ASME 1500(260)* & 2500(420)	2-½(65) thru 24(600)		65, 66, 81, 82
Equiwedge® Gate Valves	ASME 600(110)* & 900(150)*	2-½(65) thru 32(800)	Buttwelding or Flanged	37, 38, 48, 49
	ASME 1500(260)* & 2500(420)	2-½(65) thru 24(600)		61, 62, 77, 78
	ASME 3600	16(400) thru 24(600)	Buttwelding	88, 89
Flite-Flow® Globe Valves, Stop and Stop-Check (Non-Return)	ASME 300(50)	3(80) thru 16(400)	Buttwelding or Flanged	27, 29
	ASME 400(68)	3(80) thru 4(100)		32, 33
	ASME 600(110)*	3(80) thru 32(800)		36, 40
	ASME 700(120)	6(150) thru 32(800)		43, 44
	ASME 900(150)*	6(150) thru 16(400)		47, 51
	ASME 1100(190)	3(80) thru 4(100)		55, 56
	ASME 1500(260)* & 2500(420)	3(80) thru 24(600)		60, 64, 76, 80
	ASME 1800(310) & 2900 (490)	3(80) thru 4(100)		69, 70, 84, 85
	ASME 2000(340)	12(300) thru 14(350)	Buttwelding	72, 73
	ASME 3600	16(400) thru 24(600)		87, 90
	Series 4500	4(100) thru 10(250)	Buttwelding or Flanged	92, 93
Flite-Flow® Piston Check Valves	ASME 300(50)	2-½(65) thru 16(400)	Buttwelding or Flanged	31
	ASME 400(68)	3(80) thru 4(100)		34
	ASME 600(110)*	3(80) thru 32(800)		42
	ASME 700(120)	3(80) thru 4(100)		45
	ASME 900(150)*	3(80) thru 16(400)		54
	ASME 1100(190)	3(80) thru 4(100)		57
	ASME 1500(260)* & 2500(420)	3(80) thru 24(600)		67, 82
	ASME 1800(310) & 2900 (490)	3(80) thru 4(100)		71, 86
	ASME 2000(340)	12(300) thru 14(350)		74
	ASME 3600	16(400) thru 24(600	Buttwelding	91
	Series 4500	4(100) thru 10(250)	Buttwelding or Flanged	94
Tilting Disk Check Valves	ASME 600(110)*	6(150) thru 20(500)	Buttwelding	42
	ASME 900(150)*, 1500(260)* & 2500(420)	2-½(65) thru 24(600)		53, 68, 83
	Class 4500(760)	6(150) & 8(200)		95
Nuclear Valves	Thru ASME 2500(420)*	to Size 32(800)	Buttwelding	See Nuclear Catalog
Special Application Valves	Thru ASME 2500(420)	to Size 18(450)	As Required	58

Note: "References to Related Brochures" chart in the Table of Contents to locate valves that do not appear in this brochure.
*These valves can be constructed and supplied for nuclear service.
1. See 3.2 Pressure Ratings in the Technical Information section of this brochure for definition of various pressure ratings available.
2. Metric equivalent values for ratings and sizes are in parentheses.

Edward Description of Figure Number System

Special Material Suffixes

CF8C	Cast 18-8 stainless steel (type 347) body and bonnet. Parts in contact with line fluid either cast or forged 18-8 stainless steel or equivalent.
CF3M	Cast 18-8 stainless steel (type 316L) body and bonnet. Parts in contact with line fluid either cast or forged 18-8 stainless steel or equivalent.
CF8M	Cast 18-8 stainless steel (type 316) body and bonnet. Parts in contact with line fluid either cast or forged 18-8 stainless steel or equivalent.
C5	Cast chromium molybdenum (5 chromium ½ molybdenum) Grade C5 alloy steel body and bonnet. Trim of equal or higher grad alloy steel.
F11	Body and bonnet of forged chromium molybdenum (1-¼ chromium, ½ molybdenum) Grade F11 alloy steel.
F22	Body and bonnet of forged chromium molybdenum (2-¼ chromium, 1 molybdenum) Grade F22 alloy steel.
F91	Body and bonnet of forged chromium molybdenum (9 chromium, 1 molybdenum) Grade F91 alloy steel.
F316	Body and bonnet of forged Type 316 stainless steel.
F316L	Body and bonnet of forged Type 316L stainless steel.
F347	Body and bonnet of forged Type 347 stainless steel.
F347H	Body and bonnet of forged Type 347H stainless steel.
LF2	Forged carbon steel material on which Charpy impact tests have been performed on forging heat to determine low temperature properties.
WC1	Cast carbon molybdenum Grade WC1 body and bonnet.
WC6	Cast chromium molybdenum (1-¼ chromium, ½ molybdenum) Grade WC6 alloy steel body and bonnet.
WC9	Cast chromium molybdenum (2-¼ chromium, 1 molybdenum) Grade WC9 alloy steel body and bonnet.
WCB	Cast carbon steel Grade WCB body and bonnet.
WCC	Cast carbon steel Grade WCC body and bonnet.
C12A	Cast chromium molybdenum (9 chromium, 1 molybdenum) alloy steel body and bonnet.

Special Feature Suffixes

A	Special body only — body pattern alterations not required. Flanges on forged valves not normally supplied with flanges. On socket end forged steel valves the inlet and outlet ends are different.
B	Venturi pattern body.
C	Locking devices consisting of padlock and chain.
CD	Locking devices, indicator type.
DD	Equalizer external.
DDI	Equalizer internal.
E	Permanent drain, hole in disk or groove in disk face.
F	Special trim material: used to designate special disk material, special stem material, or inconel spring in check valves.
FF	Special yoke bushing material, such as Austenitic Nodular Iron.
G	Bypasses on all types of cast steel valves
H	Spur gear operation.
HH	Bevel gear operation.
HHL	Valveless bevel gear actuator but with actuator mounting equipment.
J	Any unclassified special.
K	Throttle disk or skirted disk.
L	Impactor operated. Used now only to indicate impactor handwheel or handle on valves not regularly furnished with impactor.
LD	Impactorgear or Impactodrive.
M	Motor actuated.
ML	Valve less actuator but with motor actuator mounting equipment.

MM	Cylinder/diaphragm actuated. Either hydraulic or pneumatic.
MML	Valve less cylinder/diaphragm actuator but with actuator mounting equipment.
N	Body drilled and tapped or socketed for drains, with or without nipple, with or without drain valves.
P	Non-standard packing of all types.
PL	Plastic lined.
Q	Non-standard bonnet gaskets or gasket plating.
R	Special lapping and honing and gas testing (recommended for valves on high pressure gas service).
S	Smooth finish on contact faces of end flanges
T	Critical service requiring special testing and/or NDE.
UF	Unfinished ends
W	Stellited seat and disk. Suffix not used for valves that are cataloged as having stellited seat and disk as standard.
X	Ring joint facing on body end flanges.
Y	All welding ends either socket or butt. Suffix not used for valves where figure number designates welding ends as standard, such as Fig. 36224 and 66228 for example.
T1	ASME Section III Class 1 compliance.
T2	ASME Section III Class 2 compliance.
T3	ASME Section III Class 3 compliance.
T4	ASME Section III compliance without "N" stamp.
T5	Nuclear safety related-10CFR21 invoked.

Edward Description of Figure Number System

Example

| 1" | 36224 | FF | F | J | P | R | T |

T ————————————————— SPECIAL TESTING OR NDE

R ————————————————— LAPPING FOR AIR TEST

P ————————————————— NON-STANDARD PACKING

J ————————————————— SPECIAL REQUIREMENT
(NEEDS TO BE SPECIFIED)

F ————————————————— SPECIAL TRIM MATERIAL
(NEEDS TO BE SPECIFIED)

FF ———————————————— SPECIAL YOKE BUSHING,
NODULAR IRON

36224 —————————————— PRODUCT FIGURE NO., UNWELDED,
Y-PATTERN UNIVALVE STOP VALVE

1" ———————————————— VALVE SIZE, 1-INCH
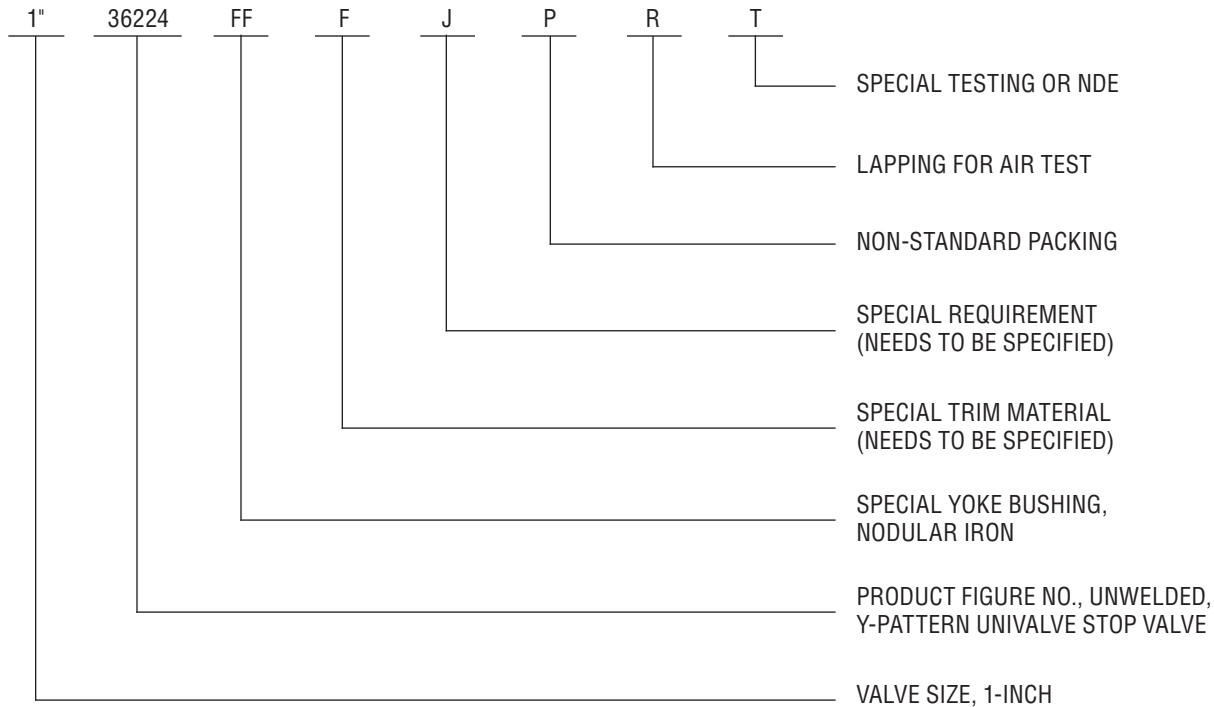
XX
1 Alpha Digit Prefix Indicates Design Revision if Applicable.

2 Alpha Digits Indicates Style of Pressure Combo Valve.

XXXXX
3-5 Digits Figure Number

(XXX)
3-4 Digits Body Material Designation

XXXXXXX
1 or more Digits As Required Suffixes (See List)

Unless otherwise specified when ordering
Edward valves, the standard material of construction for Forged
products is A105 Carbon Steel, and for Cast products is A216
Grade WCB Carbon Steel.

See the Edward Description of Figure Number System on page 8 for the letter suffixes used to indicate variations from standard construction, or special features (Ex. 618K, 7506 [WC6]Y, and 847 AH.)

When two or more suffixes follow a figure number a definite suffix sequence is to be used.

The sequence is:

1) Special material (if applicable)

2) All other applicable feature suffixes in alphabetical order. Except T1-T5 which are listed last.

High Performance for Critical Service

Temperatures that can exceed 1000°F. Pressures surpassing 10,000 psi. In critical service conditions, you can't take chances. You don't just meet standards, you exceed them. That's how Flowserve Edward forged and cast steel valves have become the specified choice for power plants, process facilities, and other high-temperature, high-pressure services.

Conservative Design

Flowserve Edward Valves takes a conservative approach to valve design. We meet all applicable codes and standards, but we go beyond that...with finite element stress analysis of critical areas and rigorous proof testing. Edward valves are built to take punishment!

And our extensive testing has also allowed us to develop extremely high flow efficiencies in all our valves.

You'll find other unique design advantages on our various product lines, such as our Equiwedge gate valves, with a two-piece wedge gate assembly that adjusts automatically to any angular distortion of the body seats. And many other design features, now considered industry "standards," started on the drawing boards at Flowserve.

Precision Manufacturing

Edward Valves also exceeds industry standards on the factory floor. Our forged valves are produced on a fully automated line, with CNC machining centers providing precise process control. And we maximize cast steel quality by producing our valve body castings using a directional solidifi-cation process from patterns designed by our own technicians. This process assures high strength void free castings for uncompromised quality.

Even with the most advanced equipment, we feel our people make the real difference at Flowserve. Our production personnel have an average 20 years in the industry, and 15 years with Flowserve! This exceptional experience level allows us to achieve an extra degree of precision that can make a very real difference in the field.

Finally, it's our people, along with our procedures for quality assurance and lot-traceability, that have earned Flowserve Edward Valves the ASME N stamp, certifying our Raleigh, North Carolina manufacturing facility for nuclear-service valve production.

Lower Total Costs

Those tough standards have carried over into every valve we manufacture. Whether it is for nuclear service or not, we design and build our valves to last at least 40 years. That means not only are they tough, but they are designed with easy maintenance in mind.

Considering the cost of valve failure, Flowserve Edward Valves quality is clearly worth specifying. That's been true since 1904, when the first Edward valve was made.

Today, as industrial companies become increasingly aware that operating expenses are part of total cost, the choice becomes both more clear and more critical than ever.

Flowserve Edward Valves • 1900 South Saunders Street, Raleigh, North Carolina 27603 • 1-800-225-6989 • 1-919-832-0525 • Fax 1-919-831-3369

Designed With an Eye on Your Bottom Line

In-house computer-aided design and finite-element method capabilities give our engineering staff powerful tools to develop reliable valves for critical service applications. CAD generated graphic models undergo FEM analysis to determine that stresses are within acceptable limits. Dynamic simulation of valve operation also helps assure reliability of Edward valve performance.

Prototyping is just as important, and rigorous proof testing is a mainstay of Edward valve design. Before we approve a valve for production, we put it through hundreds, even thousands, of cycles to demonstrate that performance and sealing integrity will be maintained in service. Transducers relay data from test assemblies to computers for further analysis.

Laboratory simulation of critical services includes a steam generator and superheater, designed for 2700 psi and 1050°F. This flexible system allows testing of prototype valves under both low pressure and high pressure conditions. In addition to prototype testing, this system has been used for applications such as: friction and wear tests of valve trim materials in hot water and steam environments; qualification tests of new or redesigned valves; and proof testing of new valve gaskets and valve stem packings.

Before we make the first production unit, that valve has already been through a rigorous program to assure long life, simple maintenance, and dependable performance for the lowest cost over the life of the valve. Again, people play important roles in design. The Flowserve product engineering department pools well over 200 years of valve experience.

Testing Beyond Code Requirements

At Flowserve Edward Valves, quality assurance starts with meeting code requirements. Valves are manufactured to ANSI B16.34 (Standard, Limited and Special Classes), including standards for:

- Minimum wall thickness of valve body.
- Body, bonnet and body-bonnet bolting to specified ASTM material standards.
- Hydrostatic shell testing at 1.5 times the 100°F rating of the valve.

From there, Flowserve Edward Valves goes on to exceed the code, with higher test standards and an additional battery of tests performed on every type of valve we make, using in-house test facilities and personnel to assure expert quality control. Edward Valves' quality assurance program includes:

Non-Destructive Examination

- All NDE personnel are qualified in accordance with ASNT-TC-1A guidelines.
- All castings are visually examined per MSS SP-55.
- The first five body castings from every pattern are 100% radiographed to verify casting quality.

Hydrostatic Testing

- The seat-leakage criteria — no visible leakage for forged steel and 2ml/hour/inch of nominal valve size for cast steel — are stricter than the allowed leakage rate of MSS SP-61, which is 10ml/hour/inch of nominal valve size.
- Seat-leakage test is performed at 110% of 100°F rating.

Statistical Process Control

Requirements are clearly stated and measurements are taken to determine conformance to those requirements. "Quality" equals conformance to requirements.

Welding

All personnel and procedures are qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

Additional Standard Tests for Specific Valves

Includes heavy-wall examination on large body castings.

We have only listed a few of the Flowserve Edward Valves standard tests that exceed industry requirements. Also, Edward Valves has the facilities and the expertise to meet additional quality-assurance standards, as required for the application.

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A History of Firsts

Feature	Benefit
Body-guided disks on globe and angle valves	Minimize wear and ensure alignment for tight sealing.
Integral Stellite hardfaced seats in globe and angle valves	Permit compact design and resist erosion.
Hermetically sealed globe valves with seal-welded diaphragms	Prevent stem leakage in critical nuclear plant applications.
Equalizers for large check and stop-check valves	Ensure full lift at moderate flow rates, and prevent damage due to instability.
Compact pressure-seal bonnet joints	Eliminate massive bolted flanges on large, high-pressure valves.
Qualified stored-energy actuators	Allow quick-closing valves in safety-related nuclear plant applications.
Qualified valve-actuator combinations	Used in main steam and feed-water service throughout the world.
Stainless steel spacer rings on gate valves, fitted between wedge halves	Simplify service. Damaged valve seats can be restored to factory fit by in-line replacement with slightly thicker ring.
Unique two-piece, flexible wedges on gate valves	Automatically adjust to any angular distortion of body seats. Shape provides greater flexibility. Assure dependable sealing and prevent sticking.
Impactor handwheels and handles	Allow workers to generate several thousand foot-pounds of torque, thus ensuring tight shutoff of manually operated globe and angle valves.
Inclined-bonnet globe valves with streamlined flow passages	Minimize pressure drop due to flow.
Globe valves available with both vertical and inclined stems	Provide stem designs suited to any installation.
Live-loaded pressure energized PressurSeat® for globe valves	Globe valve design for high pressure drain and vent service.

Miscellaneous Technical Data

Edward Technical Articles

Number	Title
EVAWP3000	A Hermetically Sealed Valve for Nuclear Power Plant Service
EVAWP3001	Development of the Edward Equiwedge Gate Valve
EVAWP3003	Nuclear Containment of Postulated Feedwater Linebreak
EVAWP3004	Quick-Closing Isolation Valves – The Equiwedge Alternative
EVAWP3005	Valve Clamp Ring Stress Analysis
EVAWP3006	Univalve Evolution – Another Advance
EVAWP3007	The Type A Stored Energy Actuator – Development and Qualification
EVAWP3008	Model for Check Valve/Feedwater System Waterhammer Analysis
EVAWP3009	Minimizing Use of Cobalt and Strategic Materials in Valves
EVAWP3010	Asbestos-Free Stem Packing for High Temperature Valves
EVAWP3011	Quick-Closing Equiwedge Isolation Valves Global Qualification
EVAWP3012	Avoiding Aluminum Nitride Embrittlement in Steel Castings for Valve Components
EVAWP3013	Quick Closing Equiwedge Isolation Valves Global Qualification
EVAWP3014	Tests of Asbestos-Free Stem Packings for Valves for Elevated Temperature Service
EVAWP3015	Design Basis Qualification of Equiwedge Gate Valves for Safety-Related MOV Applications
EVAWP3016	Flow Performance, Stability and Sealability of Piston Lift and Tilting Disk Check Valves
EVAWP3017	Edward Cast Steel, Pressure-Seal Valves: Research and Development
EVAWP3018	Pressure Locking and Overpressurization of Double Seated Valves
EVAWP3019	Check and Stop-Check Valves for High Turndown Applications
EVAWP3020	PressurCombo
EVAWP3021	Hermavalve-A Zero Emissions Valve

Copies of the above Technical Articles are available upon request, or at www.flowserve.com.

Sources for Additional Information

For further guidance on selection, shipping and storage, installation, operation, and maintenance of valves, readers are referred to the following documents:

MSS Valve User Guide
MSS SP-92

Available from:

Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
127 Park Street N.E.
Vienna, Virginia 22180

Aging and Service Wear of Check Valves Used in Engineering Safety-Feature Systems of Nuclear PowerPlants

Nureg/CR-4302

Ornl-6193/V1

Operating Experience and Failure Identification

Available from:

Superintendent of Documents
U.S. Government Printing Office
P.O. Box 37082
Washington, D.C. 20013-7982

And from:

National Technical Information Service
Springfield, Virginia 22161
EPRI Report No. NP 5479

Application Guidelines for Check Valves in Nuclear Power Plants

Available from:

Electric Power Research Institute
Research Reports Center
P.O. Box 50490
Palo Alto, CA 94303

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Special Application Valves
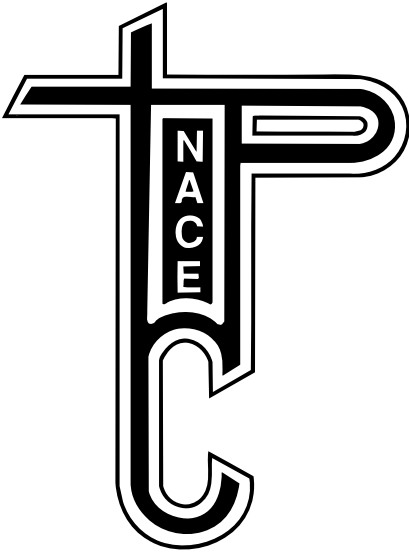
NACE VALVES

(NATIONAL ASSOCIATION OF CORROSION ENGINEERS)
Flowserve Edward Valves can provide valves constructed of materials that meet NACE standards MR-01-75 and MR-01-03 for sour service.

This standard entitled "Sulfide Stress Cracking Resistant Metallic Materials For Oil Field Equipment" covers material requirements for production, drilling, gathering and flow line equipment used in hydrogen sulfide bearing hydrocarbon service.

SPECIAL TRIM

Flowserve Edward Valves provides a standard valve trim that is compatible with the valve body chemistry, pressure class, operating temperature, and fluid. However, on application special trim materials to meet specific customer needs can be provided. Edward also can provide cobalt-free trim for nuclear applications.

- Cobalt Based Alloy 6
- Cobalt Based Alloy 21
- Iron Based Alloy
- Nickel Based Alloy
- Austenitic stainless steel
- Martensitic stainless steel
- Precipitation hardened stainless steel
- Super alloy steel

NON-STANDARD ENDS

Most Edward forged and cast steel valves can be provided with welding ends or flanged ends (small forged valves with threaded or socket weld ends also). On special order non-standard ends can be furnished to meet specific customer requirements. A partial list of available options include:

- GRAYLOC® hubs.
- Special flange facings.
- Non-standard end-to-end lengths — most Edward valves are manufactured to ANSI B16.10 criteria; however, non-standard ends are available as a special order.
- Venturi ends.
- Flanged by buttweld.
- Blank ends.
- Others as required.

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Features and Description of Edward Univalve® Globe Valves
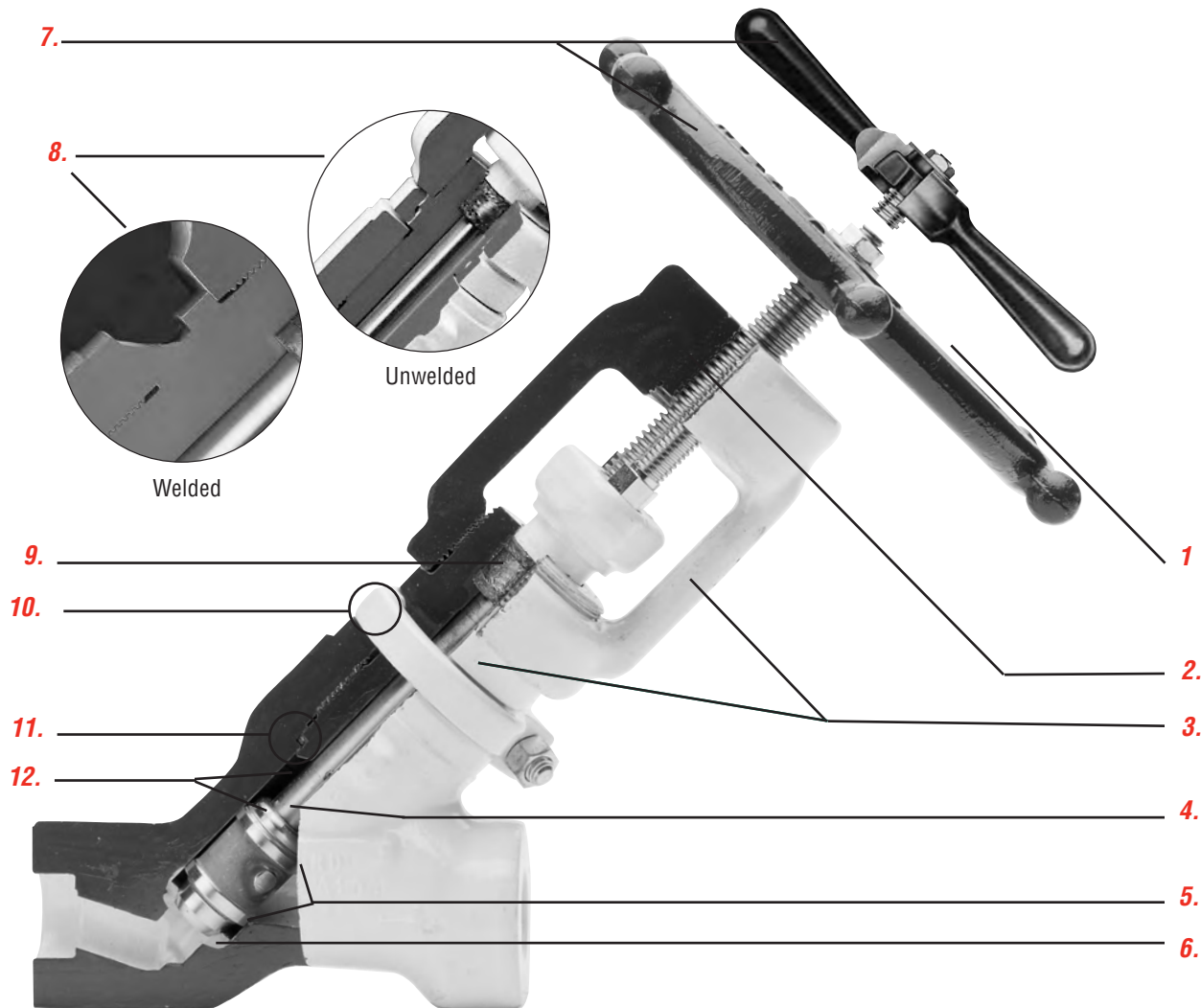
7.

8.

Unwelded

Welded

9.

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12.

1

2.

3.

4.

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6.

1. Stem has ACME threads, is ground to a fine finish and is hardened to resist wear.

2. Yoke bushing material has low coefficient of friction which substantially reduces torque and stem wear and eliminates galling. Mechanical upset locks yoke bushing to yoke.

3. Yoke-bonnet assembly is two piece to facilitate disassembly for faster in-line internal repairs.

4. Inclined stem construction and optimum flow shape minimizes flow direction changes and reduces pressure drop.

5. Body-guided disk utilizes anti-thrust rings to eliminate misalignment, galling and stem bending.

6. Integral hardsurfaced seat provides positive shutoff and long seat life.

7. Handwheel on smaller size valves is rugged and knobbed to provide sure grip even when wearing gloves. Impactor handle or

handwheel on larger, higher pressure valves provides many times the closing force of an ordinary handwheel for positive seating.

8. Threaded bonnet has ACME threads for resistance to galling and ease of disassembly. Unwelded models utilize a graphitic gasket for dependable sealing. Welded models employ a fillet weld (canopy weld on stainless steel valves) for absolute protection from body-bonnet leakage.

9. Stem packing system utilizes flexible graphite packing material with carbon fiber anti-extrusion rings for optimum sealability and life.

10. Bonnet locking collar (unwelded valves only)

11. Bonnet seal ring is die formed flexible graphite gasket seated to a prescribed bonnet torque to provide reliable bonnet seal.

12. Integral backseat provides a secondary stem seal back up for positive shutoff and leak protection.

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Part Specification List for Edward Univalve®

This is not a complete list. Construction and materials will vary between sizes and pressure classes and may be changed without notice. For a complete, accurate, and itemized description of a particular valve, contact your Flowserve Edward Valves sales representative.

Description	ASTM No.	ASTM No.	ASTM No.	ASTM No.	ASTM No.
Body	A-105 —	A-182 Grade F-22	A-182 Grade F-316/F-347*	A-182 Grade F91	A-182 Grade F92
Bonnet	A-105	A-739 Grade B-22	A-479 T-316/347	A-182 Grade F91	A-182 Grade F92
Stem	A-479 T-410CL3	A-479 T-410CL3	A-638 Grade 660	A-638 Grade 660	A-638 Grade 660
Disk	A-732 Grade 21	A-732 Grade 21	A-732 Grade 21	A-732 Grade 21	A-732 Grade 21
Body Seat	Stellite 21	Stellite 21	Stellite 21	Stellite 21	Stellite 21
Junk Ring	—	—	A-732 Grade 21	—	—
Packing Rings	Flexible Graphite System	Flexible Graphite System	Flexible Graphite System	Flexible Graphite System	Flexible Graphite System
Gland	A-668 Grade 4140	A-668 Grade 4140	A-182 Grade F6a	A-668 Grade 4140	A-668 Grade 4140
Gland Adjusting Screw	A-582 T-416	A-582 T-416	A-582 T-416	A-582 T-416	A-582 T-416
Yoke	A-181 Class 70	A-181 Class 70	A-181 Class 70	A-181 Class 70	A-181 Class 70
Yoke Bushing	B150 Alloy C61900 or C62300	B150 Alloy C61900 or C62300	B150 Alloy C61900 or C62300	B150 Alloy C61900 or C62300	B150 Alloy C61900 or C62300
Yoke Bolt	A-307 Grade A	A-307 Grade A	A-307 Grade A	A-307 Grade A	A-307 Grade A
Yoke Nut	A-563 Grade A	A-563 Grade A	A-563 Grade A	A-563 Grade A	A-563 Grade A
Handwheel/ Impactor Handle Adapter	Malleable or Ductile Iron	Malleable or Ductile Iron	Malleable or Ductile Iron	Malleable or Ductile Iron	Malleable or Ductile Iron
Stem Nut/Washer	Mild Steel Plated	Mild Steel Plated	Mild Steel Plated	Mild Steel Plated	Mild Steel Plated
Bonnet Seal Ring**	Flexible Graphite	Flexible Graphite	Flexible Graphite	Flexible Graphite	Flexible Graphite
Bonnet Insert†	A-582 T-416	A-582 T-416	A-479 T-316	A-582 T-416	A-582 T-416
Locking Collar†††	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel
Spring††	A-313 T-302	A-313 T-302	A-313 T-302	INCONEL X-750	INCONEL X-750

*Parts shown above are not applicable to all Univalve® valves. * Other Stainless grades available on application. ** Used in unwelded and Class 4500 welded design only. † Class 4500 welded design only. †† Check valves only. ††† Unwelded valves only.*

Edward Forged Steel Valves Feature Body-Guided Disks

Body Guided Disks Prevent Side-Thrust and Eliminate — 1. Stem galling & binding

2. Disk-seat misalignment and damage 3. High operating torque

Valve disks are guided by rings that fit snugly within the body bore and ensure perfect disk-and-seat alignment despite the side thrust of modern high velocities and high pressure-differentials. This protects the stem and its contact points; eliminates galling, scoring, bending and the high operating torque resulting from these abuses. Because they eliminate disk wobble and ensure alignment of disk with seat, they also provide more dependable closing and longer disk, seat and body life.

Double Duty for Lower Bearing - The lower ring not only serves as a highly efficient anti-side thrust bearing but serves too, as a "flow director." Its snug fit within the bonnet bore reduces by 90% the amount of flow that can get into the bonnet cavity and exert thrust forces against the side of the disk. In short, the anti-thrust ring design diverts 90% of the line forces into controllable channels.

Machining is Important, Too - To ensure concentric align-ment essential to tight seating, the body bore and the stellite seat are both machined in a single operation. The disk's anti-thrust rings and conical stellite seat face are also faced in a single operation.

Streamlined Flow Passages for Highest C_v Values - The inclined bonnet globe stop valves (and check and stop-check valves) continue the Flowserve reputation for the ultimate in flow passage streamlining. Inclined bonnet construction minimizes flow directional changes and minimizes wear caused by excessive turbulence.

Whether it's pounds per hour of steam or gallons per minute of liquid, the inclined bonnet valves give you better flow capacity.

Flow Under or Over Disk - Normal practice is to install globe valves with flow entering from below the disk. However, piping designers may confidently install Edward globe stop valves with flow entering over the disk when space problems or other considerations suggest this procedure. Our valves operate equally well with flow in either direction; however, with flow over the disk, packing is under pressure when the valve is closed and there is a slight penalty in C_v value.
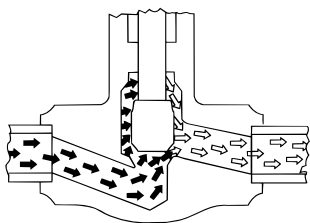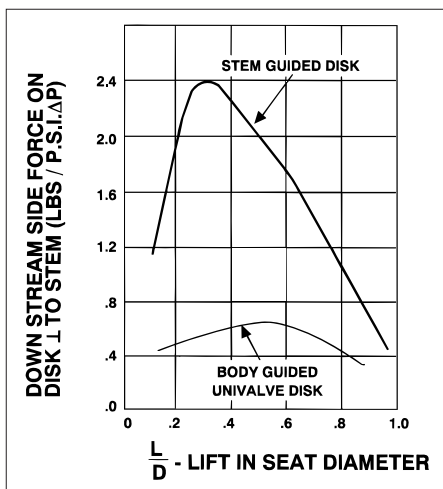
Figure 1
Ordinary Vertical Stem Globe Valves are subject to side-thrust under high pressure drop condi-tions. Illustration shows how upstream pressure can slip past stem-guided disk and impart a thrust toward the downstream side of the valve. Tests have proven that this thrust causes disk-seat misalignment plus galling and scoring.
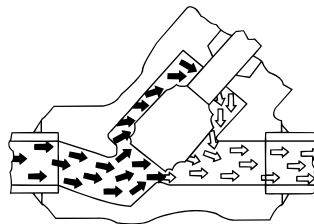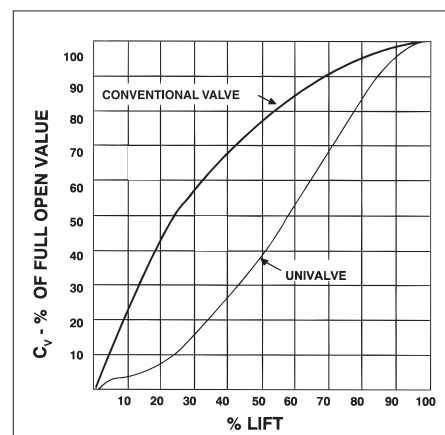
Figure 2
Inclined Stem Globe Valves of the stem-guided type are also subject to side-thrust under the same conditions. This illustration shows path pressure through the valve.
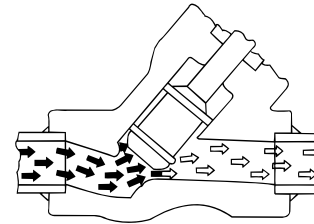
Figure 3
This illustration shows the Edward body-guided disk with anti-thrust rings. Lower guide eliminates 90% of the flow upward and behind the disk. Both guide rings maintain perfect alignment. This effectively eliminates all side-thrust problems.
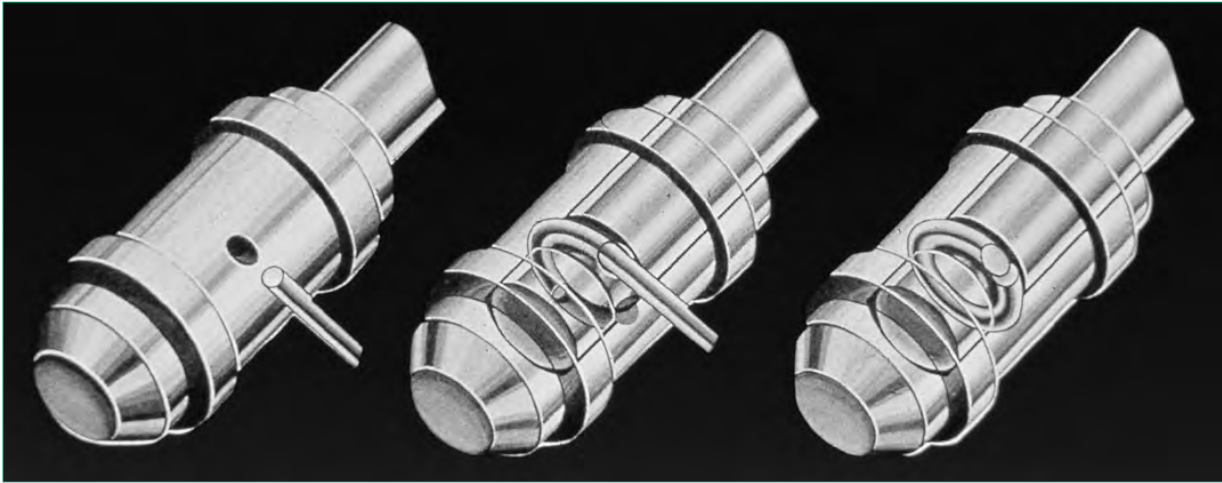
Figure 4
Graph illustrates relationship of side-thrust in conventional stem-guided Globe Valve and in Edward Univalve with body-guided disk.

Figure 5
Graph illustrates typical throttling curves for conven-tional stem-guided Globe Valve and Univalve. Note, the Univalve Curve il-lustrates that finest control is obtained at low lifts, when it is needed. Contrast this with conven-tional valve curve which shows rapid flow increase as disk lifts off seat.

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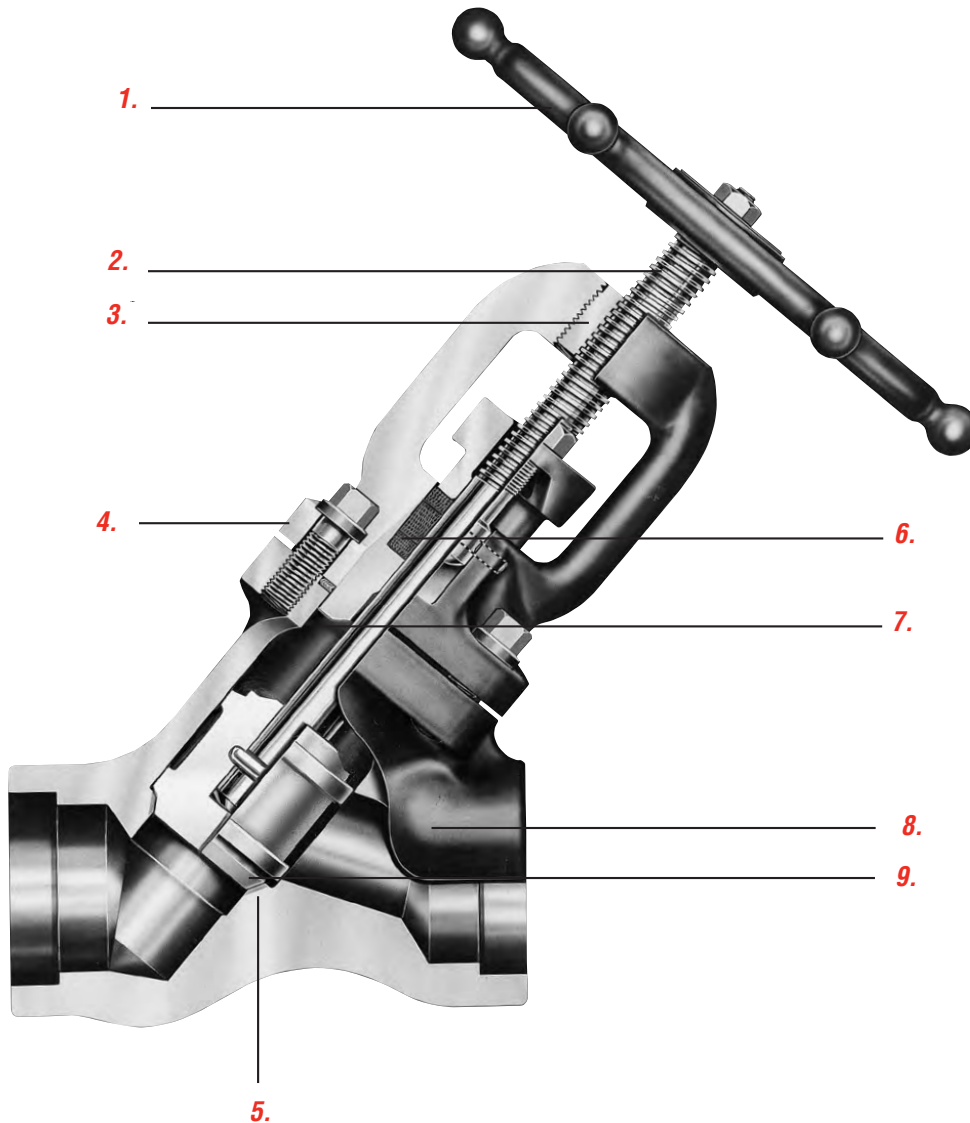# *Here's How the Unique Stem-Disk Assembly is Made…*

Figure 1
First, a Stellite wire is inserted into a hole in a Univalve body guided disk.

Figure 2
Next, the Stellite wire is fed around circular grooves, adjacent to one another, on the inside bore of the disk and outside diameter of the stem.

Figure 3
Finally the hole through which the wire was fed is welded closed.

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Features and Description of Edward Bolted Bonnet Globe Valves

1. **Handwheel** is rugged and knobbed to provide sure grip even when wearing gloves.

2. **Stem** has ACME threads, is ground to a fine finish and is hardened to resist wear.

3. **Yoke bushing material** has low coefficient of friction which substantially reduces torque and stem wear and eliminates galling. Mechanical upset locks yoke bushing to yoke.

4. **Bolted Bonnet joint** utilizes a spiral wound gasket for positive sealing and four-bolt design for ease of assembly. Bonnet has pilot extension to ensure proper alignment and positive metal to metal stop to prevent over-compression of gasket.

5. **Integral hardsurfaced seat** provides positive shutoff and long seat life.

6. **Stem packing system** utilizes flexible graphite packing material with anti-extrusion rings for optimum sealability and life.

7. **Integral backseat** provides a secondary stem seal backup for positive shutoff and leak protection.

8. **Body** utilizes optimized flow passages to minimize flow direction changes and reduce pressure drop.

9. **Body-guided disk** utilizes anti-thrust rings to eliminate misalignment, galling and stem bending.

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Part Specification List for Edward Bolted Bonnet Globe Valves

This is not a complete list. Construction and materials will vary between sizes and pressure classes and may be changed without notice. For a complete, accurate, and itemized description of a particular valve, contact your Edward Valves sales representative.

Description	Bolted Bonnet	
	ASTM No.	ASTM No.
Body/Bonnet	A-105 —	A-182 Grade F11
Disk	AISI 615 Stainless Steel	AISI 615 Stainless Steel
Body Seat	Stellite 21	Stellite 21
Stem	A-582 T-416	A-582 T-416
Cap Screws	A-193 Grade B-7	A-193 Grade B-7
Gasket	Spiral Wound Non Asbestos	Spiral Wound Non-Asbestos
Packing	Flexible Graphite System	Flexible Graphite System
Gland	A-536 GR. 80-55-06	A-536 GR. 80-55-06
Yoke Bushing	B-150 C61900 or C62300	B-150 C61900 or C62300
Handwheel/Handle	Malleable or Ductile Iron	Malleable or Ductile Iron
Stem Nut	Mild Steel-Plated	Mild Steel-Plated
Eye Bolt	A-582 T-416	A-582 T-416
Eye Bolt Nut	A-563 Grade A	A-563 Grade A
Eye Bolt Pin	AISI Grade 4140	AISI Grade 4140
Spring**	A-313 T302	A-313 T302
Ball**	A-276 T440 C	A-276 T440 C

*Check valves only
NOTES: Parts shown above are not applicable to all Bolted Bonnet valves. Consult your Flowserve sales representative for special applications.
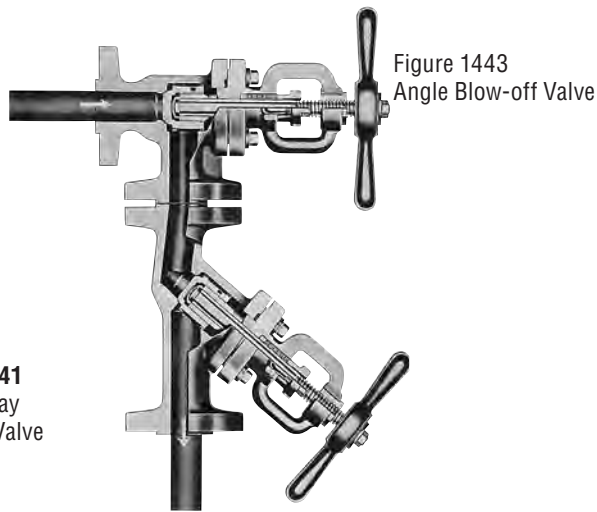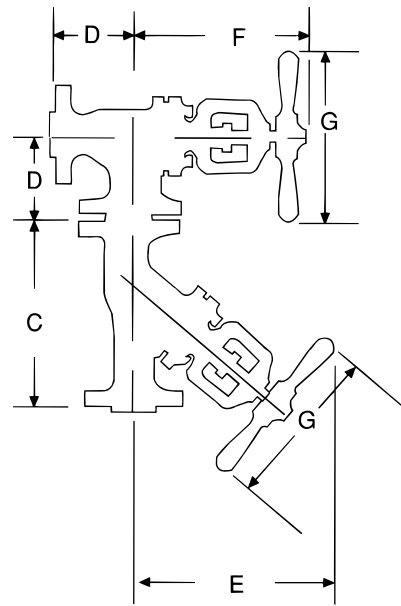
Blow-Off Valves, Class 300

Figure 1443
Angle Blow-off Valve

Figure 1441
Straightway
Blow-off Valve

1443/1441

Standard Features

- Size 1½ and 2 bodies & bonnets are forged steel (A105).
- Size 2½ bodies and bonnets are cast steel (WCB).
- Bolted bonnet, OS & Y.
- Straightway and angle design.
- Size 1½ and 2 have hardened stainless steel disk.
- Size 2½ has Stellite faced disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free spiral wound bonnet gasket.
- Impactor handle.

Standards

Edward valves sold for blow-off service are designed and manufactured to comply with all Boiler Code criteria for valves used in these applications.

Note: For Tandem Blow-off valve operation:
Opening - Open upstream valve completely, then slowly open the downstream valve.
Closing - Close the downstream valve completely and tightly seat, then close and tightly seat the upstream valve.

Pressure Class 300 (PN 50)

FIG. NO.	TYPE	ENDS	NPS (DN)
1441	Globe	Flanged	1½ (40) thru 2½ (65)
1441Y	Globe	Socket Welding	1½ (40) & 2 (50)
1441Y	Globe	Buttwelding	2½ (65)
1443	Angle	Flanged	1½ (40) thru 2½ (65)
1443Y	Angle	Socket Welding	1½ (40) & 2 (50)
1443Y	Angle	Buttwelding	2½ (65)

Pressure Ratings (B16.34 Standard Class)

Flanged or Welding Ends	Class 300 Primary Service
Maximum Boiler Drum Pressure*	490 PSI (33.8 BAR)
Maximum Non-Shock	740 PSI @ 100°F (51.1 BAR)

*This adjusted pressure rating represents the maximum allowable working pressure for this Class valve in boiler feed and blow-off line service.

![Flowserve logo]

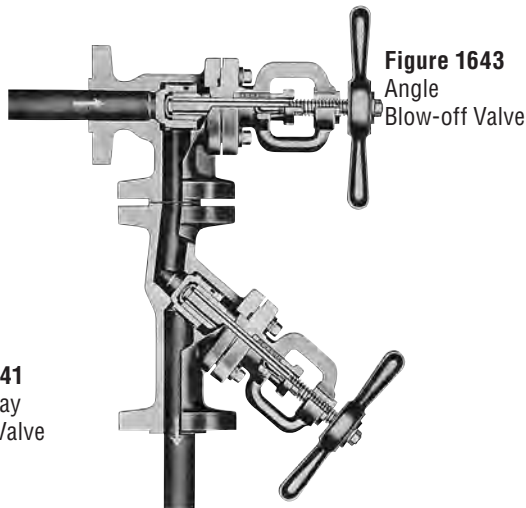# Blow-Off Valves, Class 300
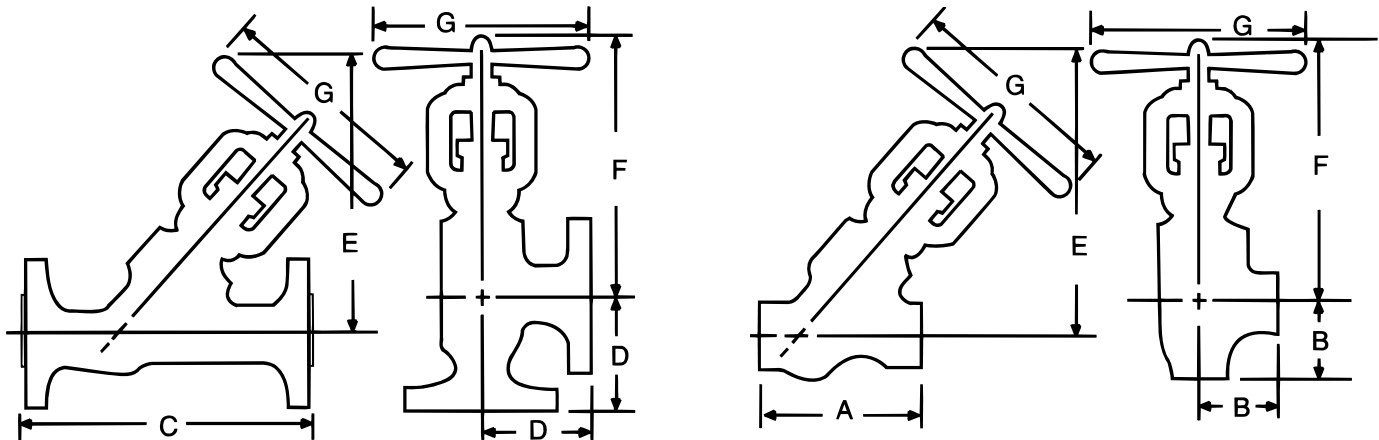
Dimensions - Globe & Angle

Figure No. 1441/1441Y, 1443/1443Y	NPS	1½	2	2½
	DN	40	50	65
A - End to End, Globe (Welding)		6.8	8	11.5
		173	203	292
B - Center to End, Angle (Welding)		3.4	3.8	5.8
		86	97	147
C - Face to Face, Globe (Flanged)		12	12.8	14
		305	325	356
D - Center to Face, Angle (Flanged)		4.5	5.3	5.8
		114	135	147
E - Center to Top, Globe (Open)		13.4	15.3	15.9
		340	389	404
F - Center to Top, Angle (Open)		12.3	13.9	14.3
		312	353	363
G - Handwheel/Handle Diameter		11	11	11
		279	279	279
Weight, Globe (Flanged)		42	60	92
		18.9	27	41.7
Weight, Globe (Welding)		27	38	60
		12.2	17.1	27
Weight, Angle (Flanged)		39	53	82
		17.6	23.9	37.2
Weight, Angle (Welding)		25	36	54
		11.3	16.2	24.3

Blow-Off Valves, Class 400 & 600

Figure 1643
Angle
Blow-off Valve

Figure 1641
Straightway
Blow-off Valve
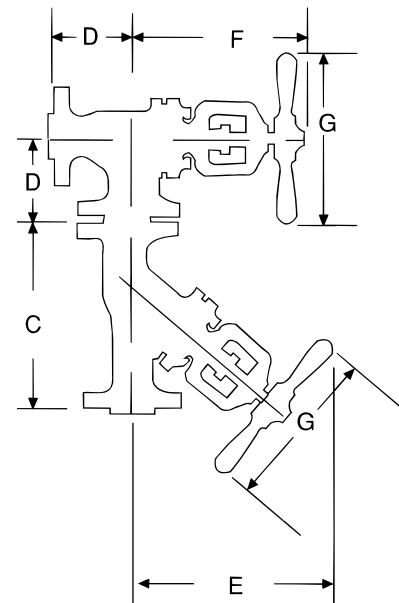
1643/1641
Angle Globe

Standard Features

- Size 11/2 and 2 bodies & bonnets are forged steel (A105).
- Size 21/2 bodies and bonnets are cast steel (WCB).
- Bolted bonnet, OS & Y.
- Straightway and angle design.
- Size 11/2 and 2 have hardened stainless steel disk.
- Size 21/2 has Stellite faced disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free spiral wound bonnet gasket.
- Impactor handle.

Standards

Edward valves sold for blow-off service are designed and manufactured to comply with all Boiler Code criteria for valves used in these applications.

Pressure Class 400 (PN 68) & 600 (PN 110)

FIG. NO.	TYPE	ENDS	NPS (DN)
1641	Globe	Flanged	1½ (40) thru 2½ (65)
1641Y	Globe	Socket Welding	1½ (40) & 2 (50)
1641Y	Globe	Buttwelding	2½ (65)
1643	Angle	Flanged	1½ (40) thru 2½ (65)
1643Y	Angle	Socket Welding	1½ (40) & 2 (50)
1643Y	Angle	Buttwelding	2½ (65)

Pressure Ratings (B16.34 Standard Class)

Flanged or Welding Ends	Class 600 Primary Service
Maximum Boiler Drum Pressure*	935 PSI (64.5 BAR)
Maximum Non-Shock	1480 PSI @ 100°F (102.1 BAR)

*This adjusted pressure rating represents the maximum allowable working pressure for this Class valve in boiler feed and blow-off line service.
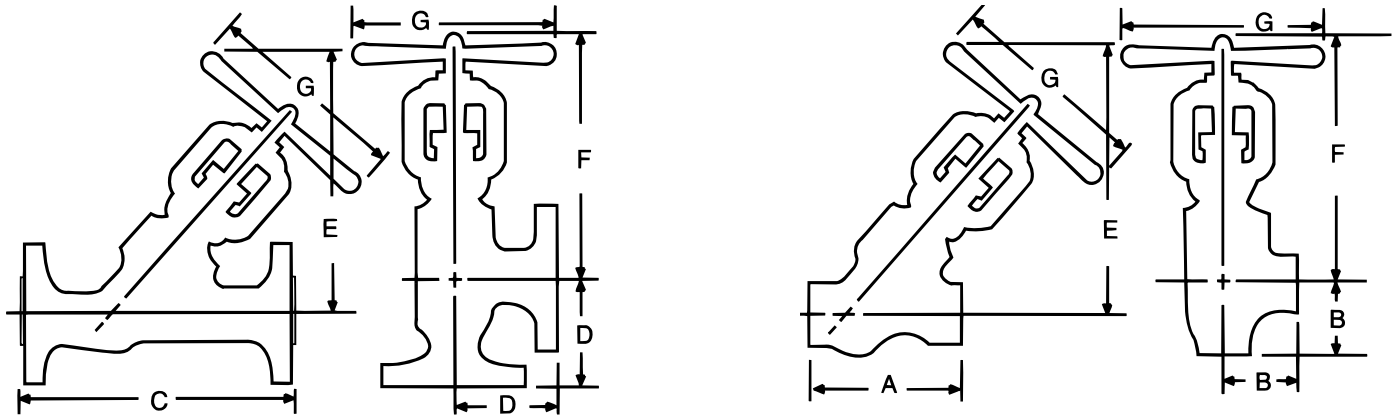
Note: For Tandem Blow-off valve operation:
   Opening - Open upstream valve completely, then slowly open the downstream valve.
   Closing - Close the downstream valve completely and tightly seat then close and tightly seat the upstream valve.

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Blow-Off Valves, Class 400 & 600

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 1641/1641Y, 1643/1643Y	NPS	1½	2	2½
	DN	40	50	65
A - End to End, Globe (Welding)		6.8	8	11.5
		173	203	292
B - Center to End, Angle (Welding)		3.4	3.8	5.8
		86	97	147
C - End to End, Globe (Flanged)		12.4	13.1	14.4
		315	333	366
D - Center to End, Angle (Flanged)		4.8	5.8	6.5
		122	147	165
E - Center to Top, Globe (Open)		13.4	15.3	15.9
		340	389	404
F - Center to Top, Angle (Open)		12.4	13.9	14.3
		315	353	363
G - Handwheel/Handle Diameter		11	11	11
		279	279	279
Weight, Globe (Flanged)		44	62	95
		19.8	27.9	43.1
Weight, Globe (Welding)		27	38	76
		12.2	17.1	34.2
Weight, Angle (Flanged)		41	55	85
		18.5	24.8	38.5
Weight, Angle (Welding)		25	36	66
		11.3	16.2	29.7

Blow-Off Valves, Class 1500 & 2500

Standard construction Flowserve Edward Class 1690 and Class 2680 carbon steel Univalves are supplied for Class 1500 and Class 2500 Blow-Off valve applications.

Although these Univalves are manufactured and tagged to ANSI B16.34 Limited Class ratings, these valves meet and exceed all Boiler Code criteria for boiler feed and blow-off line service.

Standard Features

- Body Material is A105 carbon steel.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern and Angle Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Asbestos-free graphitic packing.
- Impactor Handle/Impactor Handwheel.

Refer to pages 42, 45, 48 and 51 – Univalve Stop Valve, Class 1690 and 2680 for dimensions, etc.

Pressure Class 1500 (PN 260) & 2500 (PN 420)

FIG. NO.				TYPE	ENDS	NPS (DN)
WELDED		UNWELD				
1500	2500	1500	2500			
36124	66124	36224	66224	Globe	Socket Welding	1½ (40) thru 2 (50)
36128	66128	36228	66228	Globe	Buttwelding	2½ (65)

FIG. NO.				TYPE	ENDS	NPS (DN)
WELDED		UNWELD				
1500	2500	1500	2500			
36125	66125	36225	66225	Angle	Socket Welding	1½ (40) thru 2 (50)
36129	66129	36229	66228	Angle	Buttwelding	2½ (65)

Pressure Ratings (B16.34 Standard Class)

Socket or Welding Ends	Class 1500 Primary Service	Class 2500 Primary Service
Maximum Boiler Drum Pressure*	2455 PSI	3206 PSI#
	(169.3 BAR)	(221.1 BAR)
Maximum Non-Shock	3705 PSI @ 100°F	6170 PSI @ 100°F
	(255.3 BAR)	(425.5 BAR)

 * This adjusted pressure rating represents the maximum allowable working pressure for this Class valve in boiler feed and blow-off line service.
Rating exceeds critical pressure of water.

Note: For Tandem Blow-off valve operation:
 Opening - Open upstream valve completely, then slowly open the downstream valve.
 Closing - Close the downstream valve completely and tightly seat, then close and tightly seat the upstream valve.

Continuous Blowdown Valves, Class 1925, 4,815 PSI @ 100°F (331.8 BAR @ 38°C)

Standard Features

- Available Body Materials
  - A105 carbon steel.
  - F22 alloy steel.
  - Other materials on application.
- Unwelded (graphitic seal) or Welded Bonnet.
- OS & Y.
- Angle Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Integral backseat.
- Asbestos-free graphitic packing.
- Stellited flow passage.
- Position indicator
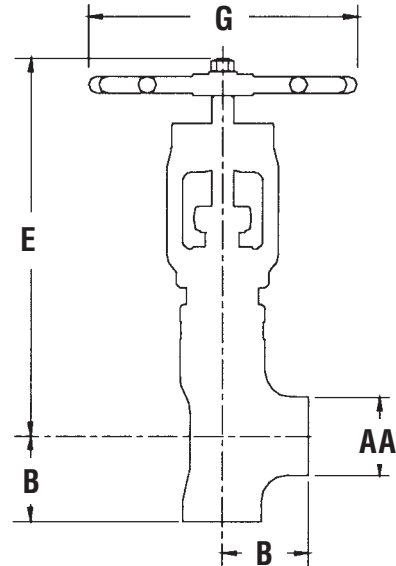
Pressure Class 1925

Size	Figure No.		Ends	Orifice Number[1]	Orifice Size
	Welded Bonnet	Unwelded Bonnet			
NPS 1 thru 1½ DN 25 thru 40	35125	35225	Socket Welding	-2	0.12 (3)
				-3	0.18 (5)
				-4	0.25 (6)
	35129	35229	Butt Welding[4]	-5	0.31 (8)
				-6	0.38 (10)
NPS 2 thru 2½ DN 50 thru 65	35129	35229	Butt Welding	-7	0.44 (11)
				-8	0.50 (13)
				-10	0.62 (16)
NPS 1¼ thru 3[2] DN 40 thru 80	35125	35225	Socket Welding[3]	-12	0.75 (19)
				-14	0.88 (22)
	35129	35229	Butt Welding	-16	1.00 (25)
NPS 2½[5] thru 4[2] DN 65 thru 100	35129	35229	Butt Welding	-18	1.12 (29)
				-20	1.25 (32)

1. Orifice number is added to Figure Numbers shown to form complete figure number (ie: 35125-7).
2. Valve sizes 2½ and smaller are ANSI B16.34 Limited Class. Size 3&4 valves are Special Class.
5. NPS 2½, socket welding only (35225)

3. Socket Welding ends are not available in Size 3 valves.
4. NPS 1 through 1½, butt weld valves, minimum bore is 0.875".

Dimensions

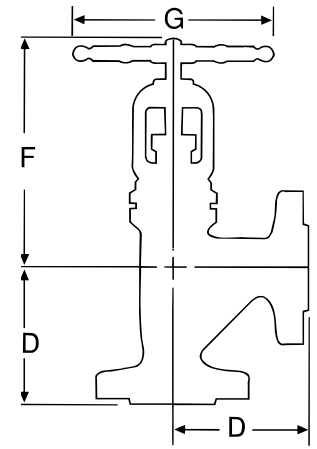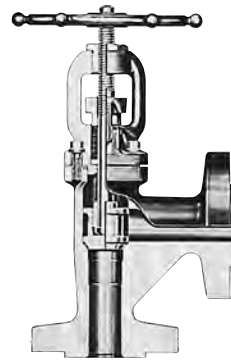| Orifice Number	Valve Sizes	AA Hub Diameter	B Center to Face	E Center to Top (open)	G Handwheel/ Handle Diameter	W Weight
-2 thru -10	1 thru 2½	3.0 76	2.6 67	11.1 282	8.5 216	25 11
-12 thru -16	1¼ thru 3	3.8 97	3.6 91	14.7 373	11* 279	45 20
-18 thru -20	2½ thru 4	4.8 122	5.3 135	19.7 500	16** 406	130 59

* Impactor Handle   ** Impactor Handwheel

27

Stop Valves, Class 600, 1480 PSI @ 100°F (102.1 BAR @ 38°C)
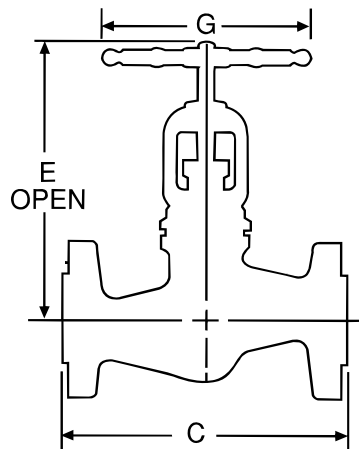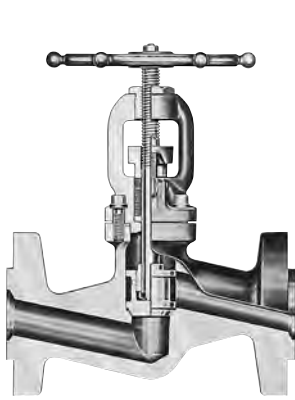
828

829

Standard Features

- Bodies and bonnets are of forged steel (A105).
- Bolted bonnet, OS&Y.
- Globe & angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.

Pressure Class 600 (PN 110)

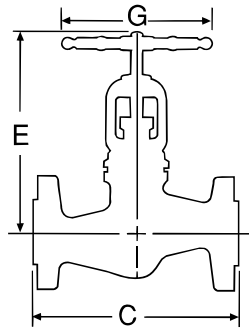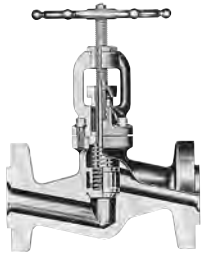| Fig. No.	Type	Ends	NPS (DN)
828	Globe	Flanged	½ (15) thru 2 (50)
829	Angle	Flanged	

- Asbestos-free graphitic packing.
- Asbestos-free spiral wound bonnet gasket.
- Knobbed handwheel.
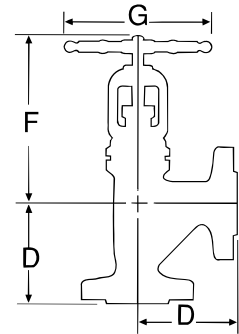
Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 828, 829	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face, Globe (Flanged)		6.5	7.5	8.5	9.5	9.5	11.5
		165	191	216	241	241	292
D - Center to Face, Angle (Flanged)		3.3	3.8	4.3	4.8	4.8	5.8
		84	97	109	122	122	147
E - Center to Top, Globe (Open)		6.1	6.9	7.7	11.1	11.1	12.1
		155	175	196	282	282	307
F - Center to Top, Angle (Open)		5.7	6.4	7.1	10.2	10.2	11.0
		145	163	180	259	259	279
G - Handwheel Diameter		3.8	4.3	4.8	7.1	7.1	8.5
		97	109	122	180	180	216
Weight, Globe		7.5	12	16	27	32	38
		3.4	5.4	7.2	12.2	14.4	17.1
Weight, Angle		7	11	15	26	31	36
		3.2	5	6.8	11.7	14	16.2

28

Stop-Check Valves, Class 600, 1480 PSI @ 100°F (102.1 BAR @ 38°C)

846

847

Standard Features

- Bodies and bonnets are of forged steel (A105).
- Bolted bonnet, OS & Y.
- Globe & angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.
- Asbestos-free spiral wound bonnet gasket.
- Knobbed handwheel.
- Stainless steel spring.

Pressure Class 600 (PN 110)

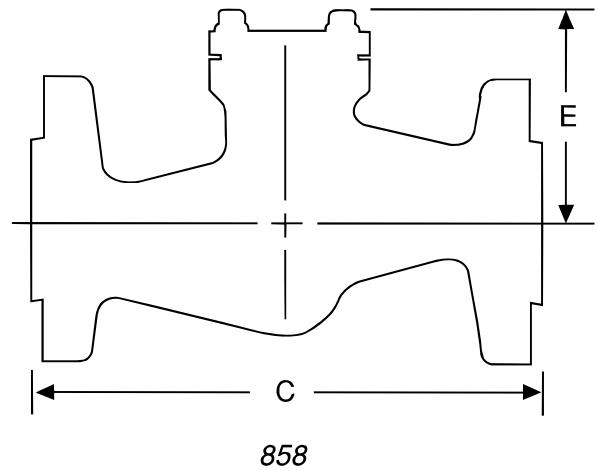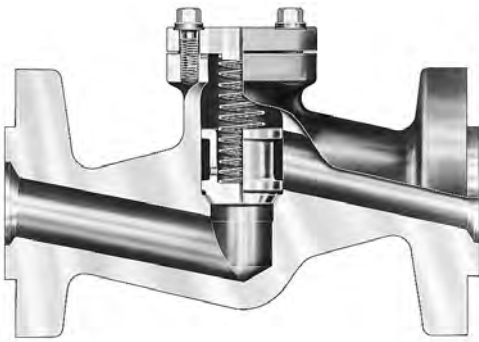| Fig. No.	Type	Ends	NPS (DN)
846	Globe	Flanged	½ (15) thru 2 (50)
847	Angle	Flanged	

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 846, 847	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face, Globe (Flanged)		6.5	7.5	8.5	9.5	9.5	11.5
		165	191	216	241	241	292
D - Center to Face, Angle (Flanged)		3.3	3.8	4.3	4.8	4.8	5.8
		84	97	109	122	122	147
E - Center to Top, Globe (Open)		6.1	6.9	7.7	11.1	11.1	12.1
		155	175	196	282	282	307
F - Center to Top, Angle (Open)		5.7	6.4	7.1	10.2	10.2	11.0
		145	163	180	259	259	279
G - Handwheel Diameter		3.8	4.3	4.8	7.1	7.1	8.5
		97	109	122	180	180	216
Weight, Globe		7.5	12	16	27	32	38
		3.4	5.4	7.2	12.2	14.4	17.1
Weight, Angle		7	11	15	26	31	36
		3.2	5	6.8	11.7	14	16.2

Piston Check Valves, Class 600, 1480 PSI @ 100°F (102.1 BAR @ 38°C)

858

Standard Features

- Bodies and covers are of forged steel (A105).
- Bolted cover.
- Globe design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Asbestos-free spiral wound cover gasket.
- Stainless steel spring.

Pressure Class 600 (PN 110)

Fig. No.	Type	Ends	NPS (DN)
858	Globe	Flanged	½ (15) thru 2 (50)

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 858	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face, Globe (Flanged)		6.5	7.5	8.5	9.5	9.5	11.5
		165	191	216	241	241	292
E - Center to Top		2.3	2.7	3.1	4.2	4.2	4.7
		58	69	79	107	107	119
Weight		6.5	11	13	21	26	29
		2.9	5	5.9	9.5	11.7	13.1

Stop Valves, Class 800, 2000 PSI @ 100°F (137.9 BAR @ 38°C)
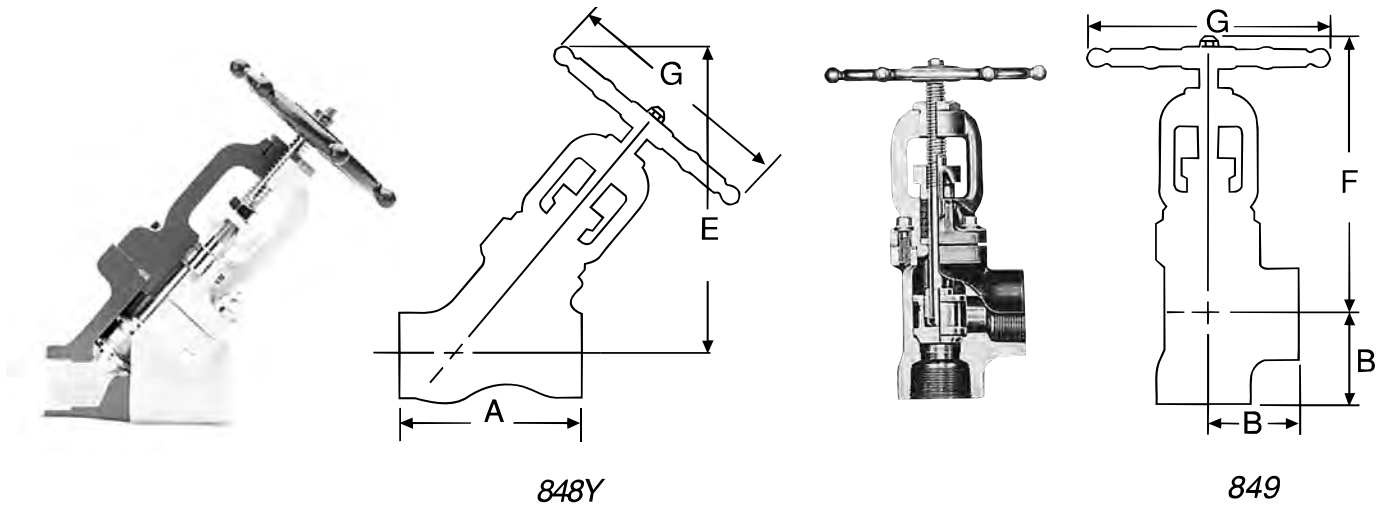
848Y

849

Standard Features

- Bodies and bonnets are of forged steel (A105 or F11).
- Bolted bonnet, OS & Y.
- Y-Pattern or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.

Pressure Class 800 *(PN 130)*

Fig. No.	Type	Ends	NPS (DN)
848	Y-Pattern	Threaded	
848Y	Y-Pattern	Socket Welding	¼ (8) thru 2 (50)
849	Angle	Threaded	
849Y	Angle	Socket Welding	

- Asbestos-free spiral wound bonnet gasket.
- Knobbed handwheel.

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 848/848Y, 849/849Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End, Globe		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
B - Center to End, Angle		1.5	1.5	1.5	1.8	2	2.9	2.9	3.3
		38	38	38	46	51	74	74	84
E - Center to Top, Globe (Open)		6	6	6	6.8	7.6	10.9	10.9	12.1
		152	152	152	173	193	277	277	307
F - Center to Top, Angle (Open)		5.7	5.7	5.7	6.4	7.1	10.2	10.2	11
		145	145	145	163	180	259	259	279
G - Handwheel Diameter		3.8	3.8	3.8	4.3	4.8	7.1	7.1	8.5
		97	97	97	109	122	180	180	216
Weight, Globe		4	4	4	5.5	7.5	16	16	23
		1.8	1.8	1.8	2.5	3.4	7.2	7.2	10.4
Weight, Angle		4	4	4	5.5	7	17	17	24
		1.8	1.8	1.8	2.5	3.2	7.7	7.7	10.8

Stop-Check Valves, Class 800, 2000 PSI @ 100°F (137.9 BAR @ 38°C)
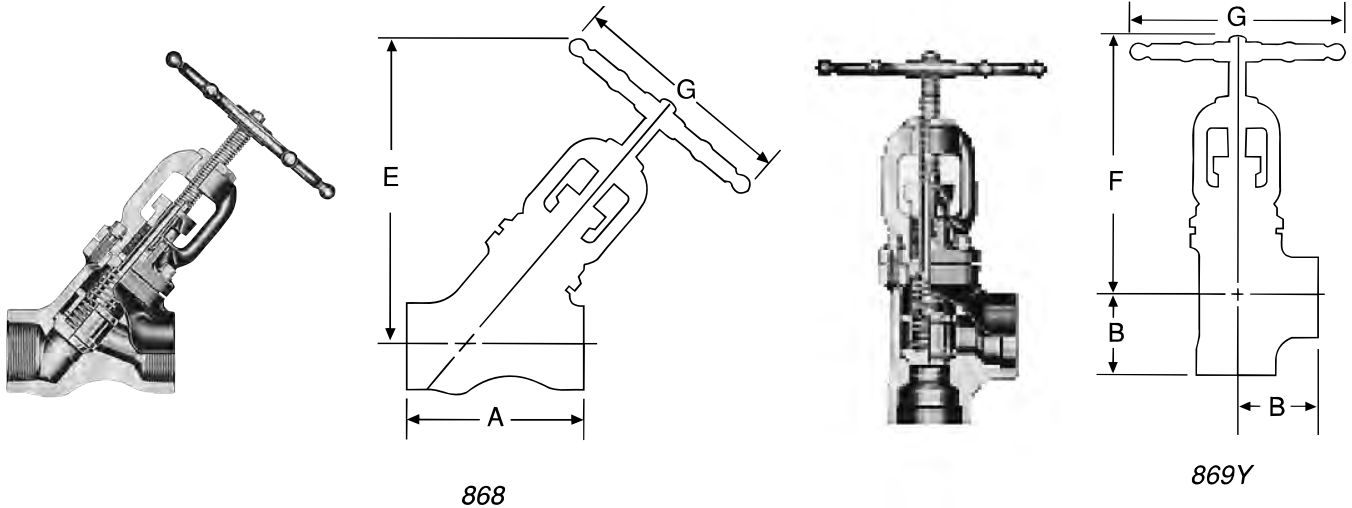
868

869Y

Standard Features

- Bodies and bonnets are of forged steel (A105 or F11).
- Bolted bonnet, OS & Y.
- Y-Pattern or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.
- Asbestos-free spiral wound bonnet gasket.

Pressure Class 800 (PN 130)

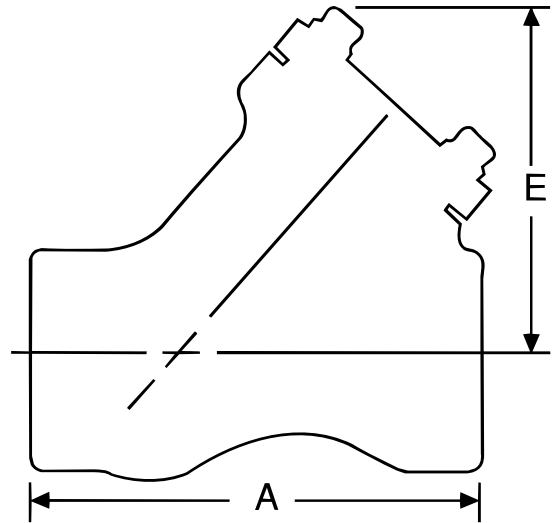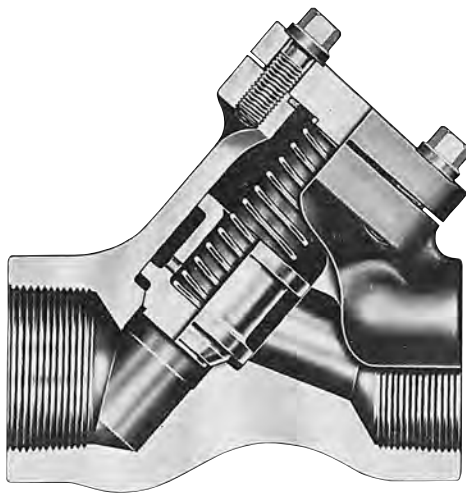| Fig. No.	Type	Ends	NPS (DN)
868	Y-Pattern	Threaded	
868Y	Y-Pattern	Socket Welding	¼ (8) thru 2 (50)
869	Angle	Threaded	
869Y	Angle	Socket Welding	

- Knobbed handwheel.
- Stainless steel spring

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 868/868Y, 869/869Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End, Globe		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
B - Center to End, Angle		1.5	1.5	1.5	1.8	2	2.9	2.9	3.3
		38	38	38	46	51	74	74	84
E - Center to Top, Globe (Open)		6	6	6	6.8	7.6	10.9	10.9	12.1
		152	152	152	173	193	277	277	307
F - Center to Top, Angle (Open)		5.7	5.7	5.7	6.4	7.1	10.2	10.2	11
		145	145	145	163	180	259	259	279
G - Handwheel Diameter		3.8	3.8	3.8	4.3	4.8	7.1	7.1	8.5
		97	97	97	109	122	180	180	216
Weight, Globe		4	4	4	5.5	7.5	16	16	23
		1.8	1.8	1.8	2.5	3.4	7.2	7.2	10.4
Weight, Angle		4	4	4	5.5	7	17	17	24
		1.8	1.8	1.8	2.5	3.2	7.7	7.7	10.8

32

Piston Check Valves, Class 800, 2000 PSI @ 100°F (137.9 BAR @ 38°C)

838

Standard Features

- Bodies and covers are of forged steel (A105 or F11).
- Bolted cover.
- Y-Pattern.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Asbestos-free spiral wound cover gasket.
- Stainless steel spring. (Optional without springs, see Technical Information section, 1.3 Check and Stop-Check Valve Installation Guidelines.)
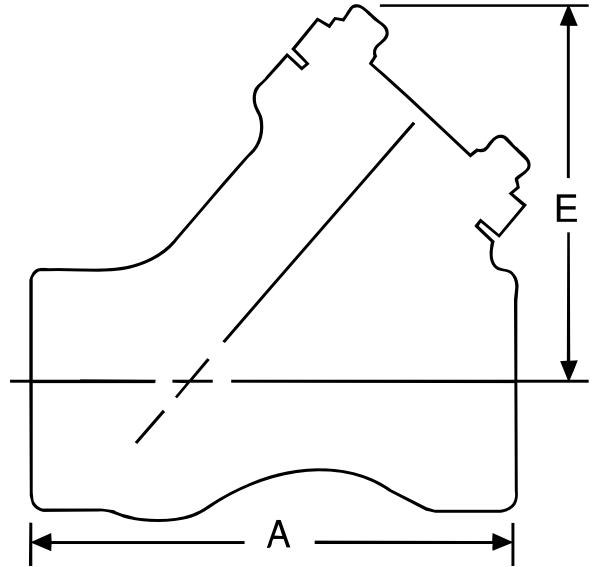
Pressure Class 800 (PN 130)

Fig. No.	Type	Ends	NPS (DN)
838	Y-Pattern	Threaded	¼ (8) thru 2 (50)
838Y	Y-Pattern	Socket Welding	

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 838/838Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
E - Center to Top		2.8	2.8	2.8	3.3	3.8	4.6	4.6	5.1
		71	71	71	84	97	117	117	130
Weight		2	2	2	3.5	5	11	10	14
		.9	.9	.9	1.6	2.3	5	4.5	6.3

Ball Check Valves, Class 800, 2000 PSI @ 100°F (137.9 BAR @ 38°C)
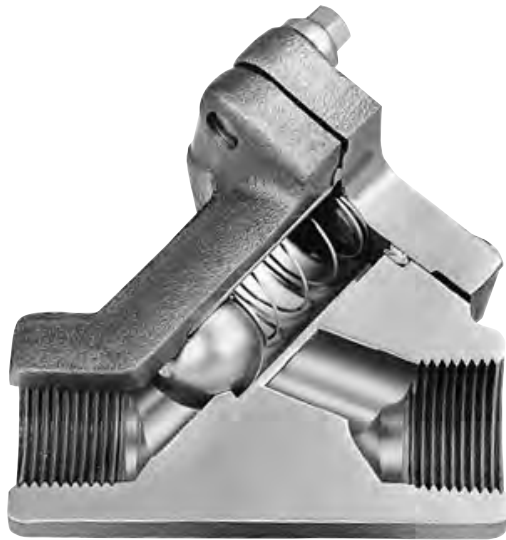
832

Standard Features

- Bodies and covers are of forged steel (A105 or F11).
- Bolted cover.
- Y-Pattern.
- Integral Stellite seat.
- Asbestos-free spiral wound cover gasket.
- Stainless steel spring.
- Stainless steel ball.

Pressure Class 800 (PN 130)

Fig. No.	Type	Ends	NPS (DN)
832	Y-Pattern	Threaded	¼ (8) thru 2 (50)
832Y	Y-Pattern	Socket Welding	

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 832/832Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
E - Center to Top		2.8	2.8	2.8	3.3	3.8	4.6	4.6	5.1
		71	71	71	84	97	117	117	130
Weight		2	2	2	3.5	5	11	10	14
		.9	.9	.9	1.6	2.3	5	4.5	6.4

Univalve® Stop Valves, Class 1500, 3705 PSI @ 100°F (255.3 BAR @ 38°C)
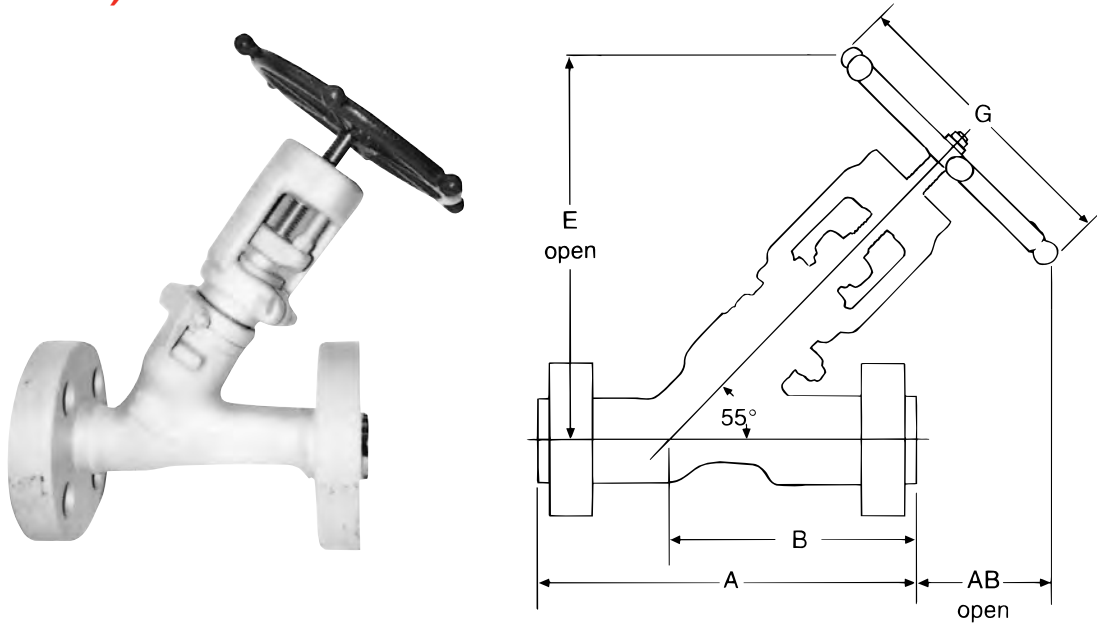
Standard Features

- Available Body Materials
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316 stainless steel.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.

Pressure Class 1500 (PN 260)

FIG. NO.		TYPE	ENDS	NPS (DN)
WELDED	UNWELD.			
36122	36222	Y-Pattern	Flanged	½ (15) thru 2 (50)

- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Integral backseat.
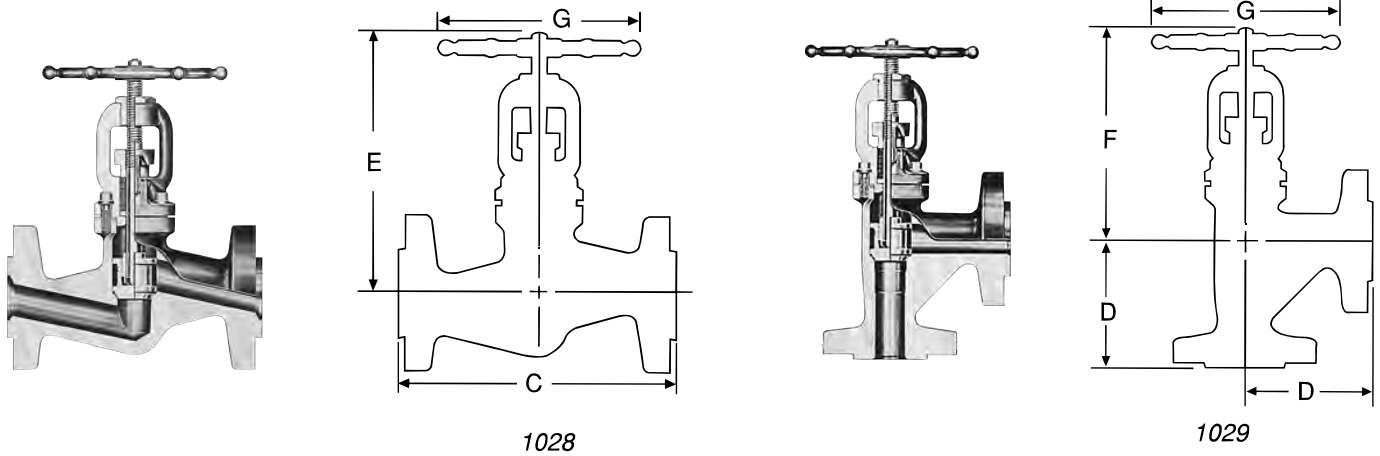- Asbestos-free graphitic packing.

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36122, 36222	NPS	½	¾	1	1½	2
	DN	15	20	25	40	50
A - End to End		10.0	10.0	10.0	12.0	14.5
		25.4	254	254	305	368
AB - Handwheel Clearance (Open)		3.0	3.0	3.0	5.3	4.9
		76.2	76.2	76.2	135	125
B - Center to End		6.9	6.9	6.9	8.3	10.0
		175	175	175	211	254
E - Center to Top (Open)		11.6	11.6	11.6	16.3	18.5
		295	295	295	414	470
G - Handwheel/Handle Diameter		8.5	8.5	8.5	14.3*	14.3*
		216	216	216	363*	363*
Weight, Welded & Unwelded		31	34	36	75	120
		14.1	15.5	16.4	34	55

* Impactor Handle

35

Stop Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 valves are designed and rated to Flowserve Edward Valve standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

1028

1029

Standard Features

- Bodies and bonnets are of forged steel (F11).
- Bolted bonnet, OS & Y.
- Globe or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.

Series 1500

FIG. NO.	TYPE	ENDS	NPS (DN)
1028	Globe	Flanged	½ (15) thru 2 (50)
1029	Angle	Flanged	

- Asbestos-free graphitic packing.
- Asbestos-free spiral wound bonnet gasket.
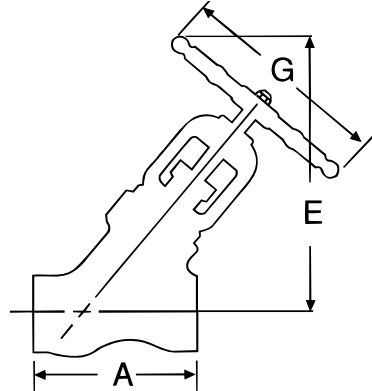- Knobbed handwheel.

Dimensions - Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

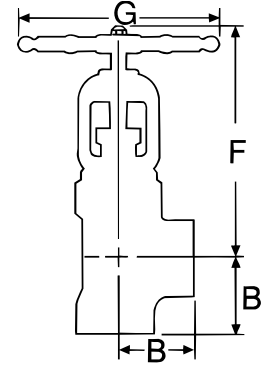| Figure No. 1028, 1029	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face, Globe (Flanged)		8.5	9	10	12	12	14.5
		216	229	254	305	305	368
D - Center to Face, Angle (Flanged)		4.3	4.5	5	6	6	7.3
		109	114	127	152	152	185
E - Center to Top, Globe (Open)		7	7.7	7.7	11.1	11.1	12
		178	196	196	282	282	305
F - Center to Top, Angle (Open)		6.6	7.1	7.1	10.2	10.2	11.1
		168	180	180	259	259	282
G - Handwheel Diameter		4.3	4.8	4.8	7.1	7.1	8.5
		109	122	122	180	180	216
Weight, Globe		15	19	26	38	47	77
		6.8	8.6	11.7	17.1	21.2	34.7
Weight, Angle		15	20	26	41	49	80
		6.8	9	11.7	18.5	22.1	36

36

Stop Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 valves are designed and rated to Flowserve Edward Valve standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

1048Y

1049

Standard Features

- Bodies and bonnets are of forged steel (A105 or F11).
- Bolted bonnet, OS & Y.
- Y-Pattern or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.

Series 1500

FIG. NO.	TYPE	ENDS	NPS (DN)
1048	Y-Pattern	Threaded	
1048Y	Y-Pattern	Socket Welding	¼ (6) thru 2 (50)
1049	Angle	Threaded	
1049Y	Angle	Socket Welding	

- Asbestos-free spiral wound bonnet gasket.
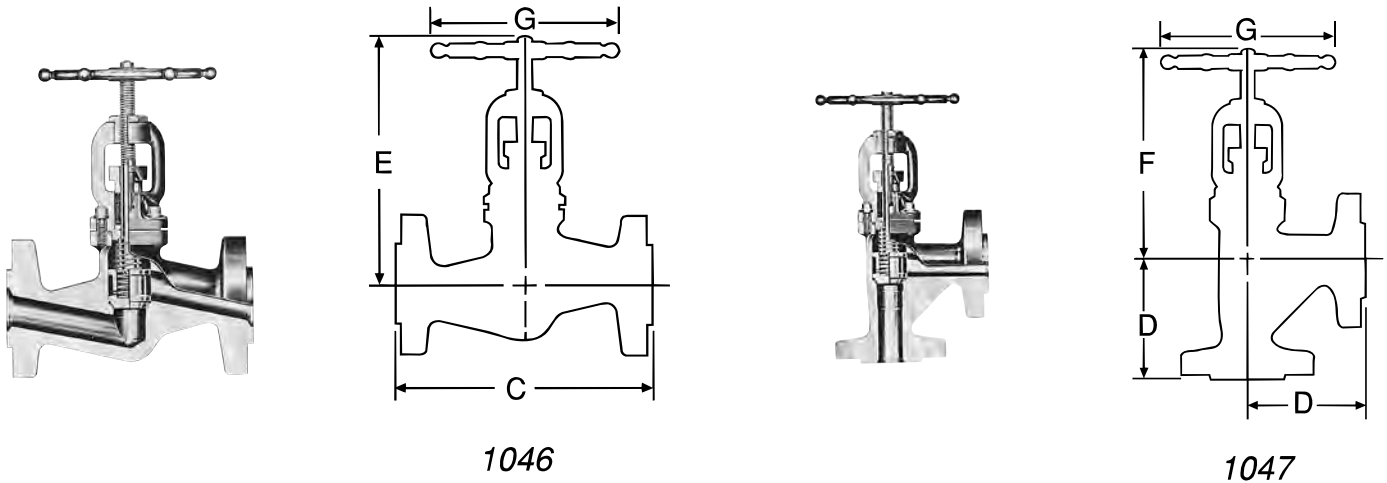- Knobbed handwheel.

Dimensions - Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 1048/1048Y, 1049/1049Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End, Globe		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
B - Center to End, Angle		1.5	1.5	1.5	1.8	2	2.9	2.9	3.3
		38	38	38	46	51	74	74	84
E - Center to Top, Globe (Open)		6.1	6.1	6.1	6.9	7.6	10.9	10.9	12.1
		155	155	155	175	197	277	277	307
F - Center to Top, Angle (Open)		5.8	5.8	5.8	6.6	7.1	10.2	10.2	11
		147	147	147	168	183	259	259	279
G - Handwheel Diameter		3.8	3.8	3.8	4.3	4.8	7.1	7.1	8.5
		97	97	97	109	122	183	183	216
Weight, Globe		4	4	4	5.5	8	17	17	24
		1.8	1.8	1.8	2.5	3.6	7.7	7.7	10.8
Weight, Angle		4	4	4	5.5	7.5	17	17	25
		1.8	1.8	1.8	2.5	3.4	7.7	7.7	11.3

<u>**37**</u>

Stop-Check Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 valves are designed and rated to Flowserve Edward Valve standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

1046

1047

Standard Features

- Bodies and bonnets are of forged steel (F11).
- Bolted bonnet, OS & Y.
- Globe or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.

Series 1500

FIG. NO.	TYPE	ENDS	NPS (DN)
1046	Globe	Flanged	½ (15) thru 2 (50)
1047	Angle	Flanged	

- Asbestos-free spiral wound bonnet gasket.
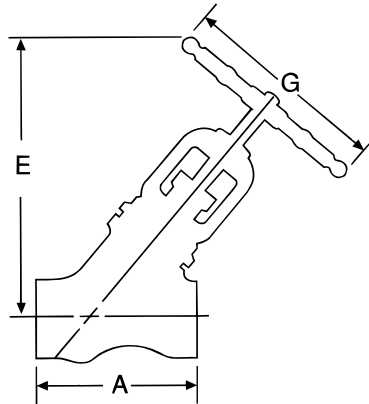- Knobbed handwheel.
- Stainless steel spring.

Dimensions - Globe & Angle

Black numerals are in inches and pounds
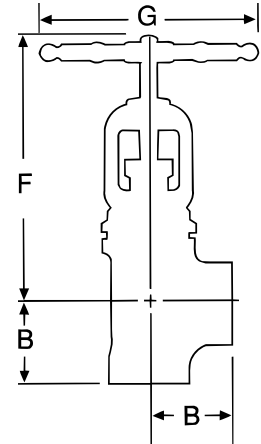Colored numerals are in millimeters and kilograms

Figure No. 1046, 1047	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face, Globe (Flanged)		8.5	9	10	12	12	14.5
		216	229	254	305	305	368
D - Center to Face, Angle (Flanged)		4.3	4.5	5	6	6	7.3
		109	114	127	152	152	185
E - Center to Top, Globe (Open)		7	7.7	7.7	11.1	11.1	12
		178	196	196	282	282	305
F - Center to Top, Angle (Open)		6.6	7.1	7.1	10.2	10.2	11.1
		168	180	180	259	259	282
G - Handwheel Diameter		4.3	4.8	4.8	7.1	7.1	8.5
		109	122	122	180	180	216
Weight, Globe		15	19	26	38	47	77
		6.8	8.6	11.7	17.1	21.2	34.7
Weight, Angle		15	20	26	41	49	80
		6.8	9	11.7	18.5	22.1	36

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Stop-Check Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 valves are designed and rated to Flowserve Edward Valves standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

1068Y

1069

Standard Features

- Bodies and bonnets are of forged steel (A105 or F11).
- Bolted bonnet, OS & Y.
- Y-Pattern or angle design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Integral backseat.
- 13% chromium stainless steel stem.
- Asbestos-free graphitic packing.
- Asbestos-free spiral wound bonnet gasket.

Series 1500

| FIG. NO.	TYPE	ENDS	NPS (DN)
1068	Y-Pattern	Threaded	
1068Y	Y-Pattern	Socket Welding	¼ (8) thru 2 (50)
1069	Angle	Threaded	
1069Y	Angle	Socket Welding	

- Knobbed handwheel.
- Stainless steel spring.

Dimensions - Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 1068/1068Y, 1069/1069Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End, Globe		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
B - Center to End, Angle		1.5	1.5	1.5	1.8	2	2.9	2.9	3.3
		38	38	38	46	51	74	74	84
E - Center to Top, Globe (Open)		6.1	6.1	6.1	6.9	7.6	10.9	10.9	12.1
		155	155	155	175	193	277	277	307
F - Center to Top, Angle (Open)		5.8	5.8	5.8	6.6	7.1	10.2	10.2	11
		147	147	147	168	180	259	259	279
G - Handwheel Diameter		3.8	3.8	3.8	4.3	4.8	7.1	7.1	8.5
		97	97	97	109	122	180	180	216
Weight, Globe		4	4	4	5.5	8	16	16	23
		1.8	1.8	1.8	2.5	3.6	7.3	7.3	10.4
Weight, Angle		4	4	4	5.5	7.5	16	16	24
		1.8	1.8	1.8	2.5	3.4	7.3	7.3	10.9

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Piston Check Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 valves are designed and rated to Flowserve Edward Valves standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

1038

1058
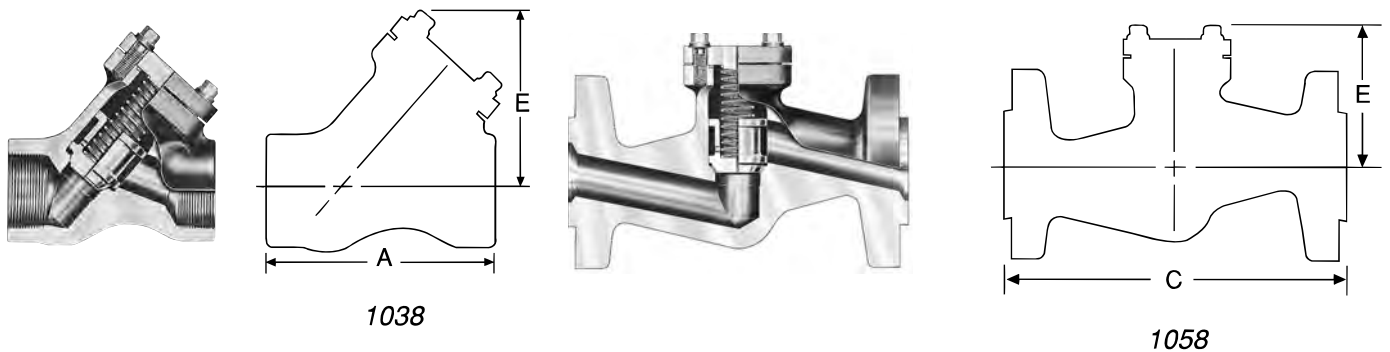
Standard Features

- Bodies and covers are of forged steel (A105 or F11).
- Bolted cover.
- Y-Pattern or globe design.
- Body-guided hardened stainless steel disk.
- Integral Stellite seat.
- Asbestos-free spiral wound cover gasket.
- Stainless steel spring.

Series 1500

FIG. NO.	TYPE	ENDS	NPS (DN)
1038	Y-Pattern	Threaded	¼ (8) thru 2 (50)
1038Y	Y-Pattern	Socket Welding	
1058 (F11)	Globe	Flanged	½ (15) thru 2 (50)

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

| Figure No. 1038/1038Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
E - Center to Top		2.8	2.8	2.8	3.3	3.8	4.6	4.6	5.1
		71	71	71	84	97	117	117	130
Weight		2.5	2.5	2.5	3.5	5.5	11	11	15
		1.1	1.1	1.1	1.6	2.5	5	5	6.8

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 1058	NPS	½	¾	1	1¼	1½	2
	DN	15	20	25	32	40	50
C - Face to Face (Flanged)		8.5	9	10	12	12	14.5
		216	229	254	305	305	368
E - Center to Top		2.7	3.1	3.1	4.2	4.2	4.7
		69	79	79	197	107	119
Weight		14	17	24	32	41	69
		6.3	7.7	10.8	14.4	18.5	31.1

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Ball Check Valves, Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

These Series 1500 Valves are designed and rated to Flowserve Edward Valves standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.
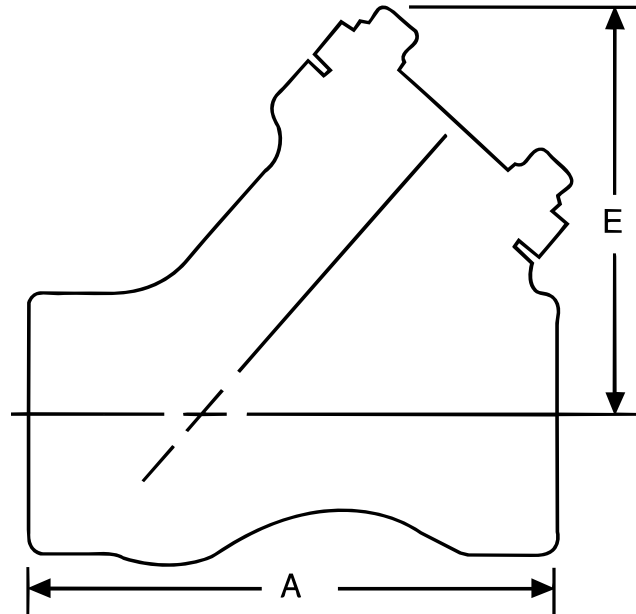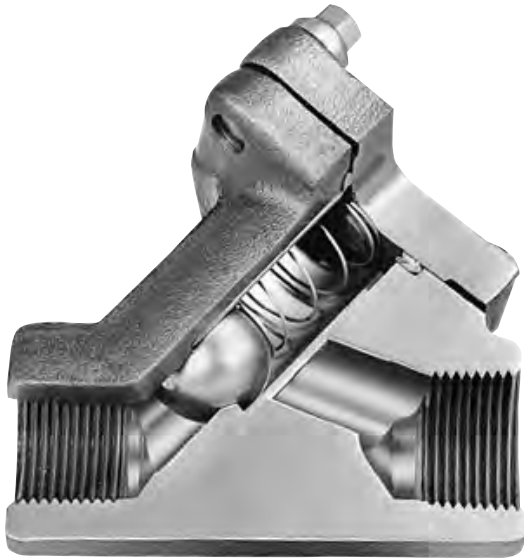
1032

Standard Features

- Bodies and covers are of forged steel (A105 or F11).
- Bolted cover.
- Y-Pattern.
- Integral Stellite seat.
- Asbestos-free spiral wound bonnet gasket.
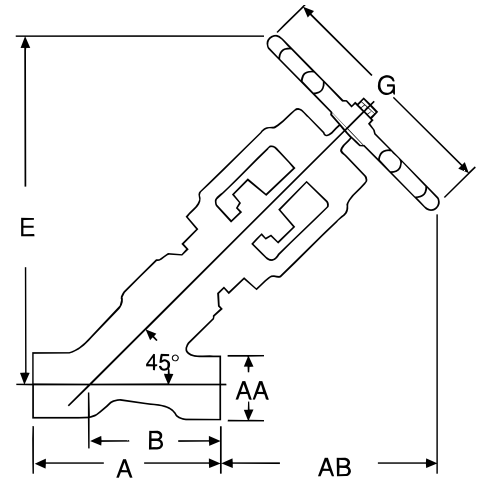- Stainless steel spring.
- Stainless steel ball.

Series 1500

FIG. NO.	TYPE	ENDS	NPS (DN)
1032	Y-Pattern	Threaded	¼ (8) thru 2 (50)
1032Y	Y-Pattern	Socket Welding	

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 1032/1032Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
E - Center to Top		2.8	2.8	2.8	3.3	3.8	4.6	4.6	5.1
		71	71	71	84	97	117	117	130
Weight		2.5	2.5	2.5	3.5	5.5	11	11	15
		1.1	1.1	1.1	1.6	2.5	5	5	6.8

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Univalve® Stop Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

36124

Standard Features

- Available Body Materials
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 1690 (PN 290)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36120	36220	Y-Pattern	Threaded	½ (15) thru 1 (25)
36124	36224	Y-Pattern	Socket Welding	½ (15) thru 2½ (65)
36128	36228	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral backseat.
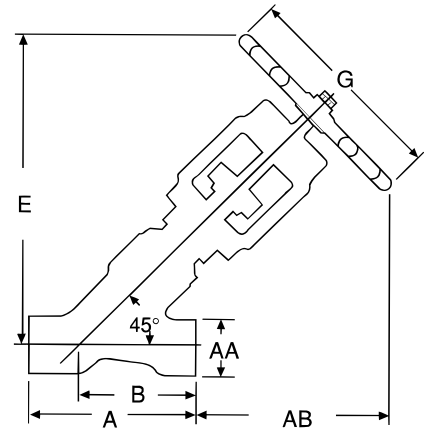- Asbestos-free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36120, 36124, 36128, 36220,36224,36228	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	8.2	10.7	10.7	12.8
		152	152	152	170	170	208	272	272	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	3.64	4.00	4.00	4.80
		58	58	58	81	81	92	102	102	122
AB - Handwheel Clearance (Open)		7.5	7.5	7.5	11.0	11.0	11.6	12.5	12.5	11.2
		191	191	191	279	279	295	318	318	284
B - Center to End		4.0	4.0	4.0	4.8	4.8	6.1	7.1	7.1	8.8
		102	102	102	122	122	155	180	180	224
E - Center to Top (Open)		11.5	11.5	11.5	15.9	15.9	17.7	19.6	19.6	20.0
		292	292	292	404	404	450	498	498	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	14.3*	14.3*	14.3*	16.0**	16.0**	16.0**
		216	216	216	363*	363*	363*	406**	406**	406**
Weight, Welded		19	19	19	36	36	57	100	100	138
		9	9	9	16	16	26	46	46	63
Weight, Unwelded		20	20	20	38	38	59	104	104	142
		9	9	9	17	17	27	47	47	64

*Impactor Handle   **Impactor Handwheel*

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Univalve® Stop-Check Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

36164

Standard Features

- Available Body Materials
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 1690 (PN 290)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36160	36260	Y-Pattern	Threaded	½ (15) thru 1 (25)
36164	36264	Y-Pattern	Socket Welding	½ (15) thru 2½ (65)
36168	36268	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral backseat.
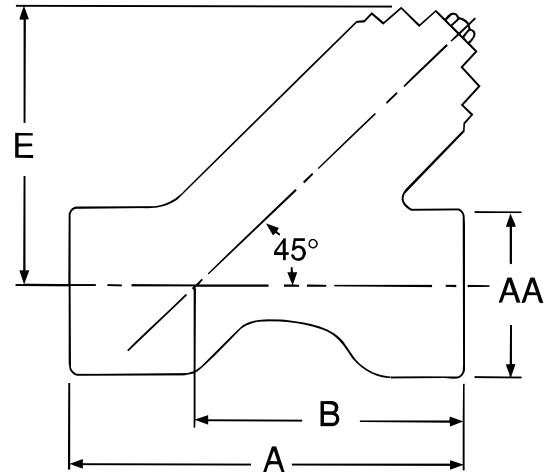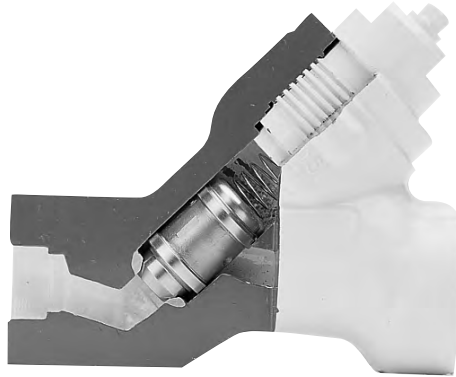- Asbestos-free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36160, 36164, 36168, 36260, 36264, 36268	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	8.2	10.7	10.7	12.8
		152	152	152	170	170	208	272	272	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	3.64	4.00	4.00	4.80
		58	58	58	81	81	92	102	102	122
AB - Handwheel Clearance (Open)		7.5	7.5	7.5	11.0	11.0	11.6	12.5	12.5	11.2
		191	191	191	279	279	295	318	318	284
B - Center to End		4.0	4.0	4.0	4.8	4.8	6.1	7.1	7.1	8.8
		102	102	102	122	122	155	180	180	224
E - Center to Top (Open)		11.5	11.5	11.5	15.9	15.9	17.7	19.6	19.6	20.0
		292	292	292	404	404	450	498	498	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	14.3*	14.3*	14.3*	16.0**	16.0**	16.0**
		216	216	216	363*	363*	363*	406**	406**	406**
Weight, Welded		19	19	19	36	36	57	100	100	138
		9	9	9	16	16	26	46	46	63
Weight, Unwelded		20	20	20	38	38	59	104	104	142
		9	9	9	17	17	27	47	47	64

* Impactor Handle   ** Impactor Handwheel

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Univalve® Piston Check Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

36174

Standard Features

- Available Body Materials
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded cover.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.

Pressure Class 1690 (PN 290)

| Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36170	36270	Y-Pattern	Threaded	½ (15) thru 1 (25)
36174	36274	Y-Pattern	Socket Welding	½ (15) thru 2-½ (65)
36178	36278	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

- Stainless steel spring. (Optional without springs, see page Technical Information section, 1.3 Check and Stop-Check Valve Installation Guidelines. Spring is not available on F91 Fig. No. 36170, 36174, and 36178 valves.)

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36170, 36174, 36178, 36270, 36274, 36278	NPS	½	¾	1	1-¼	1-½	2	2-½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	8.2	10.7	10.7	12.8
		152	152	152	170	170	208	272	272	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	3.64	4.00	4.00	4.80
		58	58	58	81	81	92	102	102	122
B - Center to End		4.0	4.0	4.0	4.8	4.8	6.1	7.1	7.1	8.8
		102	102	102	122	122	155	180	180	224
E - Center to Top		3.9	3.9	3.9	5.0	5.0	5.8	7.2	7.2	7.8
		99	99	99	127	127	147	183	183	198
Weight		14	14	14	22	22	31	44	44	86
		6	6	6	10	10	14	20	20	39
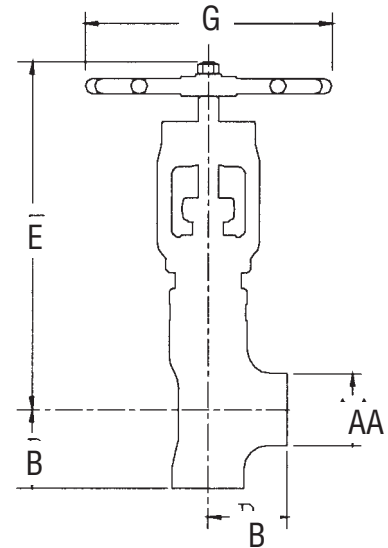
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Univalve® Angle Stop Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Bonnet.
- OS&Y.
- Angle Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 1690 (PN 290)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36125	36225	Angle	Socket Welding	½ (15) thru 2½ (65)
36129	36229	Angle	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral Backseat.
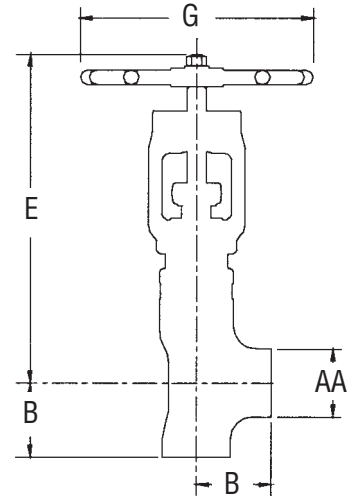- Asbestos-free graphitic packing.

Dimensions – Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36125, 36129, 36225, 36229	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	3.6	4.0	4.0	4.8
		58	58	58	97	97	91	102	102	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.1	4.5	4.5	5.3
		64	64	64	91	91	104	114	114	135
E - Center to Top (Open)		11.7	11.7	11.7	14.9	14.9	17.3	19.1	19.1	19.7
		297	297	297	378	378	439	485	485	500
G - Handwheel/Handle Diameter		8.5	8.5	8.5	14.3*	14.3*	14.3*	16.0**	16.0**	16.0**
		216	216	216	363	363	363	406	406	406
Weight, Welded		18	18	18	40	40	60	103	103	139
		8.2	8.2	8.2	18.1	18.1	27.2	46.7	46.7	63.0
Weight, Unwelded		19	19	19	42	42	62	107	107	143
		8.6	8.6	8.6	19.1	19.1	28.1	48.5	48.5	64.9

* Impactor Handle   **Impactor Handwheel

Univalve® Angle Stop-Check Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Bonnet.
- OS&Y.
- Angle Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 1690 (PN 290)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36165	36265	Angle	Socket Welding	½ (15) thru 2½ (65)
36169	36269	Angle	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral Backseat.
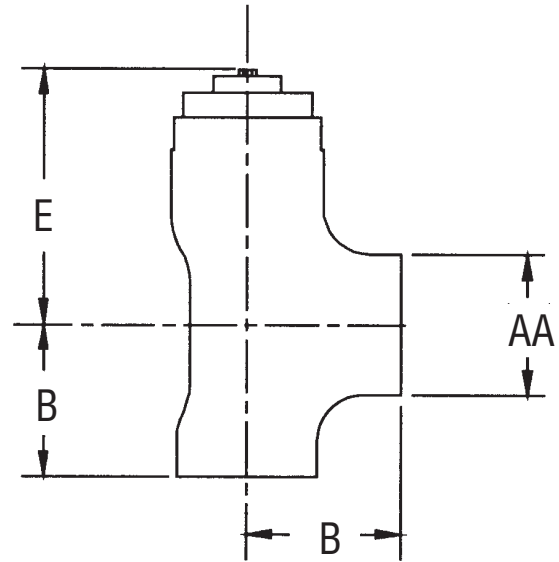- Asbestos-free graphitic packing.

Dimensions – Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36165, 36169, 36265, 36269	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	3.6	4.0	4.0	4.8
		58	58	58	97	97	91	102	102	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.1	4.5	4.5	5.3
		64	64	64	91	91	104	114	114	135
E - Center to Top (Open)		11.7	11.7	11.7	14.9	14.9	17.3	19.1	19.1	19.7
		297	297	297	378	378	439	485	485	500
G - Handwheel/Handle Diameter		8.5	8.5	8.5	14.3*	14.3*	14.3*	16.0**	16.0**	16.0**
		216	216	216	363	363	363	406	406	406
Weight, Welded		18	18	18	40	40	60	103	103	139
		8.2	8.2	8.2	18.1	18.1	27.2	46.7	46.7	63.0
Weight, Unwelded		19	19	19	42	42	62	107	107	143
		8.6	8.6	8.6	19.1	19.1	28.1	48.5	48.5	64.9

*Impactor Handle   **Impactor Handwheel

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Univalve® Angle Check Valves, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Cover.
- Angle Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Stainless steel spring. (Optional without spring, see page G14.Stainless steel spring. Spring is not available on F91 Fig. No. 36175 and 36179 valves.)

Pressure Class 1690 (PN 290)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
36175	36275	Angle	Socket Welding	½ (15) thru 2½ (65)
36179	36279	Angle	Buttwelding	½ (15) thru 4 (100)

Dimensions - Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 36175, 36179, 36275, 36279	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	3.6	4.0	4.0	4.8
		58	58	58	97	97	91	102	102	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.1	4.5	4.5	5.3
		64	64	64	91	91	104	114	114	135
E - Center to Top		4.6	4.6	4.6	5.7	5.7	6.2	7.2	7.2	7.8
		117	117	117	145	145	157	183	183	198
Weight		8	8	8	21	21	30	41	41	76
		3.6	3.6	3.6	9.5	9.5	13.6	18.6	18.6	34.5

Univalve® Stop Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)
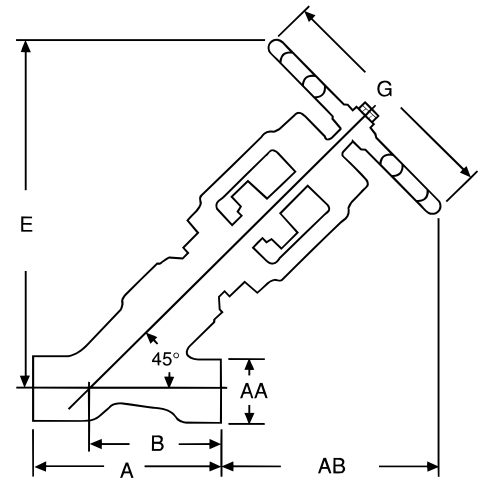
66124

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66120	66220	Y-Pattern	Threaded*	½ (15) thru 1 (25)
66124	66224	Y-Pattern	Socket Welding	½ (15) thru 2-½ (65)
66128	66228	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

* Threaded end valves are limited to Pressure Class 2500.

- Integral Stellite seat.
- Integral backseat.
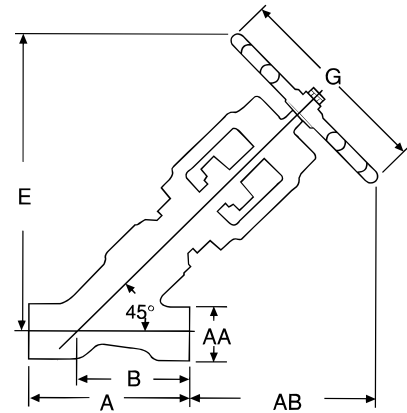- Asbestos free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66120, 66124, 66128, 66220, 66224, 66228	NPS	½	¾	1	1-¼	1-½	2	2-½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	10.7	12.8	12.8	12.8
		152	152	152	170	170	272	325	325	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	4.00	4.80	4.80	4.80
		58	58	58	81	81	102	122	122	122
AB - Handwheel Clearance, (Open)		7.5	7.5	7.5	9.8	9.8	11.6	11.2	11.2	11.2
		191	191	191	249	249	296	284	284	284
B - Center to End		4.0	4.0	4.0	4.8	4.8	7.1	8.8	8.8	8.8
		102	102	102	122	122	180	224	224	224
E - Center to Top, (Open)		11.5	11.5	11.5	14.6	14.6	18.6	20.0	20.0	20.0
		292	292	292	371	371	472	508	508	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	11.0*	11.0*	14.3*	16.0**	16.0**	16.0**
		216	216	216	279*	279*	363*	406**	406**	406**
Weight, Welded		19	19	19	34	34	79	142	142	142
		9	9	9	16	16	36	65	65	65
Weight, Unwelded		20	20	20	36	36	83	146	146	146
		9	9	9	17	17	38	66	66	66

* Impactor Handle   ** Impactor Handwheel

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Univalve® Stop-Check Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

66164

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66160	66260	Y-Pattern	Threaded*	½ (15) thru 1 (25)
66164	66264	Y-Pattern	Socket Welding	½ (15) thru 2½ (65)
66168	66268	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

Threaded end valves are limited to Pressure Class 2500

- Integral Stellite seat.
- Integral backseat.
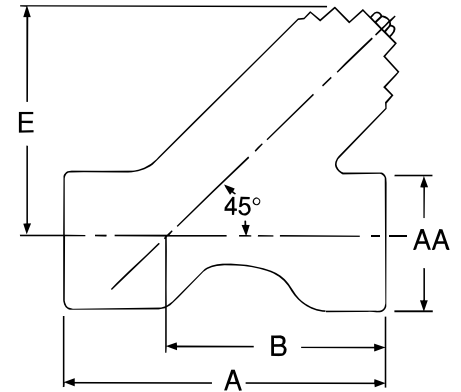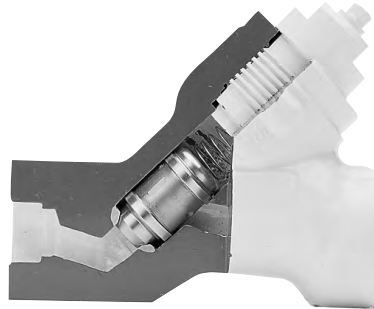- Asbestos-free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66160, 66164, 66168, 66260, 66264, 66268	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	10.7	12.8	12.8	12.8
		152	152	152	170	170	272	325	325	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	4.00	4.80	4.80	4.80
		58	58	58	81	81	102	122	122	122
AB - Handwheel Clearance (Open)		7.5	7.5	7.5	9.8	9.8	11.6	11.2	11.2	11.2
		191	191	191	249	249	295	284	284	284
B - Center to End		4.0	4.0	4.0	4.8	4.8	7.1	8.8	8.8	8.8
		102	102	102	122	122	180	224	224	224
E - Center to Top (Open)		11.5	11.5	11.5	14.6	14.6	18.6	20.0	20.0	20.0
		292	292	292	371	371	472	508	508	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	11.0*	11.0*	14.3*	16.0**	16.0**	16.0**
		216	216	216	279*	279*	363*	406**	406**	406**
Weight, Welded		19	19	19	34	34	79	142	142	142
		9	9	9	16	16	36	65	65	65
Weight, Unwelded		20	20	20	36	36	83	146	146	146
		9	9	9	17	17	38	66	66	66

* Impactor Handle   **Impactor Handwheel

Univalve® Piston Check Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

66174

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded cover.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Stainless steel spring. (Optional without springs, See Technical Information section, 1.3 Check and Stop-Check Valve Installation Guidelines. Spring is not available on F91 Fig. No. 66170, 66174, and 66178 valves.)

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66170	66270	Y-Pattern	Threaded*	½ (15) thru 1 (25)
66174	66274	Y-Pattern	Socket Welding	½ (15) thru 2½ (65)
66178	66278	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

** Threaded end valves are limited to Pressure Class 2500.*

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66170, 66174, 66178, 66270, 66274, 66278	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6.0	6.0	6.0	6.7	6.7	10.7	12.8	12.8	12.8
		152	152	152	170	170	272	325	325	325
AA - End Hub Diameter		2.30	2.30	2.30	3.20	3.20	4.00	4.80	4.80	4.80
		58	58	58	81	81	102	122	122	122
B - Center to End		4.0	4.0	4.0	4.8	4.8	7.1	8.8	8.8	8.8
		102	102	102	122	122	180	224	224	224
E - Center to Top (Open)		3.9	3.9	3.9	5.0	5.0	7.0	7.8	7.8	7.8
		99	99	99	127	127	178	198	198	198
Weight		14	14	14	22	22	52	86	86	86
		6	6	6	10	10	24	39	39	39
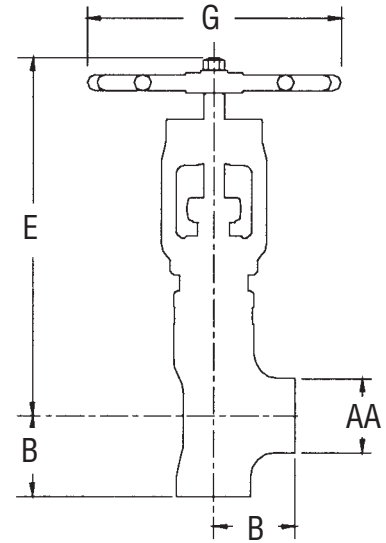
50

Univalve® Angle Stop Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Bonnet.
- OS&Y.
- Angle Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66125	66225	Angle	Socket Welding	½ (15) thru 2½ (65)
66129	66229	Angle	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral Backseat.
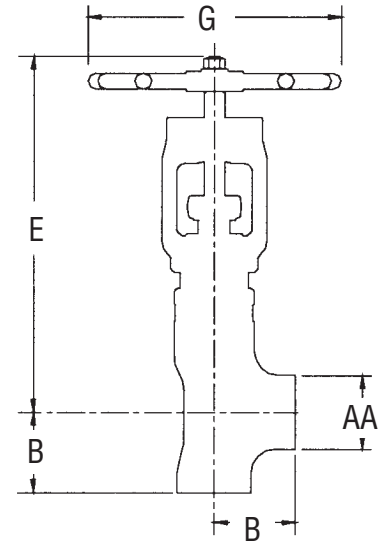- Asbestos-free graphitic packing.

Dimensions – Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66125, 66129, 66225, 66229	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	4.0	4.8	4.8	4.8
		58	58	58	97	97	102	122	122	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.5	5.3	5.3	5.3
		64	64	64	91	91	114	135	135	135
E - Center to Top (Open)		11.7	11.7	11.7	14.9	14.9	18.2	19.7	19.7	19.7
		297	297	297	378	378	462	500	500	500
G - Handwheel/Handle Diameter		8.5	8.5	8.5	11.0*	11.0*	14.3*	16.0**	16.0**	16.0**
		216	216	216	279	279	363	406	406	406
Weight, Welded		18	18	18	38	38	76	139	139	139
		8.2	8.2	8.2	17.2	17.2	34.5	63.0	63.0	63.0
Weight, Unwelded		19	19	19	40	40	80	143	143	143
		8.6	8.6	8.6	18.1	18.1	36.3	64.9	64.9	64.9

*Impactor Handle   **Impactor Handwheel

Univalve® Angle Stop-Check Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Bonnet.
- OS&Y.
- Angle Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66165	66265	Angle	Socket Welding	½ (15) thru 2½ (65)
66169	66269	Angle	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral Backseat.
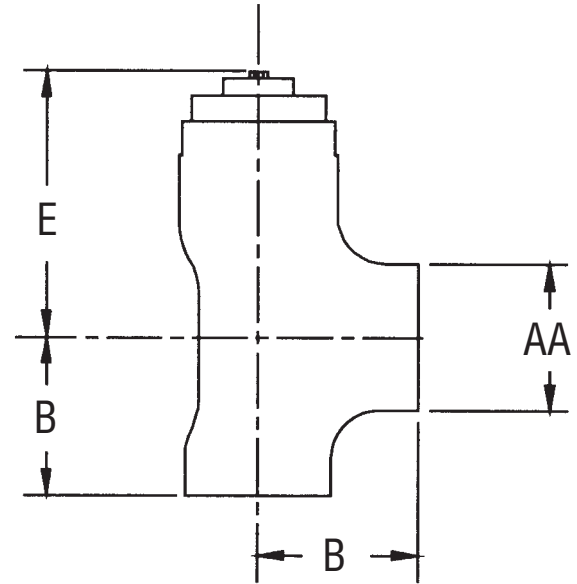- Asbestos-free graphitic packing

Dimensions – Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66165, 66169, 66265, 66269	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	4.0	4.8	4.8	4.8
		58	58	58	97	97	102	122	122	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.5	5.3	5.3	5.3
		64	64	64	91	91	114	135	135	135
E - Center to Top (Open)		11.7	11.7	11.7	14.9	14.9	18.2	19.7	19.7	19.7
		297	297	297	378	378	462	500	500	500
G - Handwheel/Handle Diameter		8.5	8.5	8.5	11.0*	11.0*	14.3*	16.0**	16.0**	16.0**
		216	216	216	279	279	363	406	406	406
Weight, Welded		18	18	18	38	38	76	139	139	139
		8.2	8.2	8.2	17.2	17.2	34.5	63.0	63.0	63.0
Weight, Unwelded		19	19	19	40	40	80	143	143	143
		8.6	8.6	8.6	18.1	18.1	36.3	64.9	64.9	64.9

* Impactor Handle   **Impactor Handwheel

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Univalve® Angle Check Valves, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or Welded Cover.
- Angle Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 2680 (PN 460)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
66175	66275	Angle	Socket Welding	½ (15) thru 2½ (65)
66179	66279	Angle	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Stainless steel spring. (Optional without spring, see page G14. Spring is not available on F91 Fig. No. 66175 and 66179 valves.)

Dimensions – Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 66175, 66179, 66275, 66279	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
AA - Hub Diameter		2.3	2.3	2.3	3.8	3.8	4.0	4.8	4.8	4.8
		58	58	58	97	97	102	122	122	122
B - Center to End		2.5	2.5	2.5	3.6	3.6	4.5	5.3	5.3	5.3
		64	64	64	91	91	114	135	135	135
E - Center to Top		4.6	4.6	4.6	5.7	5.7	7.2	7.8	7.8	7.8
		117	117	117	145	145	183	198	198	198
Weight		8	8	8	23	23	46	76	76	76
		3.6	3.6	3.6	10.4	10.4	20.9	34.5	34.5	34.5

Univalve® Stop Valves, Class 4500 11,250 PSI @ 100°F (775.7 BAR @ 38°C)

96124

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.

Pressure Class 4500 (PN 760)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
96124	96224	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
96128	96228	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

- Integral Stellite seat.
- Integral backseat.
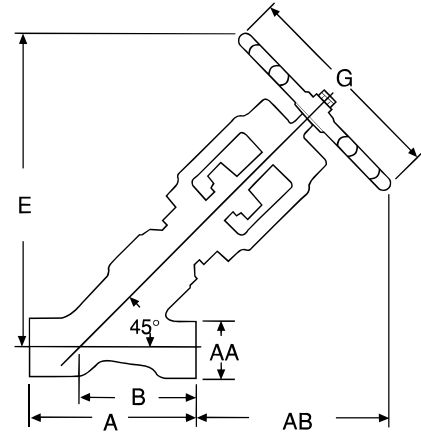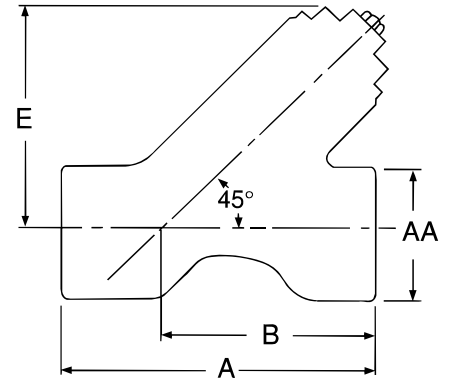- Asbestos-free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 96124, 96128, 96224, 96228	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		8.2	8.2	8.2	8.2	8.2	12.8	12.8	12.8	12.8
		208	208	208	208	208	325	325	325	325
AA - End Hub Diameter		3.64	3.64	3.64	3.64	3.64	4.80	4.80	4.80	4.80
		92	92	92	92	92	122	122	122	122
AB - Handwheel Clearance (Open)		7.3	7.3	7.3	7.3	7.3	11.2	11.2	11.2	11.2
		185	185	185	185	185	284	284	284	284
B - Center to End		6.1	6.1	6.1	6.1	6.1	8.8	8.8	8.8	8.8
		155	155	155	155	155	224	224	224	224
E - Center to Top (Open)		13.4	13.4	13.4	13.4	13.4	20.0	20.0	20.0	20.0
		340	340	340	340	340	508	508	508	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	16.0**	16.0**	16.0**	16.0**
		216	216	216	216	216	406**	406**	406**	406**
Weight, Welded		43	43	43	43	43	158	158	158	158
		20	20	20	20	20	72	72	72	72
Weight, Unwelded		45	45	45	45	45	162	162	162	162
		21	21	21	21	21	74	74	74	74

*** Impactor Handwheel*

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Univalve® Stop-Check Valves, Class 4500, 11,250 PSI @ 100°F (775.7 BAR @ 38°C)

96164

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.

Pressure Class 4500 (PN 760)

Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
96164	96264	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
96168	96268	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
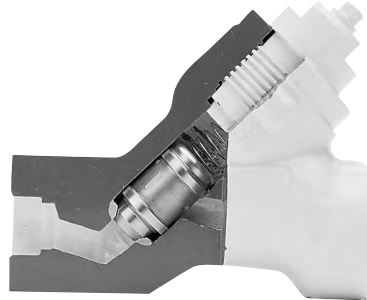- Integral backseat.
- Asbestos-free graphitic packing.

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 96164, 96168, 96264, 96268	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		8.2	8.2	8.2	8.2	8.2	12.8	12.8	12.8	12.8
		208	208	208	208	208	325	325	325	325
AA - End Hub Diameter		3.64	3.64	3.64	3.64	3.64	4.80	4.80	4.80	4.80
		92	92	92	92	92	122	122	122	122
AB - Handwheel Clearance (Open)		7.3	7.3	7.3	7.3	7.3	11.2	11.2	11.2	11.2
		185	185	185	185	185	284	284	284	284
B - Center to End		6.1	6.1	6.1	6.1	6.1	8.8	8.8	8.8	8.8
		155	155	155	155	155	224	224	224	224
E - Center to Top (Open)		13.4	13.4	13.4	13.4	13.4	20.0	20.0	20.0	20.0
		340	340	340	340	340	508	508	508	508
G - Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	16.0**	16.0**	16.0**	16.0**
		216	216	216	216	216	406**	406**	406**	406**
Weight, Welded		43	43	43	43	43	158	158	158	158
		20	20	20	20	20	72	72	72	72
Weight, Unwelded		45	45	45	45	45	162	162	162	162
		21	21	21	21	21	74	74	74	74

** Impactor Handwheel

Univalve® Piston Check Valves, Class 4500, 11,250 PSI @ 100°F (775.7 BAR @ 38°C)

96174

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
  - F316, F347 stainless steel.
  - Other material on application.
- Unwelded (graphitic seal) or welded cover.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Integral Stellite seat.
- Stainless steel spring. (Optional without springs, see page G14. Spring is not available on F91 Fig. No. 96174 and 96178 valves.)

Pressure Class 4500 (PN 760)

| Fig. No.		Type	Ends	NPS (DN)
Welded	Unweld.			
96174	96274	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
96178	96278	Y-Pattern	Buttwelding	½ (15) thru 4 (100)

Dimensions – Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 96174, 96178, 96274, 96278	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		8.2	8.2	8.2	8.2	8.2	12.8	12.8	12.8	12.8
		208	208	208	208	208	325	325	325	325
AA - End Hub Diameter		3.64	3.64	3.64	3.64	3.64	4.80	4.80	4.80	4.80
		92	92	92	92	92	122	122	122	122
B - Center to End		6.1	6.1	6.1	6.1	6.1	8.8	8.8	8.8	8.8
		155	155	155	155	155	224	224	224	224
E - Center to Top		5.4	5.4	5.4	5.4	5.4	7.9	7.9	7.9	7.9
		137	137	137	137	137	201	201	201	201
Weight		35	35	35	35	35	92	92	92	92
		16	16	16	16	16	42	42	42	42

56

Hydraulic Stop Valves 5,000 & 10,000 PSI (345 & 690 BAR) CWP

These hydraulic valves are designed and rated to Flowserve Edward Valves standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.
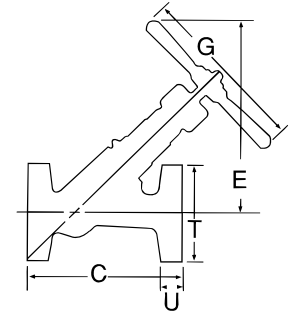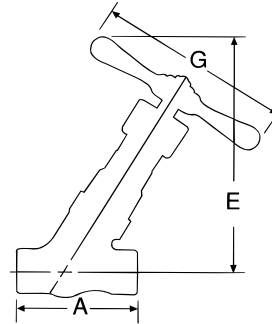
158

Standard Features

- Body is of forged alloy steel grade F-11.
- Bonnet is zinc coated for corrosion resistance.
- 13% chromium stainless steel replaceable seat.
- 13% chromium stainless steel stem and swivel needle disk.
- Hardfaced seat and disk standard on Figure 5158 & 9158 valves only.
- Impactor handle, size 1 and larger.
- Buna-N "O" rings at body-bonnet and body seat joints for leak-tight connection.
- Asbestos-free packing.

5,000 & 10,000 PSI CWP

FIG. NO.		TYPE	ENDS	NPS (DN)
5,000	**10,000**			
	158	Globe	Threaded	¼ (6) thru 2 (50)
	158Y	Globe	Socket Welding	
5158		Globe	Flanged† Series 1500	2 (50)
	9158	Globe	Flanged† Series 6BX	2-1/16 (52.4) only

For Pressure up to 10,000 PSI (690 BAR) - Edward high pressure forged steel hydraulic stop valves are used in applications involving high pressures and with temperatures to 300°F (149°C). They provide fast, certain shut-off or accurate pressure control, give long life, reduce replacement costs and lower maintenance time.

Dimensions

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 158/158Y, 5158, 9158	NPS	¼	3/8	½	¾	1	1¼	1½	2	2 (5158)	2-1/16†
	DN	8	10	15	20	25	40	40	50	50	52.4
A - End to End, Globe		3.8	3.8	3.8	4.5	5.1	7.5	7.5	9	—	—
		97	97	97	114	130	191	191	229	—	—
C - Contact Face to Contact Face		—	—	—	—	—	—	—	—	13.4	13.3
		—	—	—	—	—	—	—	—	340	338
E - Center to Top, (Open)		8.4	8.4	8.4	9.6	12	14.1	14.1	18	17.9	17.9
		213	213	213	244	305	358	358	457	455	455
G - Handwheel/Handle Diameter		5.4	5.4	5.4	6.4	11*	11*	11*	14*	14*	14*
		134	137	137	163	279	279	279	356	356	356
T - Flange Diameter		—	—	—	—	—	—	—	—	8.5	7.9
		—	—	—	—	—	—	—	—	216	201
U - Flange Thickness		—	—	—	—	—	—	—	—	1.8	1.7
		—	—	—	—	—	—	—	—	46	43
Diameter of Ring Groove & Groove Number		—	—	—	—	—	—	—	—	3¾-#24	BX-152
		—	—	—	—	—	—	—	—	—	—
Diameter of Bolt Circle		—	—	—	—	—	—	—	—	6.5	6.25
		—	—	—	—	—	—	—	—	165	160
Bolts		—	—	—	—	—	—	—	—	(8)-7/8	(8)-¾
		—	—	—	—	—	—	—	—	—	—
Weight		5.1	5.1	5.1	6.8	12.5	32	32	53	120	124
		2.3	2.3	2.3	3.1	5.6	14.4	14.4	23.9	54	55.8

*† Flanges, Ring Joint Facings and Drilling according to A.P.I. standards. Size depicts flange size only and not port size.   * Impactor Handle.*

Hydraulic Check Valves, 5,000 & 10,000 PSI (345 & 690 BAR) CWP

These hydraulic valves are designed and rated to Flowserve Edward Valve standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.

9160

160
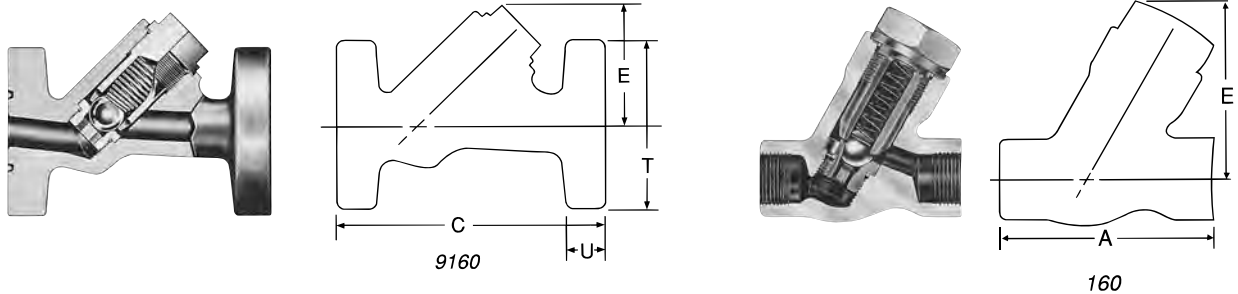
Standard Features

- Body is of forged alloy steel grade F-11.
- Carbon steel cover has a long guide for accurate ball disk seating.
- Seat and ball are 13% chromium stainless steel.
- Hardfaced seat standard on figure 5160 and 9169 only.
- Ball is precision ground for tight seating.
- Stainless steel spring capable of seating the ball disk in viscous fluids.
- Body-cover and body-seat joints have Buna-N "O" rings for leak tight connections.

5,000 & 10,000 PSI CWP

FIG. NO.		TYPE	ENDS	NPS (DN)
5,000	10,000			
	160	Globe	Threaded	¼ (6) thru 2 (50)
	160Y	Globe	Socket Welding	
5160		Globe	Flanged* Series 1500	2 (50)
	9160	Globe	Flanged* Series 6BX	2-¹⁄₁₆ (52.4) only

Recommended for use with high viscosity fluids only.
For pressure up to 10,000 PSI (690 BAR) - Edward high pressure forged steel hydraulic check valves are used in applications involving high pressures and with temperatures to 300°F (149°C).
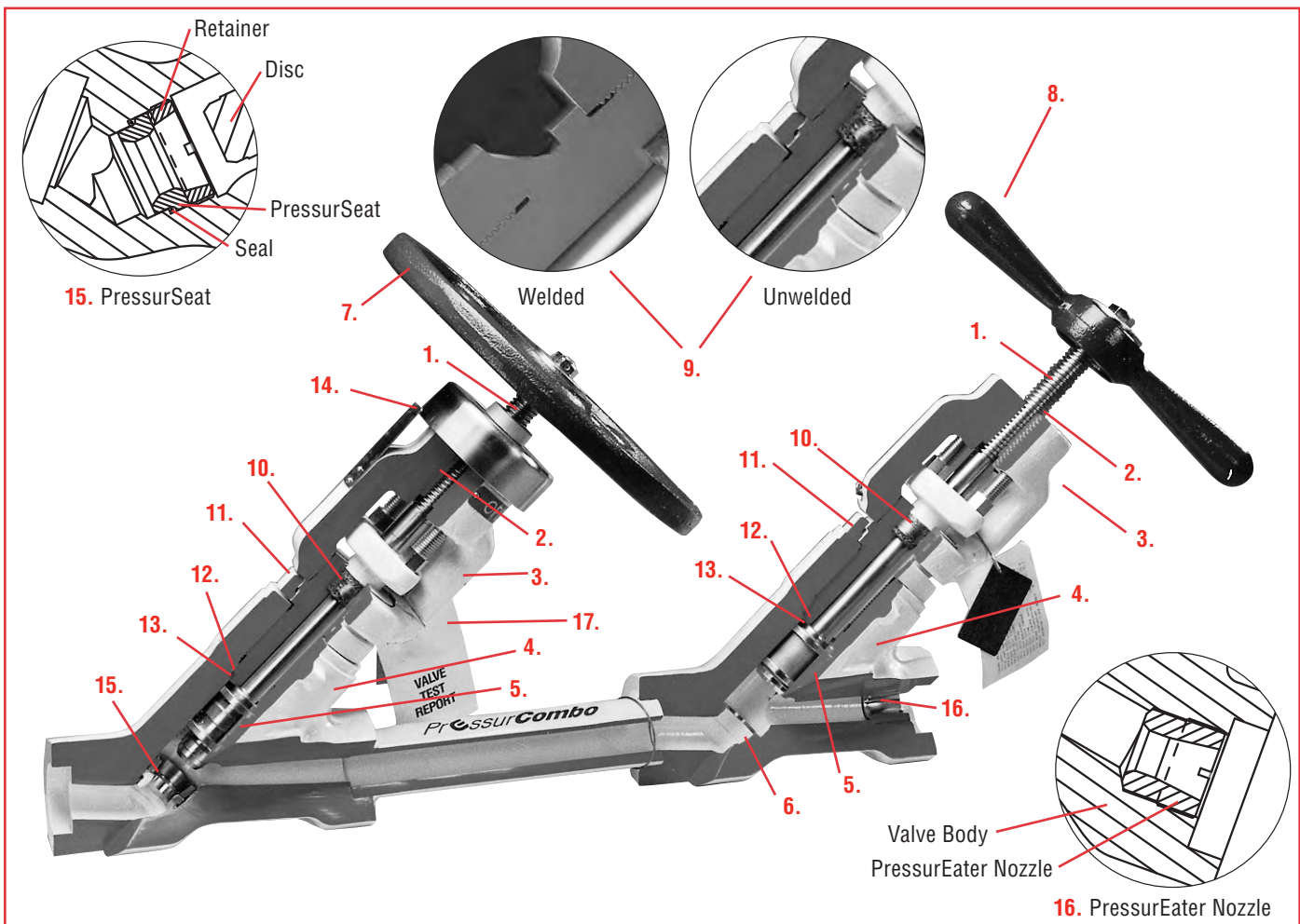
Dimensions

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 160/160Y, 5160, 9160	NPS	¼	⅜	½	¾	1	1¼	1½	2	2 (5150)	2-¹⁄₁₆
	DN	8	10	15	20	25	40	40	50	50	52.4
A - End to End		3.8	3.8	3.8	4.5	5.1	7.5	7.5	9	—	—
		97	97	97	114	130	191	191	229	—	—
C - Contact Face to Contact Face		—	—	—	—	—	—	—	—	13.4	13.3
		—	—	—	—	—	—	—	—	340	338
E - Center to Top		3	3	3	3.3	4.4	5.2	5.2	7.3	6.1	6.1
		76	76	76	84	112	132	132	185	155	155
T - Flange Diameter		—	—	—	—	—	—	—	—	8.5	7.9
		—	—	—	—	—	—	—	—	216	201
U - Flange Thickness		—	—	—	—	—	—	—	—	1.8	1.7
		—	—	—	—	—	—	—	—	46	43
Diameter of Ring Groove & Groove Number		—	—	—	—	—	—	—	—	3¾-#24	BX-152
		—	—	—	—	—	—	—	—	95	—
Diameter of Bolt Circle		—	—	—	—	—	—	—	—	6.5	6.25
		—	—	—	—	—	—	—	—	165	159
Bolts		—	—	—	—	—	—	—	—	(8)-7/8	(8)-¾
		—	—	—	—	—	—	—	—	—	—
Weight		2.6	2.6	2.6	4	7	19	19	34	101	105
		1.2	1.2	1.2	1.8	3.2	8.6	8.6	15.3	45.5	47.3

* Flanges, Ring Joint Facings and Drilling according to A.P.I. standards. Size depicts flange size only and not port size.

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Features and Description of Edward PressurCombo Valves

Retainer

Disc

PressurSeat

Seal

15. PressurSeat

7.

Welded

Unwelded

8.

9.

1.

14.

1.

10.

11.

10.

12.

11.

2.

13.

12.

3.

15.

13.

17.

4.

VALVE TEST REPORT

5.

4.

Pr ssur**Combo**

16.

5.

6.

Valve Body

PressurEater Nozzle

16. PressurEater Nozzle

Note: Also available as a single valve.

1. Stem has ACME threads, is ground to a fine finish and is hardened to resist wear.

2. Yoke bushing material has low coefficient of friction which substantially reduces torque and stem wear and eliminates galling. Mechanical upset locks bushing to yoke.

3. Yoke-bonnet assembly is two-piece to facilitate disassembly for faster in-line internal repairs.

4. **Inclined stem** construction and optimum flow shape minimizes flow direction changes and reduces pressure drop.

5. Body-guided disk utilizes anti-thrust rings to eliminate misalignment, galling and stem bending.

6. Integral hardsurfaced seat provides positive shutoff and long seat life.

7. Handwheel is rugged and knobbed to provide sure grip even when wearing gloves.

8. Impactor handle provides many times the closing force of an ordinary handwheel for positive seating.

9. Threaded bonnet has ACME threads for resistance to galling and ease of disassembly.

10. Stem packing system utilizes flexible graphite packing material with carbon fiber anti-extrusion rings for optimum sealability and life.

11. Bonnet locking collar.

12. Bonnet seal ring is die formed flexible graphite seated to a prescribed bonnet torque to provide reliable bonnet seal.

13. Integral backseat provides a secondary stem seal backup for positive shutoff and leak protection.

14. Position indicator provides positive indication of closed valve.

15. PressurSeat features live-loaded, pressure-energized Stellite seat, providing tight shut-off under varying pressures and temperatures.

16. PressurEater nozzle prevents excess wear on valve seat.

17. Valve test report is an actual report of the individual valve hydrostatic test.

18. Nameplate contains all relevant data for operational and maintenance records.

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PressurCombo, Class 1690, 4225 PSI @ 100°F (291.3 BAR @ 38°C)

Maximum Recommended Differential Pressure = 4200 Psi (289.7 Bar)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
- Available as tandem assembly or individual valves.**
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Investment cast Stellite seat in PressurSeat and PressurCombo.
- Integral Stellite seat in PressurEater.
- PressurEater & PressurCombo have outlet choke/nozzles.
- Integral Stellite backseat.
- Asbestos-free graphitic packing.
- PressurSeat and PressurCombo have position indicators.

Flow, DP
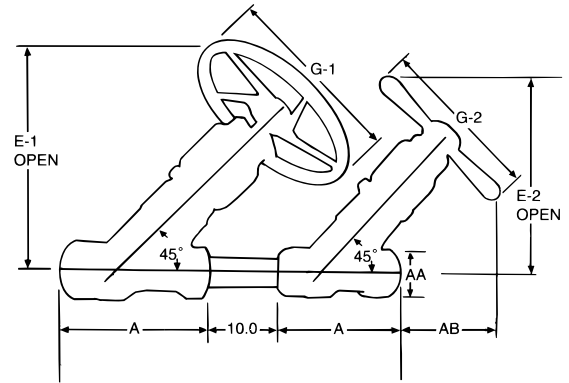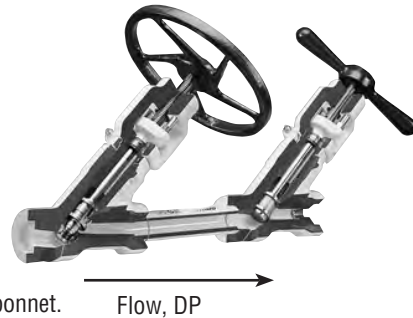
Pressure Class 1690 (PN 290)

FIG. NO.		TYPE	ENDS	NPS (DN)
WELDED	UNWELD.			
**36124	**36224	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
**36128	**36228	Y-Pattern	Buttwelding	2½ (65) thru 4 (100)

```
** DS36xxx PressurSeat    Inv. cast Stellite seat
   DE36xxx PressurEater   Integral Stellite seat, choke
   DC36xxx PressurCombo   Inv. cast Stellite seat, choke
```

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

| Figure No. **36124, **36128, **36224, **36228	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6	6	6	6.7	6.7	8.2	10.7	10.7	12.8
		152	152	152	170	170	208	272	272	325
AA - End Hub Diameter		3.20	3.20	3.20	3.20	3.20	3.64	4.00	4.00	4.8
		81	81	81	81	81	92	102	102	122
AB - Handwheel Clearance, (Open)		7.8	7.8	7.8	9.8	9.8	11.6	12.5	12.5	11.2
		198	198	198	249	249	295	318	318	284
E - 1 Center to Top, (Open)		12.2	12.2	12.2	13.7	13.7	17.1	20.3	20.3	20.7
		310	310	310	348	348	434	516	516	526
E - 2 Center to Top (Open)		12.1	12.1	12.1	14.6	14.6	17.7	19.6	19.6	20.0
		307	307	307	371	371	450	498	498	508
G - 1 Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	14.0	18.0	18.0	18.0
		216	216	216	216	216	356	457	457	457
G - 2 Handwheel/Handle Diameter		8.5	8.5	8.5	11.0*	11.0*	14.3*	16.0**	16.0**	16.0**
		216	216	216	279	279	363*	406**	406**	406**
Weight, Welded (Tandem DS/DE)		51	51	51	79	79	124	210	210	286
		23	23	23	36	36	56	95	95	130
Weight, Unwelded (Tandem DS/DE)		53	53	53	83	83	128	218	218	294
		24	24	24	38	38	58	99	99	133

* Impactor Handle   ** Impactor Handwheel

Flow coefficients are listed on page G32.

PressurCombo, Class 2680, 6700 PSI @ 100°F (461.9 BAR @ 38°C)

Maximum Recommended Differential Pressure = 4500 psi (310.3 bar)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
- Available as tandem assembly or individual valves.**
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Investment cast Stellite seat in PressurSeat and PressurCombo.
- Integral Stellite seat in PressurEater.
- PressurEater & PressurCombo have outlet choke/nozzles.
- Integral Stellite backseat.
- Asbestos-free graphitic packing.
- PressurSeat and PressurCombo have position indicators.v

Flow, DP
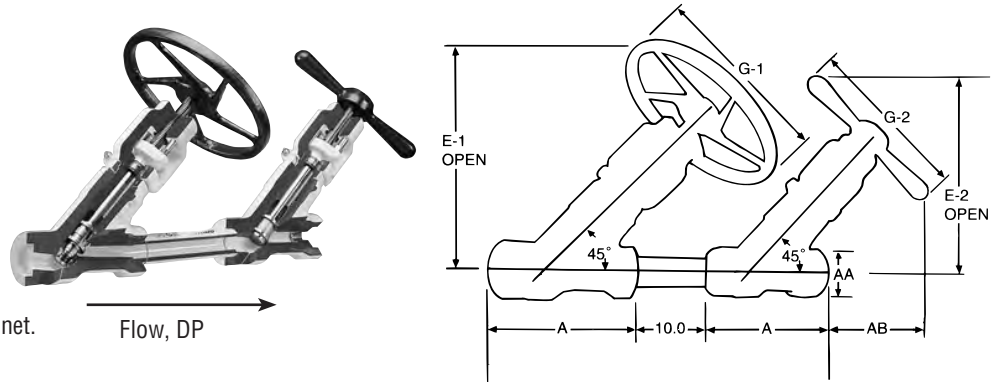
Pressure Class 2680 (PN 460)

FIG. NO.		TYPE	ENDS	NPS (DN)
WELDED	UNWELD.			
**66124	**66224	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
**66128	**66228	Y-Pattern	Buttwelding	2½ (65) thru 4 (100)

**DS66xxx PressurSeat   Inv. cast Stellite seat
  DE66xxx PressurEater   Integral Stellite seat, choke
  DC66xxx PressurCombo Inv. cast Stellite seat, choke

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. **66124, **66128, **66224, **66228,	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		6	6	6	6.7	6.7	10.7	12.8	12.8	12.8
		152	152	152	170	170	272	325	325	325
AA - End Hub Diameter		3.20	3.20	3.20	3.20	3.20	4.00	4.80	4.80	4.80
		81	81	81	81	81	102	122	122	122
AB - Handwheel Clearance (Open)		7.8	7.8	7.8	9.8	9.8	11.6	11.2	11.2	11.2
		198	198	198	249	249	295	285	285	285
E - 1 Center to Top (Open)		12.2	12.2	12.2	13.7	13.7	18.5	20.7	20.7	20.7
		310	310	310	348	348	470	526	526	526
E - 2 Center to Top (Open)		12.1	12.1	12.1	14.6	14.6	18.6	20.0	20.0	20.0
		307	307	307	371	371	472	508	508	508
G - 1 Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	14	18	18	18
		216	216	216	216	216	356	457	457	457
G - 2 Handwheel/Handle Diameter		8.5	8.5	8.5	11*	11*	14.3*	16**	16**	16**
		216	216	216	279*	279*	363*	406**	406**	406**
Weight, Welded (Tandem DS/DE)		51	51	51	79	79	167	298	298	298
		23	23	23	36	36	76	135	135	135
Weight, Unwelded (Tandem DS/DE)		53	53	53	83	83	169	306	306	306
		24	24	24	38	38	77	139	139	139

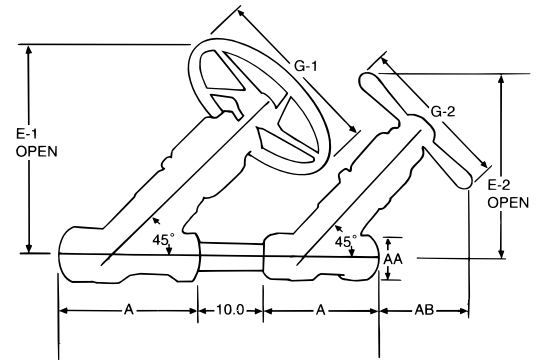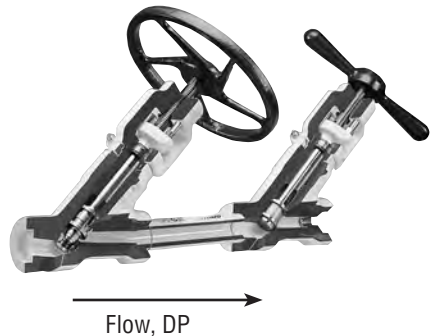 * Impactor Handle   ** Impactor Handwheel   Weights are listed for tandem assembly combo. Flow coefficients are listed on page G32.

PressurCombo, Class 4500, 11,250 PSI @ 100°F (775.7 BAR @ 38°C)

Maximum Recommended Differential Pressure = 5000 psi (344.8 bar)

Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F91 alloy steel.
- Available as tandem assembly or individual valves.**
- Unwelded (graphitic seal) or welded bonnet.
- OS & Y.
- Y-Pattern.
- Body-guided investment cast Stellite disk.
- Investment cast Stellite seat in PressurSeat and PressurCombo.
- Integral Stellite seat in PressurEater.
- PressurEater & PressurCombo have outlet choke/nozzles.
- Integral Stellite backseat.
- Asbestos-free graphitic packing.
- PressurSeat and PressurCombo have position indicators.

Flow, DP

Pressure Class 4500 (PN 760)

FIG. NO.		TYPE	ENDS	NPS (DN)
WELDED	UNWELD.			
**96124	**96224	Y-Pattern	Socket Welding	½ (15) thru 2 (50)
**96128	**96228	Y-Pattern	Buttwelding	2½ (65) thru 4 (100)

**DS96xxx PressurSeat   Inv. cast Stellite seat
  DE96xxx PressurEater   Integral Stellite seat, choke
  DC696xxx PressurCombo Inv. cast Stellite seat, choke

Dimensions - Globe

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

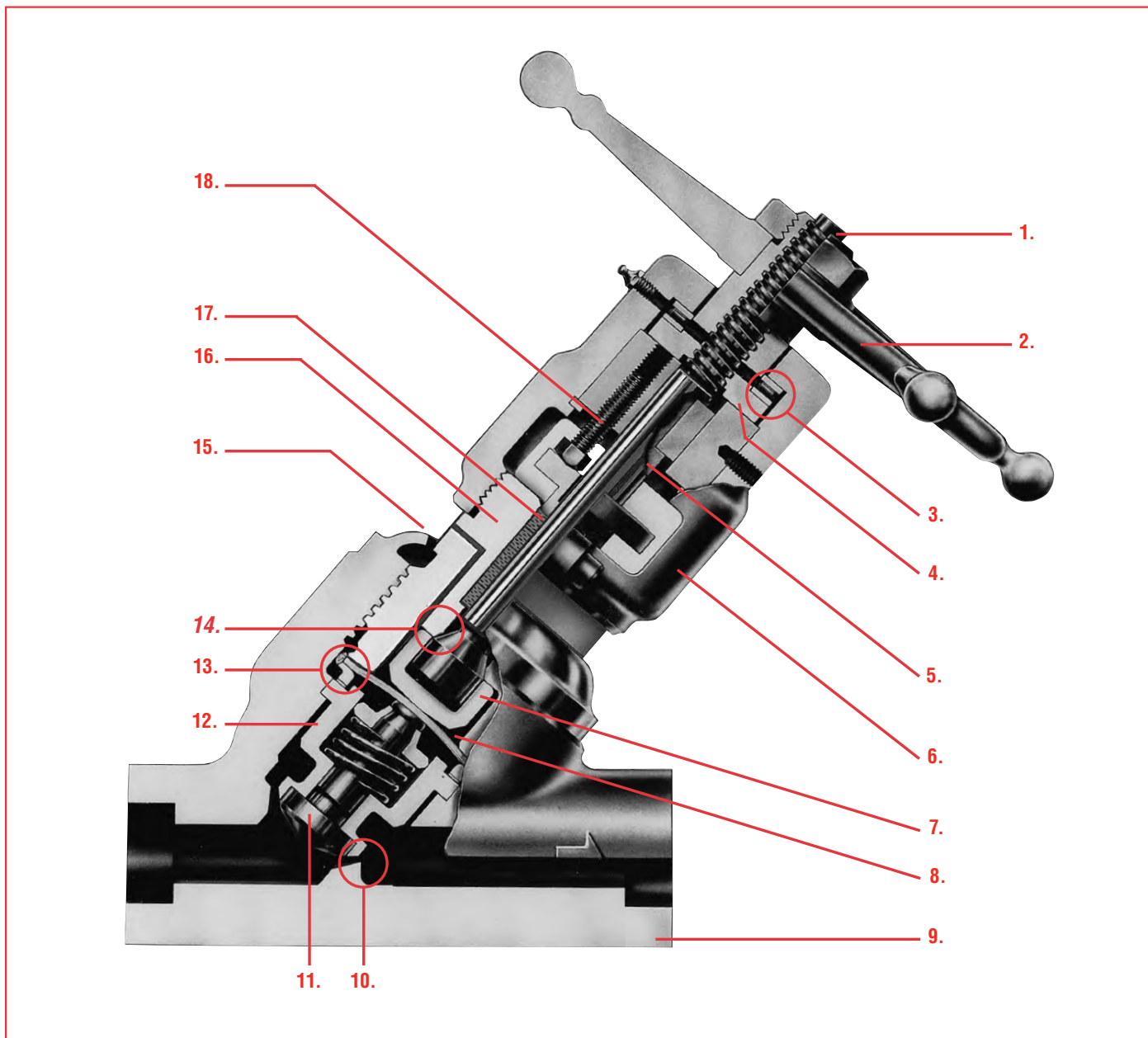| Figure No. **96124, **96128, **96224, **96228	NPS	½	¾	1	1¼	1½	2	2½	3	4
	DN	15	20	25	32	40	50	65	80	100
A - End to End		8.2	8.2	8.2	8.2	8.2	12.8	12.8	12.8	12.8
		208	208	208	208	208	325	325	325	325
AA - End Hub Diameter		3.64	3.64	3.64	3.64	3.64	4.80	4.80	4.80	4.80
		92	92	92	92	92	122	122	122	122
AB - Handwheel Clearance (Open)		7.3	7.3	7.3	7.3	7.3	11.2	11.2	11.2	11.2
		185	185	185	185	185	284	284	284	284
E - 1 Center to Top (Open)		13.1	13.1	13.1	13.1	13.1	19.1	19.1	19.1	19.1
		333	333	333	333	333	485	485	485	485
E - 2 Center to Top (Open)		13.4	13.4	13.4	13.4	13.4	20.0	20.0	20.0	20.0
		340	340	340	340	340	508	508	508	508
G - 1 Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	14.0	14.0	14.0	14.0
		216	216	216	216	216	356	356	356	356
G - 2 Handwheel/Handle Diameter		8.5	8.5	8.5	8.5	8.5	16.0**	16.0**	16.0**	16.0**
		216	216	216	216	216	406**	406**	406**	406**
Weight, Welded (Tandem DS/DE)		90	90	90	90	90	320	320	320	320
		41	41	41	41	41	145	145	145	145
Weight, Unwelded (Tandem DS/DE)		94	94	94	94	94	328	328	328	328
		43	43	43	43	43	149	149	149	149

** Impactor Handwheel   *Flow coefficients are listed on page G32.*

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Strainers, Class 800, 2000 PSI @ 100°F (137.9 BAR @ 38°C)
Series 1500, 3600 PSI @ 100°F (248.3 BAR @ 38°C)

The Class 800 Strainers are rated in accordance with ASME/ANSI B16.34 criteria. The Series 1500 Strainers are designed and rated to Flowserve Edward Valves standards. See 3.2 Pressure Ratings in the Technical Information section for additional information.
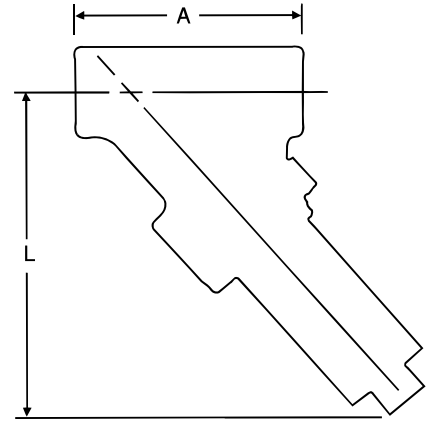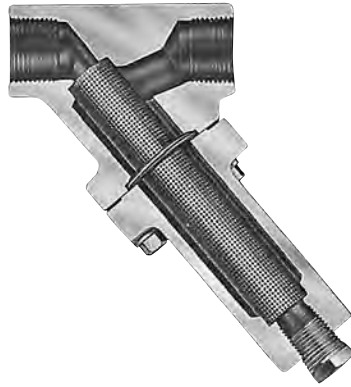
238/338

Standard Features

- Bodies and covers are of forged carbon steel.
- Screen is stainless steel.
- Screen specification (400, .027 dia. holes per square inch).
- Removable drain plug for easy cleaning.

Pressure Class 800 (PN 130) and Series 1500

FIG. NO.		ENDS	NPS (DN)
800	1500		
238	338	Threaded	¼ (8) thru 2 (50)
238Y	338Y	Socket Welding	

Dimensions – Globe & Angle

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 238/238Y, 338/338Y	NPS	¼	3/8	½	¾	1	1¼	1½	2
	DN	8	10	15	20	25	32	40	50
A - End to End		3	3	3	3.6	4.3	5.8	5.8	6.5
		76	76	76	91	109	147	147	165
L - Center to Bottom		3.4	3.4	3.4	4.8	6.1	10.4	10.4	12.1
		86	86	86	122	155	264	264	307
Plug Size (NPT)		¼	¼	¼	¼	½	½	½	½
		6	6	6	6	13	13	13	13
Weight		2	2	2	4	6	13	13	20
		.9	.9	.9	1.8	2.7	5.9	5.9	9

Special interior surface preparation for corrosive and erosive water services available on size 1 (DN 25) only.

Features and Descriptions of Edward Hermavalve® Hermetically-Sealed Valves

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*Features and Descriptions of Edward Hermavalve®
Hermetically-Sealed Valves*

1. Position indicator shows whether the valve is open or closed.

2. Handwheel is rugged and knobbed to permit sure grip even when wearing gloves.

3. Needle thrust bearings minimize torque. Their upper yoke location protects from heat and allows lubrication.

4. Yoke bushing. Revolving bushing of aluminum bronze material has low coefficient of friction, substantially reduces torque, stem wear and eliminates galling.

5. Non-revolving stem is stainless steel. It is ground to a fine finish and keyed to the yoke to prevent rotation and torsional stress on the diaphragm.

6. Yoke of carbon steel.

7. Diaphragm disk is a unique shape which maximizes diaphragm life.

8. Diaphragm of multi-ply flexible metal provides a reliable primary stem seal.

9. Body with inclined stem construction and unique flow shape minimizes flow directional changes and cuts pressure drop.

10. Integral hardfaced seat of hard, heat resistant hardfacing material is integrally welded to the body.

11. Solid Stellite disk assures maximum seating life.

12. Disk guide assembly assures disk/seat alignment. Its completely encapsulated spring assures full disk life.

13. Diaphragm seal weld is a unique seal weld which makes the diaphragm an integral part of the bonnet and eliminates a potential leak path past the stem.

14. Backseat provides a secondary stem seal backup.

15. Body-bonnet seal features leak-proof seal-welded construction. The weld is for seal only; the threaded section carries the pressure load. Canopy weld in stainless steel; fillet weld in carbon steel.

16. Bonnet is barstock steel with gall-resistant Acme threads to ensure easy disassembly from body.

17. Backup packing with O.S. & Y. design allows for inspection or addition of packing without disassembling valve.

18. Adjustable gland screws with O.S. & Y. design allow for easy access to packing adjustment if necessary.

What is a Hermavalve? A Hermavalve is a hermetically sealed valve that cannot leak to the environment. The Edward Hermavalve cannot leak because it is double seal welded:

1. The multi-ply flexible metal diaphragm is seal welded to the bonnet.

2. The body-to-bonnet joint is also seal welded.

This unique construction eliminates any potential leakage through a mechanical joint. It is more than just packless, it is hermetically sealed.

Zero leakage to environment — Welded, heretic design and dependable metal diaphragm help to ensure zero leakage for the life of the valve. In approved services the valve is warranted against leakage to the environment.

High efficiency flow-shape — Unique flow shape assures high C_v comparable to or greater than conventionally packed valves — proven by extensive flow testing.

Non-revolving stem design — Assures lowest possible operating torque and is the only absolute method of avoiding diaphragm damage caused by rotational forces from a revolving stem.

Two backup stem seals — 1) Packing and 2) backseat provide redundancy in backup seals.

Part Specification List For Edward Hermavalve®

DESCRIPTION	ASTM NO.	ASTM NO.	ASTM NO.
Body	A-105	A-182 Grade F22	A-182 Grade F316
Disk	A-565 Grade 615	A-565 Grade 615	A-732 Grade 21
Body Seat	Stellite 21	Stellite 21	Stellite 21
Stem	A-479 T410 Class 3	A-479 T410 Class 3	A-479 T410 Class 3
Junk Ring	A-582 T416	A-582 T416	A-582 T416
Bonnet	A-105	A-739 Grade B22	A-479 T316
Yoke Bolt	A-307 Grade A	A-307 Grade A	A-307 Grade A
Packing	Flexible Graphite System	Flexible Graphite System	Flexible Graphite System
Gland	A-696 Grade C	A-696 Grade C	A-696 Grade C
Retaining Ring	Nickel Plated Steel	Nickel Plated Steel	Nickel Plated Steel
Gland Adjusting Screw	A-193 Grade B6	A-193 Grade B6	A-194 Grade B6
Stem Guide Bushing	A-696 Grade C Nickel Plated	A-696 Grade C Nickel Plated	A-696 Grade C Nickel Plated
Yoke Bolt Nut	A-563 Grade A	A-563 Grade A	A-563 Grade A
Yoke	A-216 Grade WCB	A-216 Grade WCB	A-216 Grade WCB
Yoke Bushing	B-150 Alloy C61900 or C62300	B-150 Alloy C61900 or C62300	B-150 Alloy C61900 or C62300
Drive Pin	Alloy Steel	Alloy Steel	Alloy Steel
Key	A-331 Grade 4140	A-331 Grade 4140	A-331 Grade 4140
Spring Housing	A-582 T416	A-582 T416	A-479 T316
Diaphragm Ring	A-696 Grade C	A-739 Grade B22	A-479 T316
Diaphragm Assembly	B-670 Alloy 718 (Inconel)	B-670 Alloy 718 (Inconel)	B-670 Alloy 718 (Inconel)
Diaphragm Disk	A-732 Grade 21	A-732 Grade 21	A-732 Grade 21
Shims	A-167 T316	A-167 T316	A-167 T316
Disk Collar	A-565 Grade 615	A-565 Grade 615	A-479 T316
Spring	Inconel X-750	Inconel X-750	Inconel X-750
Handwheel	Malleable or Ductile Iron	Malleable or Ductile Iron	Malleable or Ductile Iron
Handwheel Nut	Steel	Steel	Steel
Indicator	A-479 T316	A-479 T316	A-479 T316
Thrust Bearing	Steel	Steel	Steel
Lube Fitting	Steel	Steel	Steel

Hermavalve® Hermetically-Sealed Valves
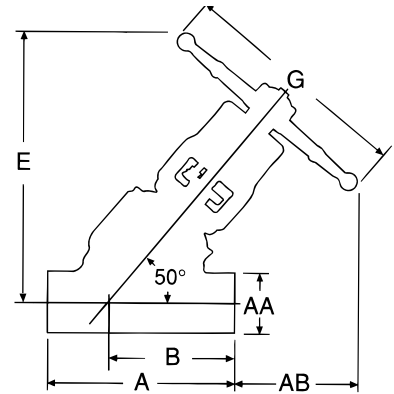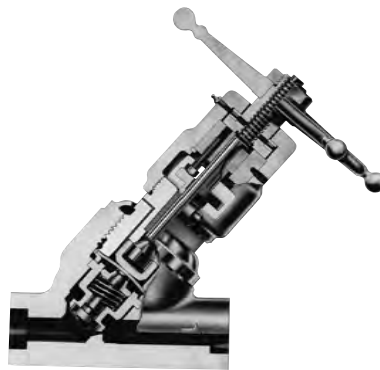
Standard Features

- Available Body Material
  - A105 carbon steel.
  - F22 alloy steel.
  - F316 stainless steel.
- Seal welded diaphragm and seal welded body/bonnet joint.
- OS & Y.
- Y-Pattern.
- Non-revolving stem with position indicator.
- Back-up asbestos-free graphitic packing and secondary stem backseat.
- Integral backseat.
- Knobbed handwheel.

Pressure Class 1690 (PN 290)

FIG. NO.	TYPE	ENDS	PORT	NPS (DN)
16004	Y-Pattern	Socket Welding	Regular	½ (15) thru 2 (50)
16008	Y-Pattern	Buttwelding	Regular	
16014	Y-Pattern	Socket Welding	Reduced	1 (25) thru 2½ (40)
16018	Y-Pattern	Buttwelding	Reduced	

Dimensions

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

Figure No. 16004, 16008, 16014, 16018	NPS	½	¾	1	1½	2	1	1½*	2	2½
	DN	15	20	25	40	50	25	40	50	65
A - End to End		5.5	5.5	6.62	8.7	10	5.5	6.62	8.7	10
		140	140	168	220	254	140	168	220	254
AA - End Hub Diameter		2.06	2.06	2.12	3.4	3.4	2.06	2.12	3.4	3.4
		52	52	54	86	86	52	54	86	86
AB - Handwheel Clearance (Open)		4.62	4.62	5.69	9.06	10.88	4.62	5.69	9.06	10.88
		117	117	145	230	276	117	145	230	276
E - Center to Top		9.12	9.12	11.19	16	18.5	9.12	11.19	16	18.5
		232	232	284	406	470	232	284	406	470
B - Center to End		3.8	3.8	4.62	6	6.86	3.8	4.62	6	6.86
		97	97	117	152	174	97	117	152	174
G - Handwheel Diameter		7.12	7.12	8.5	11.5	15	7.12	8.5	11.5	15
		181	181	216	292	381	181	216	292	381
Weight		18	18	30	73	106	18	30	73	106
		8	8	14	33	48	8	14	33	48

*Available in buttweld only.

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Accessories – Forged Steel

The following "accessories" or "options" are available for Edward Forged Steel Valves. Consult your Flowserve sales representative for specific details.

Custom Paint

Unless otherwise specified Edward Cast and Forged (carbon or alloy) Steel Valves are painted with a high temperature aluminum lacquer paint. Upon special order Edward Valves can be provided with customer specified paints or coatings.

Locking Devices

Edward Valves can be provided with padlock & chain or other locking devices as specified.

Position Indicators & Limit Switches

If required, Edward Valves can be fitted with a variety of position indicators and/or limit switches for remote indication.

Soft Seats

This option is available for both Forged and Cast Steel Globe and Check Valves on a limited basis.

The disk face can be fitted with a soft seat or insert when drop tight sealing is a must. However, some limitations (temperature, differential pressure, radiation) may apply. Consult your Flowserve Edward Valves representative for more information.

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Actuators – Forged Steel
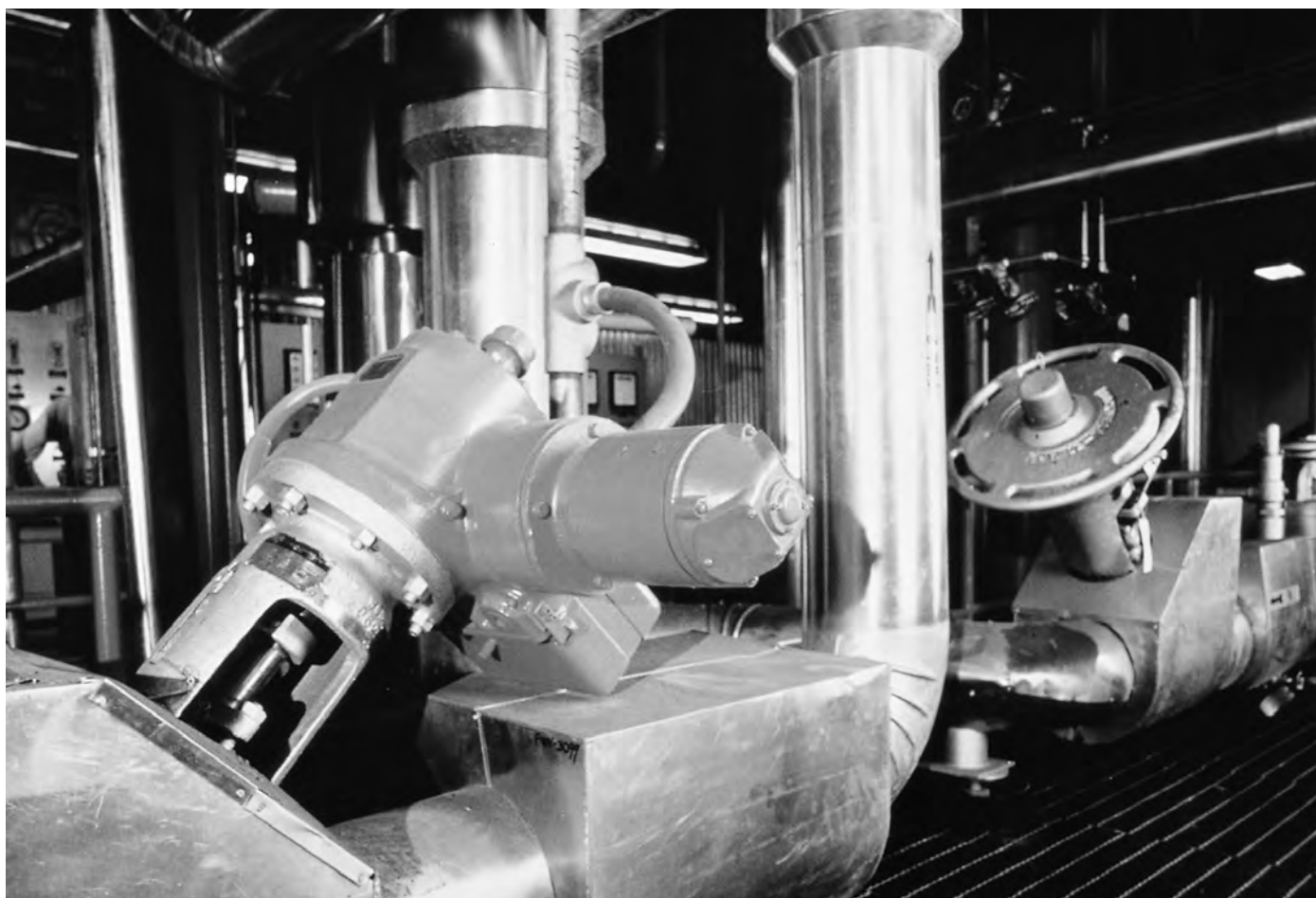
Flowserve Edward Valves supplies actuators for Edward forged and cast steel valves when alternate sources of power are required to open, close or maintain an intermediate position in the valve.

The most commonly used actuators are: electric, pneumatic, hydraulic, manual gear, or a stored energy gas hydraulic used in nuclear applications. Most Edward valves can be equipped with an actuator, if required. Where specific or special customer requirements are needed, Flowserve engineering and expertise with all types of actuators can be applied and adapted to meet the most rigid codes.

The following information on page 70 will allow Flowserve engineers to correctly size and select the proper motor actuator for your application.

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Required Information for Motor Actuators

1. OPERATING PRESSURES:

      A) PRESSURE UNDER SEAT = _____ psig

      B) PRESSURE OVER SEAT = _____ psig

      C) PRESSURE DIFFERENTIAL = _____ psig

2. MOTOR POWER SUPPLY*:

      A) AC = _____ V. _____ HZ. _____ PH. _____

      B) DC = _____ V.

      *STANDARD VOLTAGE VARIANCE ± 10%, IF OTHERWISE, PLEASE INDICATE

3. LIMIT SWITCH, TOTAL QUANTITY OF CONTACTS = _____

4. DOUBLE TORQUE SWITCH IS STANDARD.

5. CONTROL POWER SUPPLY TO SWITCH COMPARTMENT = _____

6. CLOSING TIME:

      A) STANDARD (GLOBE VALVES APPROX. 4 IN./MIN., GATE VALVES APPROX. 12 IN./MIN. STEM SPEED.)

      B) SPECIAL _____ INDICATE REQUIRED CLOSING TIME:_____

7. OPTIONAL EQUIPMENT: (PLEASE INDICATE REQUIRED OPTIONS)

      A) MECHANICAL DIAL POSITION INDICATOR

      B) EXTRA TERMINALS

      C) REVERSING MOTOR CONTROLLER: _____ INTEGRAL OR _____ NON-INTEGRAL.

      D) PUSH-BUTTON STATION: _____ INTEGRAL OR _____ NON-INTEGRAL.

      E) POSITION TRANSMITTER, INDICATE TYPE _____

      F) POSITION RECEIVER _____

      H) OTHERS _____

      _____

8. AMBIENT CONDITIONS: _____

9. NEMA RATING: *STANDARD IS NEMA 4 (WEATHERPROOF), IF OTHERWISE, PLEASE LIST*

      _____

10. STEM POSITION OF INSTALLED VALVE:

      A) VERTICAL UP-RIGHT _____

      B) VERTICAL UP-SIDE DOWN _____

      C) HORIZONTAL _____

Data in the Table above represents the minimum information that should be provided when ordering a valve equipped with a motor operator.

Material Chemical Analysis (ASTM) for Edward Valves

MATERIAL	ELEMENTS	PERCENTAGE*	
		CAST	FORGED
Carbon Steel (Body)	Carbon	0.30 max.	0.22 max.
	Manganese	1.00 max.	.60 to 1.05
Cast - ASTM A216 Grade WCB	Phosphorus	0.04 max.	0.04 max.
	Sulfur	0.045 max.	0.05 max.
Forged - ASTM A105	Silicon	0.60 max.	0.35 max.

Continued on next page

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MATERIAL	ELEMENTS	PERCENTAGE*	
		CAST	FORGED
Carbon Steel (Body) **Cast - ASTM A216-WCC**	Carbon Manganese Phosphorus Sulfur Silicon	0.25 max. 1.20 max. 0.04 max. 0.045 max. 0.60 max.	
1¼ Chromium-Molybdenum Steel (Body) **Cast - ASTM A217 Grade WC6** **Forged - ASTM A182 Grade F11**	Carbon Manganese Phosphorus Sulfur Silicon Chromium Molybdenum	0.20 max. 0.50 to 0.80 0.04 max. 0.045 max. 0.60 max. 1.00 to 1.50 0.45 to 0.65	0.10 to 0.15 0.30 to 0.80 0.04 max. 0.04 max. 0.50 to 1.00 1.00 to 1.50 0.44 to 0.65
2¼ Chromium-Molybdenum Steel (Body) **Cast - ASTM A217 Grade WC9** **Forged - ASTM A182 Grade F22**	Carbon Manganese Phosphorus Sulfur Silicon Chromium Molybdenum	0.18 max. 0.40 to 0.70 0.04 max. 0.045 max. 0.60 max. 2.00 to 2.75 0.90 to 1.20	0.15 max. 0.30 to 0.60 0.04 max. 0.04 max. 0.50 max. 2.00 to 2.50 0.87 to 1.13
9 Chromium, 1 Molybdenum Steel Body **Cast - ASTM A-217 Grade C12A** **Forged - ASTM A-182 Grade F91**	Carbon Manganese Phosphorus Sulfur Silicon Chromium Molybdenum Columbium Venadium Nitrogen Nickel	0.12 max. 0.30-0.60 max. 0.02 max. 0.018 max. 0.20-0.50 8.0-9.5 0.85-1.05 0.060-0.10 0.18-0.25 0.030-0.070 0.40 max.	0.08-0.12 max. 0.30-0.60 max. 0.02 max. 0.01 max. 0.20-0.50 max. 8.00-9.50 0.85-1.05 0.060-0.10 0.18-0.25 0.030-0.070 0.40 max.
9 Chromium, 1.8 Tungsten, 0.2 Vanadium **Forged - ASTM A182 Grade F92**	Carbon Manganese Phosphorus Sulfur Silicon Chromium Molybdenum Nickel		0.07 - 0.13 0.30 - 0.60 0.02 max. 0.01 max. 0.50 max. 8.50 - 9.50 0.30 - 0.60 0.40 max.
Austenitic Stainless Steel (Body) **Cast - ASTM A-351 Grade CF8M** **Forged - ASTM A-182 Grade F316**	Carbon Manganese Phosphorus Nickel Sulfur Silicon Chromium Molybdenum	0.03 max. 1.50 max. 0.04 max. 9.00 to 13.00 0.04 max. 1.50 max. 17.00 to 21.00 2.00 to 3.00	0.08 max. 2.00 max. 0.04 max. 10.00 to 14.00 0.03 max. 1.00 max. 16.00 to 18.00 2.00 to 3.00
Martensitic Stainless Steel (Stems) **Bolted Bonnet T416** **Cast Valves - ASTM A182 Grade F6a** **Univalves - A-479 T-410 Cl 3**	Carbon Manganese Phosphorus Sulfur Silicon Nickel Chromium Molybdenum	0.15 max. 1.00 max. 0.04 max. 0.03 max. 1.00 max. 0.50 max. 11.50 to 13.50 —	0.15 max. 1.25 max. 0.06 max. 0.15 min. 1.00 max — 12.00 to 14.00 0.60 max.

MATERIAL	ELEMENTS	CAST	FORGED	
Aluminum Bronze (Yoke Bushings) **Cast Valves - ASTM B 148 Alloy 95400** **Forged Valves - ASTM B150 Alloy 61900-62300**			61900	62300
	Copper Aluminum Iron Tin Lead Manganese Zinc Silicon Nickel & Cobalt	remainder 10.00 to 11.50 3.00 to 5.00 — — 0.50 max. — — 1.50 max.	remainder 8.50 to 10.00 3.00 to 4.50 0.60 max. 0.80 max. — 0.02 max. — —	remainder 8.50 to 11.00 2.00 to 4.00 0.60 max. — 0.50 max. — 0.25 max. 1.00 max.

MATERIAL	ELEMENTS	FORGED
Chromium-Molybenum (Bolting) **ASTM A193 Grade B7** **Forged - ASTM A105**	Carbon Manganese Phosphorus Sulfur Silicon Chromium Molybdenum	0.37 to 0.49 0.65 to 1.10 0.035 max. 0.04 max. 0.15 to 0.35 0.75 to 1.20 0.15 to 0.25
Hard Surfacing for Seats and Disks **A732 Grade 21 & Stellite 21®**	Chromium Manganese Molybdenum Nickel Iron Boron Carbon Silicon	25.00 to 29.00 1.00 max. 5.00 to 6.00 1.75 to 3.75 3.00 .007 max. 0.20 to 0.30 1.00

The equivalent Edward valve material specification for valve bodies meets all of the requirements of the referenced ASTM Specification; additionally Flowserve restricts certain elements (i.e. carbon, manganese) to tighter allowable ranges to enhance weldability.

This ASTM specification data is provided for customer information. The data was based on information available at time of printing and may not reflect the latest ASTM revision. Flowserve suggests referring to the applicable specification for complete information or contacting your Edward Valves sales representative.

Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings

Forged Steel Univalves

MATERIAL	TEMP (°F)	PRESSURE (PSIG)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A105/ A216 WCB (4) (6)	-20 to 100	3705	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3395	4225	4225	4815	4815	6250	6700	6700	11250	11250
	300	3270	4170	4170	4750	4750	6170	6615	6615	11105	11105
	400	3170	4130	4130	4700	4700	6105	6545	6545	10995	10995
	500	3015	4130	4130	4700	4700	6105	6545	6545	10995	10995
	600	2840	4130	4130	4700	4700	6105	6545	6545	10995	10995
	650	2745	4030	4030	4590	4590	5960	6390	6390	10730	10730
	700	2665	3895	3895	4435	4435	5760	6175	6175	10365	10365
	750	2535	3570	3570	4070	4070	5285	5665	5665	9515	9515
	800	2055	2895	2895	3300	3300	4285	4595	4595	7715	7715
	850	1595	2245	2245	2560	2560	3320	3560	3560	5980	5980
	900	1150	1615	1615	1845	1845	2395	2565	2565	4305	4305
	950	685	990	965	1130	1100	1485	1595	1535	2745	2570
	1000	430	650	605	750	690	1000	1085	960	1990	1605
A 182 F22 (5) (6)	-20 to 100	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	300	3640	4165	4165	4745	4745	6160	6605	6605	11090	11090
	400	3530	4100	4100	4670	4670	6065	6500	6500	10915	10915
	500	3325	4080	4080	4645	4645	6035	6470	6470	10865	10865
	600	3025	4060	4060	4625	4625	6010	6440	6440	10815	10815
	650	2940	4035	4035	4595	4595	5965	6395	6395	10735	10735
	700	2840	3985	3985	4540	4540	5895	6320	6320	10605	10605
	750	2660	3985	3985	4540	4540	5895	6320	6320	10605	10605
	800	2540	3985	3985	4540	4540	5895	6320	6320	10605	10605
	850	2435	3815	3815	4345	4345	5645	6050	6050	10160	10160
	900	2245	3380	3380	3850	3850	5000	5360	5360	9000	9000
	950	1930	2725	2660	3115	3025	4075	4380	4215	7555	7070
	1000	1335	2030	1880	2335	2145	3120	3375	2985	6215	5015
	1050	875	1330	1235	1530	1405	2040	2205	1950	4065	3280
	1100	550	835	770	960	880	1280	1385	1225	2545	2055
	1150	345	520	485	600	550	800	865	765	1590	1285
	1200	205	310	290	360	330	480	520	460	955	770

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
   Limited Class Threaded ends limited to Size 1 and smaller, 1000°F maximum and Class 2500 maximum.
3. Special Class, Sizes 3 and 4, Butt-weld ends only.
4. Permissible but not recommended for prolonged usage above approx. 800°F.
5. Permissible but not recommended for use above 1100°F.
6. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings (metric)
Forged Steel Univalves

1 bar = 100 kPa = 14.50 psi

MATERIAL	TEMP (°C)	PRESSURE (BAR)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A105/ A216 WCB (4) (6)	-29 to 38	255.3	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	250.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	100	233.0	290.9	290.9	331.3	331.3	430.3	461.3	461.3	774.5	774.5
	150	225.4	287.5	287.5	327.5	327.5	425.3	455.9	455.9	765.5	765.5
	200	219.0	284.9	284.9	324.5	324.5	421.4	451.7	451.7	758.6	758.6
	250	209.7	284.6	284.6	324.2	324.2	421.1	451.4	451.4	757.9	757.9
	300	199.1	284.6	284.6	324.2	324.2	421.1	451.4	451.4	757.9	757.9
	325	193.6	282.3	282.3	321.6	321.6	417.6	447.7	447.7	751.7	751.7
	350	187.8	275.6	275.6	313.9	313.9	407.6	436.9	436.9	733.7	733.7
	375	181.8	265.3	265.3	302.2	302.2	392.5	420.8	420.8	706.5	706.5
	400	173.6	244.5	244.5	278.5	278.5	361.7	387.7	387.7	651.0	651.0
	425	143.8	202.6	202.6	230.7	230.7	299.6	321.2	321.2	539.3	539.3
	450	115.0	162.0	162.0	184.5	184.5	239.6	256.9	256.9	431.4	431.4
	475	87.2	122.8	122.8	139.9	139.9	181.6	194.7	194.7	326.9	326.9
	500	58.8	84.1	82.8	96.0	94.3	122.4	134.7	131.2	230.3	220.4
	538	29.5	44.8	41.6	51.7	47.4	69.0	74.6	66.0	137.3	110.8
A 182 F22 (5) (6)	-29 to 38	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	100	257.6	290.8	290.8	331.2	331.2	430.2	461.2	461.2	774.3	774.3
	150	250.8	287.1	287.1	327.0	327.0	424.6	455.2	455.2	764.3	764.3
	200	243.4	282.9	282.9	322.2	322.2	418.5	448.6	448.6	753.4	753.4
	250	231.8	281.6	281.6	320.7	320.7	416.5	446.5	446.5	749.7	749.7
	300	214.4	280.4	280.4	319.4	319.4	414.8	444.7	444.7	746.7	746.7
	325	206.6	279.4	279.4	318.3	318.3	413.3	443.1	443.1	743.9	743.9
	350	201.1	277.2	277.2	315.7	315.7	410.0	439.5	439.5	738.1	738.1
	375	194.1	274.7	274.7	312.9	312.9	406.3	435.5	435.6	731.3	731.3
	400	183.1	274.7	274.7	312.9	312.9	406.3	435.5	435.6	731.3	731.3
	425	175.1	274.7	274.7	312.9	312.9	406.3	435.5	435.6	731.3	731.3
	450	169.0	265.7	265.7	302.7	302.7	393.1	421.4	421.4	707.6	707.6
	475	158.2	240.8	240.8	274.3	274.3	356.3	382.0	382.0	641.3	641.3
	500	140.9	204.5	201.2	233.4	229.1	304.8	327.3	318.9	559.4	535.4
	538	92.2	139.9	129.8	162.2	147.9	215.2	232.6	205.9	428.3	345.7
	550	78.2	118.7	110.1	136.6	125.4	182.3	197.2	174.5	363.1	293.1
	575	52.6	79.9	74.1	92.1	84.5	122.9	132.9	117.6	244.6	197.4
	600	34.4	52.5	48.5	60.2	55.2	80.3	86.8	76.9	159.9	129.1
	625	22.3	33.9	31.4	39.0	35.8	52.1	56.3	49.8	103.7	83.7
	650	14.2	21.5	19.9	24.8	22.7	33.0	35.7	31.6	65.9	53.2

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
   2.. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
      Limited Class Threaded ends limited to Size 1 and smaller, 538°C maximum and Class 2500 maximum.
   3. Special Class, Sizes 3 and 4, Butt-weld ends only.
   4. Permissible but not recommended for prolonged usage above approx. 425°C.
   5. Permissible but not recommended for use above 595°C.
   6. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

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Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings

Forged Steel Univalves

| MATERIAL | TEMP (°F) | CLASS 1500 | CLASS 1690 | | CLASS 1925 | | CLASS 2500 | CLASS 2680 | | CLASS 4500 | |
| | | PRESSURE (PSIG) | | | | | | | | | |
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A182 F91	-20 to 100	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	300	3640	4225	4225	4815	4815	6250	6700	6700	11250	11250
	400	3530	4225	4225	4815	4815	6250	6700	6700	11250	11250
	500	3325	4225	4225	4815	4815	6250	6700	6700	11250	11250
	600	3025	4225	4225	4815	4815	6250	6700	6700	11250	11250
	650	2940	4225	4225	4815	4815	6250	6700	6700	11250	11250
	700	2840	4130	4130	4705	4705	6110	6550	6550	10995	10995
	750	2660	4105	4105	4675	4675	6070	6505	6505	10930	10930
	800	2540	4055	4055	4620	4620	6000	6430	6430	10800	10800
	850	2435	3815	3815	4345	4345	5645	6050	6050	10160	10160
	900	2245	3380	3380	3850	3850	5000	5360	5360	9000	9000
	950	1930	2725	2660	3115	3025	4075	4380	4215	7555	7070
	1000	1820	2555	2370	2945	2700	3925	4245	3755	7555	6310
	1050	1800	2555	2370	2945	2700	3925	4245	3755	7555	6310
	1100	1510	2290	2125	2640	2420	3520	3810	3370	7005	5655
	1150	1115	1695	1570	1950	1790	2600	2810	2485	5180	4180
	1200	720	1095	1015	1260	1155	1680	1815	1610	3345	2700
A 182 F92	-20 to 100	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3750	4225	4225	4815	4815	6250	6700	6700	11250	11250
	300	3640	4225	4225	4815	4815	6250	6700	6700	11250	11250
	400	3530	4225	4225	4815	4815	6250	6700	6700	11250	11250
	500	3325	4225	4225	4815	4815	6250	6700	6700	11250	11250
	600	3025	4225	4225	4815	4815	6250	6700	6700	11250	11250
	650	2940	4225	4225	4815	4815	6250	6700	6700	11250	11250
	700	2840	4130	4130	4705	4705	6110	6550	6550	10995	10995
	750	2660	4105	4105	4675	4675	6070	6505	6505	10930	10930
	800	2540	4055	4055	4620	4620	6000	6430	6430	10800	10800
	850	2435	3815	3815	4345	4345	5645	6050	6050	10160	10160
	900	2245	3380	3380	3850	3850	5000	5360	5360	9000	9000
	950	1930	2725	2660	3115	3025	4075	4380	4215	7555	7070
	1000	1820	2555	2370	2945	2700	3925	4245	3755	7555	6310
	1050	1800	2555	2370	2945	2700	3925	4245	3755	7555	6310
	1100	1610	2450	2270	2820	2585	3765	4070	3600	7490	6045
	1150	1370	2085	1935	2400	2200	3205	3465	3065	6375	5145
	1200	960	1460	1350	1680	1540	2240	2420	2145	4460	3600

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
  2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
     Limited Class Threaded ends limited to Size 1 and smaller, 1000°F maximum and Class 2500 maximum.
  3. Special Class, Sizes 3 and 4, Butt-weld ends only.

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Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings (metric)

Forged Steel Univalves   1 bar = 100 kPa = 14.50 psi

MATERIAL	TEMP (°C)	PRESSURE (BAR)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2½ (1) STANDARD	SIZES ½ to 2½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A 182 F91	-29 to 38	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	100	257.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	150	250.8	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	200	243.4	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	250	231.8	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	300	214.4	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	325	206.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	350	201.1	289.7	289.7	330.0	330.0	428.6	459.5	459.5	771.4	771.4
	375	194.1	284.5	284.5	324.1	324.1	420.9	451.2	451.2	757.4	757.4
	400	183.1	282.9	282.9	322.2	322.2	418.3	448.4	448.4	753.2	753.2
	425	175.1	279.6	279.6	318.5	318.5	413.7	443.5	443.5	744.6	744.6
	450	169.0	265.7	265.7	302.7	302.7	393.1	421.4	421.4	707.6	707.6
	475	158.2	240.8	240.8	274.3	274.3	356.3	382.0	381.9	641.3	641.3
	500	140.9	204.5	201.2	233.4	229.1	297.5	327.3	318.9	559.4	535.4
	538	125.5	176.2	163.5	202.9	186.2	270.7	292.7	259.1	539.1	435.1
	550	124.9	176.2	163.5	202.9	186.2	270.7	292.7	259.1	539.1	435.1
	575	119.7	173.7	161.1	200.0	183.5	266.9	288.6	255.4	531.3	428.8
	600	97.5	148.8	137.3	170.5	156.4	227.5	246.0	217.7	453.0	365.6
	625	73.0	110.9	102.9	127.7	117.1	170.4	184.2	163.1	339.2	273.8
	650	49.6	75.4	69.9	86.8	79.7	115.8	125.2	110.9	230.7	186.2
A 182 F92	-29 to 38	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	258.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	100	257.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	150	250.8	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	200	243.4	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	250	231.8	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	300	214.4	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	325	206.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	350	201.1	289.7	289.7	330.0	330.0	428.6	459.5	459.5	771.4	771.4
	375	194.1	284.5	284.5	324.1	324.1	420.9	451.2	451.2	757.4	757.4
	400	183.1	282.9	282.9	322.2	322.2	418.3	448.4	448.4	753.2	753.2
	425	175.1	279.6	279.6	318.5	318.5	413.7	443.5	443.5	744.6	744.6
	450	169.0	265.7	265.7	302.7	302.7	393.1	421.4	421.4	707.6	707.6
	475	158.2	240.8	240.8	274.3	274.3	356.3	382.0	381.9	641.3	641.3
	500	140.9	204.5	201.2	233.4	229.1	304.8	327.3	318.9	559.4	535.4
	538	125.5	176.2	163.5	202.9	186.2	270.7	292.7	259.1	539.1	435.1
	550	124.9	176.2	163.5	202.9	186.2	270.7	292.7	259.1	539.1	435.1
	575	119.7	173.7	161.1	200.0	183.5	266.9	288.6	255.4	531.3	428.8
	600	107.0	162.8	151.0	187.5	172.0	250.2	270.5	239.5	497.9	401.9
	625	91.2	138.9	128.8	159.9	146.7	213.5	230.8	204.3	424.7	342.8
	650	66.2	100.5	93.2	115.7	106.2	154.4	167.0	147.8	307.5	248.2

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
   2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
   Limited Class Threaded ends limited to Size 1 and smaller, 1000°F maximum and Class 2500 maximum.
   3. Special Class, Sizes 3 and 4, Butt-weld ends only.

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Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings

Forged Steel Univalves

MATERIAL	TEMP (°F)	PRESSURE (PSIG)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A182 F316 (4)	-20 to 100	3600	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3095	3895	3895	4435	4435	5760	6175	6175	10365	10365
	300	2795	3515	3515	4005	4005	5200	5575	5575	9360	9360
	400	2570	3230	3230	3675	3675	4775	5120	5120	8600	8600
	500	2390	3000	3000	3420	3420	4440	4760	4760	7995	7995
	600	2255	2840	2840	3230	3230	4195	4495	4495	7555	7555
	650	2210	2775	2775	3160	3160	4105	4400	4400	7395	7395
	700	2170	2730	2730	3110	3110	4040	4330	4330	7270	7270
	750	2135	2685	2685	3060	3060	3975	4260	4260	7150	7150
	800	2110	2655	2655	3025	3025	3930	4215	4215	7070	7070
	850	2090	2625	2625	2990	2990	3885	4165	4165	6990	6990
	900	2075	2610	2610	2970	2970	3860	4140	4140	6950	6950
	950	1930	2580	2580	2940	2940	3815	4090	4090	6870	6870
	1000	1820	2370	2370	2700	2700	3505	3755	3755	6310	6310
	1050	1800	2370	2370	2700	2700	-	3755	3755	6310	6310
	1100	1525	2200	2145	2515	2445	-	3545	3410	6115	5720
	1150	1185	1799	1665	2070	1900	-	2985	2640	5495	4435
	1200	925	1405	1300	1620	1485	-	2335	2070	4300	3470
	1250	735	1120	1035	1290	1180	-	1860	1645	3425	2765
	1300	585	885	820	1020	935	-	1470	1300	2705	2185
	1350	480	730	675	840	770	-	1210	1070	2230	1800
	1400	380	570	530	660	605	-	950	840	1755	1415
	1450	290	445	410	510	465	-	735	650	1355	1095
	1500	205	315	290	360	330	-	520	460	955	770

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
Limited Class Threaded ends limited to Size 1 and smaller, 1000°F maximum and Class 2500 maximum.
3. Special Class, Sizes 3 and 4, Butt-weld ends only.
4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings (metric)

Forged Steel Univalves

1 bar = 100kPa = 14.50 psi

MATERIAL	TEMP (°C)	PRESSURE (BAR)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A182 F316 (4)	-29 to 38	248.2	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	240.6	286.3	286.3	326.1	326.1	423.5	454.0	454.0	762.3	762.3
	100	211.0	265.3	265.3	302.2	302.2	392.4	420.7	420.7	706.4	706.4
	150	192.5	242.0	242.0	275.7	275.7	358	383.8	383.8	644.4	644.4
	200	178.3	224.2	224.2	255.4	255.4	331.7	355.6	355.6	597.0	597.0
	250	166.9	209.9	209.9	239.0	239.0	310.4	332.8	332.8	558.8	558.8
	300	158.1	198.8	198.8	226.4	226.4	294.1	315.3	315.3	529.3	529.3
	325	154.4	194.1	194.1	221.1	221.1	287.2	307.9	307.9	517.0	517.0
	350	151.6	190.7	190.7	217.2	217.2	282.1	302.4	302.4	507.7	507.7
	375	149.4	187.8	187.8	214.0	214.0	277.9	297.9	297.9	500.2	500.2
	400	147.2	185.1	185.1	210.8	210.8	273.8	293.5	293.5	492.9	492.9
	425	145.7	183.2	183.2	208.7	208.7	271.1	290.6	290.6	487.9	487.9
	450	144.2	181.4	181.4	206.6	206.6	268.3	287.6	287.6	482.9	482.9
	475	143.4	180.3	180.3	205.3	205.3	266.6	285.8	285.8	480.0	480.0
	500	140.9	178.7	178.7	203.5	203.5	264.3	283.3	283.3	475.7	475.7
	538	125.5	163.5	163.5	186.2	186.2	241.7	259.1	259.1	435.1	435.1
	550	124.9	163.5	163.5	186.2	186.2	-	259.1	259.1	435.1	435.1
	575	119.7	162.4	161.1	185.2	183.5	-	258.7	255.4	435.1	428.8
	600	99.5	145.1	140.2	166.0	159.6	-	234.8	222.2	410.1	373.2
	625	79.1	120.0	111.3	138.2	126.8	-	199.5	176.6	367.3	296.5
	650	63.3	96.1	89.1	110.7	101.5	-	159.7	141.4	294.1	237.4
	675	51.6	78.3	72.7	90.2	82.8	-	130.2	115.2	239.7	193.5
	700	41.9	69.4	64.3	79.9	73.3	-	115.3	102.0	212.2	171.3
	725	34.9	57.9	53.7	66.7	61.2	-	96.3	85.2	177.2	143
	750	29.3	44.6	41.4	51.3	47.1	-	74.1	65.6	136.7	110.3
	775	22.8	34.6	32.1	39.9	36.6	-	57.6	51.0	106.1	85.6
	800	17.4	26.7	24.8	30.7	28.2	-	44.3	39.2	81.3	65.6
	816	14.1	21.7	20.1	24.9	22.9	-	35.8	31.7	65.8	53.1

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
   Limited Class Threaded ends limited to Size 1 and smaller, 538°C maximum and Class 2500 maximum.
3. Special Class, Sizes 3 and 4, Butt-weld ends only.
4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings

Forged Steel Univalves

MATERIAL	TEMP (°F)	PRESSURE (PSIG)									
		CLASS 1500	CLASS 1690		CLASS 1925		CLASS 2500	CLASS 2680		CLASS 4500	
		SIZES ½ to 2 ½ (1) STANDARD	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 1 (2) LIMITED	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL	SIZES ½ to 2 ½ (2) LIMITED	SIZES 3 & 4 (3) SPECIAL
A182 F347/ F347H (4) (5)	-20 to 100	3600	4225	4225	4815	4815	6250	6700	6700	11250	11250
	200	3310	4165	4165	4745	4745	6160	6605	6605	11090	11090
	300	3085	3875	3875	4415	4415	5735	6150	6150	10325	10325
	400	2880	3620	3620	4125	4125	5355	5740	5740	9645	9645
	500	2710	3410	3410	3885	3885	5045	5410	5410	9080	9080
	600	2580	3245	3245	3695	3695	4800	5145	5145	8640	8640
	650	2530	3185	3185	3625	3625	4710	5050	5050	8480	8480
	700	2485	3120	3120	3555	3555	4620	4955	4955	8315	8315
	750	2460	3095	3095	3525	3525	4575	4905	4905	8235	8235
	800	2435	3065	3065	3490	3490	4530	4855	4855	8155	8155
	850	2425	3050	3050	3470	3470	4510	4835	4835	8115	8115
	900	2245	3050	3050	3470	3470	4510	4835	4835	8115	8115
	950	1930	2660	2660	3025	3025	3930	4215	4215	7070	7070
	1000	1820	2370	2370	2700	2700	3505	3755	3755	6310	6310
	1050	1800	2370	2370	2700	2700	-	3755	3755	6310	6310
	1100	1610	2325	2270	2660	2585	-	3745	3600	6310	6045
	1150	1370	2085	1935	2400	2200	-	3465	3065	6310	5145
	1200	1030	1560	1450	1800	1650	-	2600	2300	4780	3860
	1250	910	1380	1280	1590	1460	-	2295	2030	4225	3410
	1300	685	1045	970	1200	1100	-	1730	1535	3185	2570
	1350	515	780	725	900	825	-	1295	1145	2390	1930
	1400	380	570	530	660	605	-	950	840	1755	1415
	1450	290	445	410	510	470	-	740	655	1355	1095
	1500	205	315	290	360	330	-	520	460	955	770
A182 F316L	-20 to 100	3000	4070	3775	4685	4300	6250	6760	5980	12445	10045
	200	2555	3215	3215	3665	3665	4755	5095	5095	8560	8560
	300	2280	2865	2865	3265	3265	4240	4545	4545	7635	7635
	400	2100	2640	2640	3010	3010	3905	4185	4185	7030	7030
	500	1970	2475	2475	2820	2820	3660	3925	3925	6590	6590
	600	1860	2340	2340	2665	2665	3460	3710	3710	6230	6230
	650	1825	2295	2295	2615	2615	3395	3640	3640	6105	6105
	700	1800	2265	2265	2580	2580	3350	3590	3590	6025	6025
	750	1765	2220	2220	2525	2525	3280	3515	3515	5905	5905
	800	1730	2175	2175	2475	2475	3215	3445	3445	5785	5785
	850	1690	2130	2130	2425	2425	3145	3370	3370	5665	5665

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
   Limited Class Threaded ends limited to Size 1 and smaller, 1000°F maximum and Class 2500 maximum.
3. Special Class, Sizes 3 and 4, Butt-weld ends only.
4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.
5. A182 F347 material is not to be used over 1000°F.

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Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings (metric)

Forged Steel Univalves

1 bar = 100kPa = 14.50 psi

MATERIAL	TEMP (°C)	CLASS 1500 SIZES ½ to 2½ (1) STANDARD	CLASS 1690 SIZES ½ to 2½ (2) LIMITED	CLASS 1690 SIZES 3 & 4 (3) SPECIAL	CLASS 1925 SIZES ½ to 2½ (2) LIMITED	CLASS 1925 SIZES 3 & 4 (3) SPECIAL	CLASS 2500 SIZES ½ to 1 (2) LIMITED	CLASS 2680 SIZES ½ to 2½ (2) LIMITED	CLASS 2680 SIZES 3 & 4 (3) SPECIAL	CLASS 4500 SIZES ½ to 2½ (2) LIMITED	CLASS 4500 SIZES 3 & 4 (3) SPECIAL
A182 F347/ F347H (4) (5)	-29 to 38	248.2	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	50	240.6	291.3	291.3	331.8	331.8	430.9	461.9	461.9	775.7	775.7
	100	211.0	284.8	284.8	324.4	324.4	421.3	451.6	451.6	758.3	758.3
	150	192.5	267.0	267.0	304.1	304.1	395.0	423.4	423.4	711.0	711.0
	200	178.3	251.1	251.1	286.1	286.1	371.5	398.2	398.2	668.6	668.6
	250	166.9	237.7	237.7	270.8	270.8	351.7	377.0	377.0	633.0	633.0
	300	158.1	226.9	226.9	258.4	258.4	335.6	359.8	359.8	604.1	604.1
	325	154.4	222.3	222.3	253.2	253.2	328.8	352.5	352.5	591.8	591.8
	350	151.6	218.6	218.6	249.0	249.0	323.3	346.6	346.6	581.9	581.9
	375	149.4	215.1	215.1	245.0	245.0	318.1	341.0	341.0	572.7	572.7
	400	147.2	213.2	213.2	242.8	242.8	315.4	338.1	338.1	567.7	567.7
	425	145.7	211.4	211.4	240.7	240.7	312.6	335.1	335.1	562.7	562.7
	450	144.2	210.3	210.3	239.6	239.6	311.1	333.5	333.5	560.0	560.0
	475	143.4	210.1	210.1	239.4	239.4	310.9	333.3	333.3	559.6	559.6
	500	140.9	201.2	201.2	229.1	229.1	297.5	318.9	318.9	535.4	535.4
	538	125.5	163.5	163.5	186.2	186.2	241.7	259.1	259.1	435.1	435.1
	550	124.9	163.5	163.5	186.2	186.2	-	259.1	259.1	435.1	435.1
	575	119.7	162.4	161.1	185.2	183.5	-	258.7	255.4	435.1	428.8
	600	99.5	156.3	151.0	178.9	172.0	-	253.0	239.5	435.1	401.9
	625	79.1	138.9	128.8	159.9	146.7	-	230.8	204.3	424.7	342.8
	650	63.3	107.7	99.9	124.0	113.8	-	179.1	158.5	329.7	266.1
	675	51.6	95.9	88.9	110.5	101.3	-	159.5	141.2	293.6	237.0
	700	41.9	75.6	70.2	87.1	79.9	-	125.6	111.2	231.1	186.5
	725	34.9	58.6	54.4	67.4	61.9	-	97.1	86.0	179.0	144.5
	750	29.3	44.6	41.4	51.3	47.1	-	74.1	65.6	136.7	110.3
	775	22.8	34.6	32.1	39.9	36.6	-	57.6	51.0	106.1	85.6
	800	17.4	26.7	24.8	30.7	28.2	-	44.3	39.2	81.3	65.6
	816	14.1	21.7	20.1	24.9	22.9	-	35.8	31.7	65.8	53.1
A182 F316L	-29 to 38	206.8	260.1	260.1	296.3	296.3	384.8	412.5	412.5	692.6	692.6
	50	200.1	251.6	251.6	286.6	286.6	372.2	399.0	399.0	670.0	670.0
	100	173.9	218.7	218.7	249.1	249.1	323.6	346.9	346.9	582.4	582.4
	150	157.0	197.4	197.4	224.8	224.8	291.9	312.9	312.9	525.5	525.5
	200	145.8	183.3	183.3	208.8	208.8	271.2	290.7	290.7	488.1	488.1
	250	137.3	172.7	172.7	196.7	196.7	255.4	273.8	273.8	459.8	459.8
	300	130.3	163.9	163.9	186.7	186.7	242.4	259.9	259.9	436.4	436.4
	325	127.4	160.2	160.2	182.5	182.5	237.0	254.1	254.1	426.6	426.6
	350	125.4	157.6	157.6	179.6	179.6	233.2	250.0	250.0	419.7	419.7
	375	123.8	155.6	155.6	177.2	177.2	230.2	246.8	246.8	414.4	414.4
	400	121.5	152.8	152.8	174.0	174.0	226.0	242.3	242.3	406.9	406.9
	425	119.3	150.0	150.0	170.8	170.8	221.9	237.9	237.9	399.4	399.4
	450	117.1	147.1	147.1	167.6	167.6	217.7	233.4	233.4	391.9	391.9

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES:
1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 ½ and smaller, butt weld and socket weld ends.
   Limited Class Threaded ends limited to Size 1 and smaller, 538°C maximum and Class 2500 maximum.
3. Special Class, Sizes 3 and 4, Butt-weld ends only.
4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.
5. A182 F347 material is not to be used over 538°C.

Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings

Forged Steel, Bolted Bonnet

MATERIAL	TEMP (°F)	PRESSURE (PSIG)			
		CLASS 300	CLASS 400	CLASS 600	CLASS 800
		STANDARD (1) (4)	STANDARD (1) (4)	STANDARD (1) (4)	LIMITED (2) (4)
A105 / A216 WCB (3)	-20 to 100	740	985	1480	2000
	200	680	905	1360	2000
	300	655	875	1310	1975
	400	635	845	1265	1955
	500	605	805	1205	1955
	600	570	760	1135	1955
	650	550	735	1100	1905
	700	530	705	1060	1845
	750	505	675	1015	1695
	800	410	550	825	1375
	850	320	425	640	1060
	900	230	305	460	765
	950	135	180	275	465
	1000	85	115	170	295
A182 F11	-20 to 100	-	-	1500	2000
	200	-	-	1500	2000
	300	-	-	1445	2000
	400	-	-	1385	2000
	500	-	-	1330	2000
	600	-	-	1210	2000
	650	-	-	1175	2000
	700	-	-	1135	1955
	750	-	-	1065	1945
	800	-	-	1015	1920
	850	-	-	975	1805
	900	-	-	900	1565
	950	-	-	640	1075
	1000	-	-	430	745
	1050	-	-	290	495
	1100	-	-	190	330
	1150	-	-	130	225
	1200	-	-	80	145

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
2. Limited Class, Sizes 2 and smaller, butt weld and socket weld ends.
Limited Class Threaded ends limited to Size 2 and smaller, 1000°F maximum and Class 2500 maximum.
3. Permissible but not recommended for prolonged usage above approx. 800°F
4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

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Reference: ASME B16.34 – 2009 Pressure/Temperature Ratings (metric)

Forged Steel, Bolted Bonnet

MATERIAL	TEMP (°F)	PRESSURE (BAR)			
		CLASS 300	CLASS 400	CLASS 600	CLASS 800
		STANDARD (1) (4)	STANDARD (1) (4)	STANDARD (1) (4)	LIMITED (2) (4)
A105 / A216 WCB (3)	-29 to 38	51.1	68.1	102.1	137.9
	50	50.1	66.8	100.2	137.9
	100	46.6	62.1	93.2	137.7
	150	45.1	60.1	90.2	136.1
	200	43.8	58.4	87.6	134.8
	250	41.9	55.9	83.9	134.8
	300	39.8	53.1	79.6	134.8
	325	38.7	51.6	77.4	133.6
	350	37.6	50.1	75.1	130.4
	375	36.4	48.5	72.7	125.6
	400	34.7	46.3	69.4	115.7
	425	28.8	38.4	57.5	95.9
	450	23.0	30.7	46.0	76.7
	475	17.4	23.2	34.9	58.1
	500	11.8	15.7	23.5	39.5
	538	5.9	7.9	11.8	20.4
A182 F11	-29 to 38	-	-	103.4	137.9
	50	-	-	103.4	137.9
	100	-	-	103.0	137.9
	150	-	-	99.5	137.9
	200	-	-	95.9	137.9
	250	-	-	92.7	137.9
	300	-	-	85.7	137.9
	325	-	-	82.6	137.9
	350	-	-	80.4	137.1
	375	-	-	77.6	134.7
	400	-	-	73.3	133.9
	425	-	-	70.0	132.4
	450	-	-	67.7	125.7
	475	-	-	63.4	114.0
	500	-	-	51.5	85.8
	538			29.8	51.4
	550			25.4	43.9
	575			17.6	30.4
	600			12.2	21.1
	625			8.5	14.7
	650	-	-	5.7	9.8

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.

NOTES: 1. Standard Class, Flanged Ends only.
   2. Limited Class, Sizes 2 and smaller, butt weld and socket weld ends.
      Limited Class Threaded ends limited to Size 2 and smaller, 538°C maximum and Class 2500 maximum.
   3. Permissible but not recommended for prolonged usage above approx. 800°F
   4. Shaded ratings may require special trim and packing. Consult your Flowserve sales representative for applications in these ranges.

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Reference: Series 1500 Pressure/Temperature Ratings

Forged Steel, Bolted Bonnet

VALVE TYPE	TEMPERATURE °F	PRESSURE (PSIG)	
		A-105 (1)	F-11
SOCKET WELDING, THREADED AND FLANGED END VALVES SERIES 1500 (2) (3) MANUFACTURER'S RATING ASME B31.1 PARA. 107.1B	-20 to 100	3600	3600
	200	3375	3510
	300	3280	3365
	400	3170	3290
	500	2995	3130
	600	2735	2770
	650	2560	2595
	700	2350	2420
	750	2130	2255
	800	1830	2085
	850	1500	1920
	900	—	1750
	950	—	1585
	975	—	1500

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.
1. Permissible but not recommended for prolonged use at temperatures above approx. 800°F.
2. Series 1500 components are designed and rated to Edward Valves standards. Series 1500 components do not meet ANSI BI6.34 requirements. See 3.2 Pressure Ratings from the Technical Information section for additional information.
3. Shaded ratings exceed those of Edward Valves. Consult your Flowserve sales representative for applications in these ranges.

Reference: Series 1500 Pressure/Temperature Ratings (metric)

Forged Steel, Bolted Bonnet

1 bar = 100 kPa = 14.50 psi

VALVE TYPE	TEMPERATURE °C	PRESSURE (BAR)	
		A-105 (1)	F-11
SOCKET WELDING, THREADED AND FLANGED END VALVES SERIES 1500 (2) (3) MANUFACTURER'S RATING ASME B31.1 PARA. 107.1B	-29 to 38	248.3	248.3
	50	244.9	246.9
	100	232.0	240.9
	150	226.1	232.0
	200	219.2	227.3
	250	208.7	217.8
	300	193.6	198.0
	350	173.1	176.1
	375	159.9	165.3
	400	146.1	155.0
	425	127.4	144.5
	454/450	103.4	134.2
	475	—	123.7
	500	—	113.4
	524	—	103.4

IMPORTANT: The above ratings are only for reference. Refer to ASME B16.34 for pressure/temperature ratings.
1. Permissible but not recommended for prolonged use at temperatures above approx. 427°C.
2. Series 1500 components are designed and rated to Edward Valves standards. Series 1500 components do not meet ANSI B16.34 requirements. See 3.2 Pressure Ratings from the Technical Information section for additional information.
3. Shaded ratings exceed those of Edward Valves. Consult your Flowserve sales representative for applications in these ranges.

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1. Stop and Check Valve Applications Guide

1.1 Stop Valve Applications

Foreword
Edward stop valves are used primarily as isolation valves in medium and high pressure piping systems. They are offered in a broad range of sizes, pressure ratings, and types, and they are used in an immense array of diverse applications. Only a few are listed for illustration:

• Normally open valves in main steam lines; used only for equipment isolation, e.g. during maintenance.

• Normally open valves to provide for emergency shutoff due to failure of downstream piping or other equipment; closed periodically for verification of operability.

• Normally open valves that are throttled to varying degrees during start-up or shutdown of plants or systems.

• Frequently cycled valves that are opened and closed for control of batch processes or for start-up and shutdown of equipment (e.g., equipment that is on-stream daily but shut-down at night).

• Normally closed valves; used only for filling or draining systems during outages.

Stop valves are sometimes referred to as "on-off valves." They should not normally be considered as "control valves," but they are suitable for moderate or infrequent flow-control functions. Valves that must open and close under high differential pressure and flow conditions (such as "blowdown" service) inherently function as flow-control devices while they are stroking.

Considering the diversity of stop valve applications, it is not surprising that there is no universal valve type that is best for all services. Users' experience with specific applications is a valuable basis for selecting the best valves.

The goal of this guide is to supplement users' experience with information based on decades of Flowserve Edward Valves' laboratory tests and field experience.

Introduction
While many other types of valves (ball, plug, butterfly) are used as stop valves where

service conditions permit, emphasis in this guide is on selection and application of Edward valves with forged- and cast-steel bodies and bonnets. Comparisons are presented with other similar valves where appropriate.

Edward stop valves are typically of metal-seated construction and, where necessary, use gaskets and stem seals designed for severe high-pressure, high-temperature service. While special designs with "soft seats" and O-ring seals are supplied for unique specific applications, the standard products are designed to stand up to tough service conditions with minimum requirements for maintenance or parts replacement.

Edward stop valves fall into two basic categories – **globe valves** and **gate valves**. The following sections of this guide will address the principal features of each type and the design variations within the types.

Globe valves are offered in stop, stop-check, and check versions. Stop-check valves can also be used for isolation in unidirectional flow applications. These valves are discussed in the Check Valves Applications section (1.2).

The FLOW PERFORMANCE section of this catalog provides equations and coefficients for the calculation of pressure drop across any of these valves. This information can be used to evaluate the effects of different valve sizes and types of system energy efficiency.

1.1.1 Stop Valve Types and Typical Uses

Brief notes on the advantages, disadvantages, applications and limitations of the various types of Edward stop valves are presented in the Stop Valve Applications Chart (section 1.1.4). Some additional highlights of the features of these valves and some comparisons with similar valves are presented in the following paragraphs.

Globe Valves
A globe valve employs a poppet or disk that opens and closes by moving linearly along the seat axis. There are many types of globe valve bodies, seats and methods of guiding the disk to and from the seat.

• **Bodies** – Edward stop, stop-check and check type globe valves are offered with three basic body styles:

Conventional or 90°-bonnet globe valves are usually the most compact, and the stem and yoke position allow easy handwheel or actuator access and convenience for maintenance. Relatively short stem travel allows fast actuation. Multiple direction changes in the flow stream result in higher pressure drop than with other types, but streamlined flow passages in Flowserve Edward valves generally yield lower pressure drop than competitive valves of this type.

Angle valves are otherwise similar to conventional globe valves, but the less tortuous flow path yields lower pressure drop. Angle valves are particularly economical in piping layouts where use of this configuration eliminates an elbow and associated flanged or welded joints.
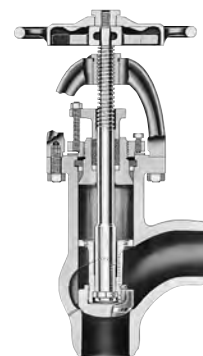
Inclined bonnet or "Y type" valves, such as Univalves® and Flite-Flow® valves, yield lower pressure drop than other styles, because they permit a more nearly straight-through flow path. Typically, they require a longer stem travel. In large sizes, this body shape is heavier and requires a greater end-to-end length than conventional globe valves.

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• **Seats** – Industrial globe valves are available from various manufacturers with a broad variety of seat designs — flat or tapered, and integral or inserted (threaded or welded).

All Edward globe valves employ tapered seats with "area contact" under load to seal over minor imperfections. Many similar valves use "line-contact" seats that seal with less load when new but degrade rapidly if damaged at the seating line.

Except for hydraulic stop valves, all Edward globe valves employ integral (hardfaced) body seats to permit compact design and assure that there can be no leakage "behind" the seat.

• **Disk Guiding** – Globe valve disks may be guided by either the stem or the body. When opened or closed under very high differential pressure, side load due to flow pushes a stem-guided disk eccentric to the seat and makes it difficult to obtain a seal. Under extreme conditions, the stem may bend.

All Edward globe valves employ body guided disks which are held closely concentric with the body seat. Guiding is provided at both the top and bottom of the disk to form a fully body-guided disk piston. The bottom guide ring on the disk, a Flowserve Edward Valves innovation, minimizes flow behind the disk and minimizes the side load. These features make Edward globe valves well suited to "blowdown" applications in which there is a high differential pressure across the valve when it is partially open.

Since globe valves are not symmetrical with respect to flow, consideration must be given to the direction of flow and differential pressure. It should be noted that the direction of flow when open and differential pressure when closed may not be the same in all applications (e.g., a block valve on a feed line may involve flow into a system when open but may need to prevent leakage out of the

system when closed). Users should consider both factors when deciding on the installation direction for a globe valve.

In most globe valve applications, pressure is under the seat when the valve is closed, and the flow is from under to over the seat (termed "flow to open" or "underseat flow"). In installations where the downstream pressure is zero or very low, this arrangement minimizes packing leakage problems. However, handwheel or actuator effort to close the valve is high, because the stem must supply enough load to both overcome the differential pressure load across the seat area and ensure sufficient sealing load on the metal seat-contact surfaces. Since this flow direction is the most common for globe valves, the flow coefficients given in the Flow Performance section of this catalog are for underseat flow.

Globe valves can also be used with overseat flow and pressure ("flow to close"), but such applications require careful consideration. In systems with dirty line fluids, this arrangement could lead to trapping foreign material in locations where it would interfere with opening. With overseat pressure, the effort to close the valve is low, because closure and sealing are pressure-assisted. However, the effort to open the valve at high differential pressure is high, because the stem must overcome the pressure force to lift the disk (in small valves, the stem diameters approaching the seat diameter, this may not be a problem, because the pressure helps to lift the stem). Also, since the flow coefficients given in this catalog are for underseat flow, pressure-drop predictions may not be as accurate (pressure drop may be up to 10% higher with overseat flow).

While not designed as control valves and not recommended for continuous modulation, Edward globe valves are often used successfully for manual or automatic control during limited periods of system operation (start-up, shutdown, etc.). Some manual valves are also used for continuous throttling or "trimming." Inclined-bonnet valves, (e.g., Univalves® and Flite-Flow® valves) have an approximately linear flow characteristic (C_v versus % open).

The Flow Performance section of this catalog covers only flow coefficients for fully open valves, but consult Flowserve concerning applications involving flow control. It should be understood that severe throttling at high pressure drops involves high energy dissipation, and serious problems (e.g., noise, vibration, cavitation, erosion) can develop if not carefully considered when a system is designed.

1.1.2 Throttling Characteristics of Edward Stop Valves

As noted in the previous section, Edward stop valves are not normally recommended for continuous modulation, and Edward Valves should be consulted concerning applications involving flow control. This section is intended only to provide general guidelines on flow-control characteristics of typical Edward stop valves. These guidelines may be used for preliminary studies relating to applications involving throttling, but they should not be considered as a substitute for a complete evaluation of the acceptability of a valve for a critical application.

Figure A

Inherent Flow Characteristics

Valve Opening – Percent
1 - Conventional 90° bonnet globe valve
2 - Angle valve
3 - Flite-Flow
4 - Univalve
5 - Equiwedge Gate valve
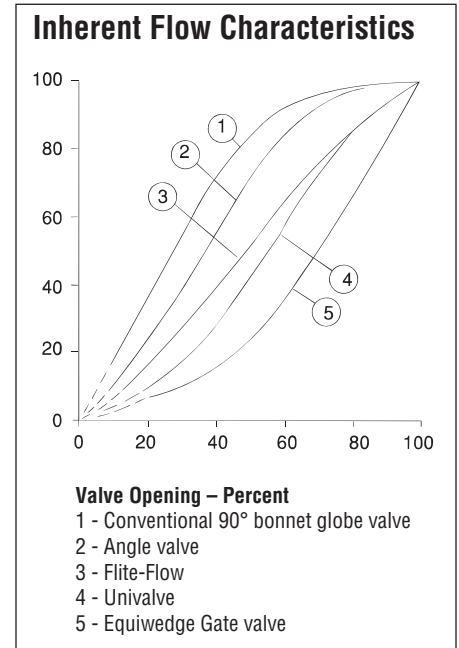
Figure A provides typical **inherent flow-characteristic** curves (percent of full-open flow coefficient versus percent opening) of the most common types of Edward stop valves. It should be understood that these curves are approximate, because there are variations due to size and pressure class that cannot be represented accurately by a single curve for each valve type. Nevertheless, these typical curves can provide some guidance relating to control capabilities of the various valve types.

Note the following subtle differences between the curves in Figure A:

• The conventional 90°-bonnet globe valve provides a relatively steep slope at small

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openings approaching a "quick-opening" characteristic. While the body-guided disk in Edward globe valves moderates this effect, it makes the flow coefficient very sensitive to small changes in stem position, so it may prove difficult to control low flow rates.

• The angle valve has a characteristic similar to that of a globe valve, but it is slightly closer to linear due to its normally higher full-open flow coefficient. An angle valve has about the same control characteristics as a globe valve of the same size at small openings.

• The cast-steel Flite-Flow® Y-type valve provides a characteristic that is nearly linear over most of its stem-travel range. For control of flow over a broad range, the high flow efficiency of this type of valve may permit use of a smaller valve size for a given allowable pressure drop. The smaller size, combined with the linear characteristic, can give improved control of low flow rates when the valve is throttled.

• The forged-steel Y-type Univalve® provides even better control at very small openings because of its "double throttling" characteristic as the lower disk-guide ring opens the machined port in the body. Other forged-steel valves have this characteristic to some degree.

• The Equiwedge gate valve has an excellent inherent flow characteristic ("concave upward"), approaching that of an **equal-percentage** control valve. However, this is somewhat misleading. When installed in pipe of the same nominal size as the valve, the pressure drop of a gate valve is so low at large openings (e.g., over 70%) that piping flow resistance usually overshadows that of the valve. The gate valve would provide little control over flow in that range.

While not normally recommended for throttling for the reasons cited in the previous section, the gate valve flow-characteristic curve is attractive from a standpoint of controlling low flow rates without excessive sensitivity. Use of a gate valve for throttling may be considered for some applications.

1.1.3 Stop Valve Actuators and Accessories

Most Edward stop and stop-check valves illustrated in this catalog are shown with handwheels, and the majority of valves are furnished for applications where manual actuation is acceptable. Most larger and higher-pressure globe valves are furnished with standard Impactor handles or hand-wheels, which provide up to twelve times the stem force of an ordinary handwheel, to provide for adequate seating thrust. Impacto-gear assemblies on the largest globe valves permit operation using an air wrench. These Flowserve Edward Valves innovations permit practical manual operation of many valves that would otherwise require gearing or power actuators.

Manual Gear Actuators
When specified, many Edward valves can be supplied with manual actuators with gear reduction in lieu of a handwheel. Such actuators reduce the required rim-pull effort and often permit operation by one person in cases where several people would be required to seat the valve with a handwheel. While manual gear actuators slow down operation, they are often an attractive option for valves that are not operated frequently. Operating pressure and differential pressure should be specified.

Note: Users sometimes specify that valves be operable at maximum differential pressure with very low rim-pull forces. This may require selection of gearing that may cause two problems: (1) literally thousands of handwheel turns for full-stroke valve operation and/or (2) capability to damage the valve easily with rim-pull forces that are readily applied by many operating personnel. Manual gear actuators with high ratios provide relatively little "feel" to the operator, and it is difficult to tell when a valve is fully open or closed. Good judgment should be exercised in specifying practical rim-pull force requirements.

Power Actuators
Where valves are inaccessible for manual operation or where relatively fast opening or closing is required, most Edward valves can be furnished with power actuators. The most commonly used actuators are electric actua-tors with torque- and position-control fea-

tures. Users frequently have individual preferences on actuator brand names and type, so Edward valves can be furnished with Flowserve actuators or other brand actuators to satisfy customer requirements.

Flowserve establishes actuator sizes and switch setting based on specific valve-application requirements, using a computer program that matches the valve and actuator operating characteristics to the service-pressure conditions. Flowserve can help make this selection since we best know the requirements of our valve. However, we must also know the requirements of your application. As a minimum, requests for quotation should specify:

- Operating pressures – under-and over-seat and differential
- Maximum valve operating temperature
- Ambient conditions – temperature, humidity, radiation
- Motor power supply – AC voltage, frequency, and phase or DC voltage (including variance)
- NEMA rating
- Closing/opening time – if important. If not specified, standard nominal stem speed will be 4 inches/minute (100 mm/min) for globe valves and 12 inches/min (305 mm/min) for gate valves.
- Valve-stem plane – vertical (stem up or down) or horizontal
- Special accessories – position indicator, etc.

Any other special requirements should be clearly specified. If there are non-standard manual-override requirements, see the note above relative to rim-pull forces for manual gear actuators.

1.2 Check Valve Applications Guide

Foreword
Check valves are used in fluid circuits in applications similar to those in which diodes are used in electrical circuits. Reduced to simplest terms, the duty of most check valves is to allow flow in one direction and to prevent flow in the reverse direction. The ideal check would have zero resistance to flow in the normal flow direction and infinite resistance to flow (leakage) in the reverse direction. Of course, the ideal check valve should also be perfectly reliable and should require no maintenance.

There are many different types of check valves, and most do their duty well, giving long, trouble-free service. However, in the real world, no single type of check valve achieves the ideal performance characteristics users sometimes expect. In a very few cases, mismatching of check valves to the needs of fluid circuits has produced serious problems (noise, vibration, severe pressure surges and check-element failures with attendant gross leakage and consequential damage to other equipment). While it is not necessary for every application to be ideal, knowledge of the characteristics of each type of check valve should help system designers and valve users to select the best type

1.1.4 Stop Valve Application Chart (For Large Valves, See Cast Steel Catalog)

Type	Advantages	Disadvantages	Applications	Limitations
Globe 90° Bonnet	• Compact • Easy access to handwheel or actuator • Fast response	• High pressure drop • High torque • Heavy in large sizes	• Class 300-2500 steam and water • Other gasses and liquids • Usable for throttling	• Not for stem-down installations • Sizes ¼ through **24**
Angle	• Same as globe • Replaces an elbow • Lower pressure drop than globe	• High torque • Heavy in large sizes	• Same as globe	• Same as globe
Globe Inclined Bonnet	• Lower pressure drop than globe or angle • May permit smaller size than globe	• Same as angle • Longest end-to-end length • Handwheel or actuator on an angle • Long stem travel slows response	• Class 600-4500 through size 4 • Class 300-2500 through size 24 • Otherwise, same as globe	• Same as globe
Equiwedge® Gate	• Lowest pressure drop • Lowest torque • May permit smallest size	• Not recommended for throttling • Long stem travel slows response with manual actuation	• Class 600-2500 steam and water • Other gasses and liquids • Main steam isolation	• Possibility of pressure binding • Sizes **2½** through **32**

and size intelligently. This knowledge should also help in assuring that serious problems are avoided.

Most check valves seem deceptively simple, with only one moving part — a poppet or flapper that appears capable of allowing flow in only one direction. However, this single mechanical part cannot be expected to take the place of a sophisticated control system that senses flow (direction, quantity, rate of change) and provides output to (1) open the valve fully when flow is in one direction and yet (2) close the valve to prevent flow and leakage in the reverse direction. Each type of check valve has features that enable it to perform one or more of its duties well, but each type also has weaknesses. The relative importance of these strengths and weaknesses is highly dependent on the requirements of individual applications.

The goal of this guide is to provide application engineers and users with practical advice on check valve selection and sizing, location in piping systems, preventive maintenance and repairs. Emphasis will be on Flowserve Edward Valves products, but comparisons will be provided in some cases with other types of check valves.

This guide is based on extensive testing of Edward check valves in sizes from NPS ½ through 18 as well as a reasonable sampling of other types. Since complete performance testing of every valve type, size and pressure class is not practical, predictions of the performance of some valves are based on mathematical models. However, the models are based on substantial test data and are believed to be reasonably accurate or conservative. The laboratory test files cover over forty years. Perhaps even more important, the files include feedback from substantial field experience — in fossil and nuclear-fueled power plants, refineries, chemical plants, oil fields and in countless other applications. It is hoped that this test and field experience will help others avoid problems and pitfalls in the application and use of check valves.

Introduction
This guide has been prepared to aid fluid-system designers in sizing and selecting check valves for industrial and power-piping systems. Guidance is also provided on valve orientation (inclination from horizontal, etc.) and on location of check valves with respect to other flow disturbances. In addition, this guide should aid users in planning preventive maintenance programs, performing main-

tenance and repairs when necessary, and in evaluating and correcting problems.

Emphasis in this guide is on selection and application of forged- and cast-steel Edward Valves products, but comparisons with other types of check valves are given where this can be done based on valid information.

The Flow Performance section of this catalog provides equations and coefficients for the calculation of pressure drop and the flow required to assure full valve opening. In addition, that section provides most of the necessary supplemental data required for routine calculations, such as water and steam density.

This guide also provides caution notes relative to system-related problems to be avoided (such as piping vibration, flow instability, waterhammer). Some of these guidelines are qualitative and could involve further analysis. However, attention to these notes should help to avoid problems.

Finally, this guide addresses check valve maintenance. History indicates that preventive maintenance of check valves is often neglected, and this can lead to serious valve failures which may damage other equipment. The guidelines provided on periodic inspection and preventive maintenance should pay off in terms of reduced overall plant maintenance and repair costs.

1.2.1 Check Valve Types and Typical Uses

While other types are sometimes encountered in power hydraulics and other specialized applications, four basic types of check valves are commonly used in industrial and power piping applications.

1-Lift Check Valves
The closure element is a poppet or disk that is lifted open by flow and which seats, usually on a mating conical surface in the valve body, under no-flow conditions.
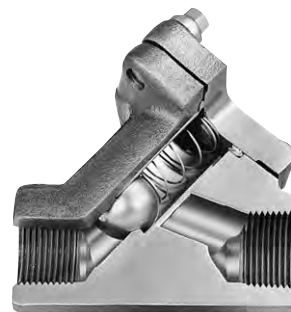
2-Ball Check Valves
A lift check valve in which the closure element is a ball.
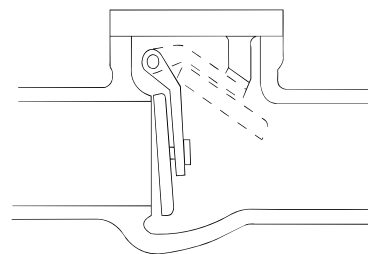
3-Swing Check Valves
The closure element is a pivoted flapper which is swung open by flow and which seats, generally against a mating flat surface in the valve body, under no-flow conditions.

4-Tilting-Disk Check Valve
The closure element is a pivoted disk or flapper, somewhat like that in a swing check valve but with a pivot axis close to the center of the flow stream. It is swung open by flow and seats against a mating conical surface in the valve body under no-flow conditions.

There are many variations among these four basic types of check valves. For example, springs may be included to assist closure and counteract gravitational forces, and accessories may be provided for exercising or position indication. All Edward lift check

valves employ body-guided disks with a piston-like extension to provide good guidance and resistance to wear. Accordingly, they are referred to in this guide as piston-lift check valves. In addition, Flowserve manufactures Edward stop-check valves which are piston-lift check valves that allow positive closure for isolation, just like globe stop valves.

Illustrations of the Edward valve types manufactured by Flowserve are provided in this catalog, and brief notes on advantages, disadvantages, applications, and limitations are provided in the Check Valve Applications Chart (section 1.2.2). Some further highlights of the features of these valves are provided in the following paragraphs.

Edward Piston-Lift Check Valves
In both small forged-steel and large cast-steel Edward lines, three distinctly different valve body styles appear in the illustrations – inclined-bonnet globe valve style, angle valve style, and 90°-bonnet globe valve style.
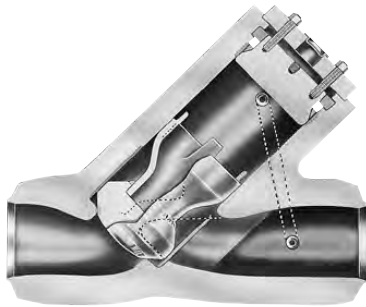
With respect to check valve function, these valves are all similar, with only slightly different orientation limits as discussed in the Valve-Installation Guidelines section (1.3). The main difference between these systems is in flow performance:

• Inclined-bonnet piston-lift check valves produce low pressure drop due to flow when fully open. They have flow coefficients comparable to those of tilting-disk check valves and only slightly lower than provided by many swing check valves.

• In most cases, angle piston-lift check valves have lower flow coefficients and thus produce more pressure drop than inclined-bonnet valves, but they are superior to 90°-bonnet valves. Where a piping system requires a bend and a valve, use of an angle piston-lift check valve eliminates the cost and pressure drop of an elbow and the cost of

associated piping welds or flanged connections.

• 90°-bonnet piston-lift check valves have the lowest flow coefficients and produce pressure drops comparable to 90°-bonnet globe valves. They are sometimes preferred in systems where pressure drop is not critical or where space requirements dictate a minimum size and easy access to a handwheel or actuator (on a stop-check valve).

Piston-lift check valves are generally the most practical type for small sizes, and they generally provide the best seat tightness. Small forged-steel piston-lift check valves normally include a disk-return spring, but may be ordered without springs. The Flow Performance section of this catalog and section 1.3 below address such valves, both with and without springs. Cast-steel piston-lift check valves have equalizer tubes which connect the volume above the piston with a relatively low-pressure region near the valve outlet. This feature allows a much larger valve opening (and higher flow coefficient) than would be possible otherwise, and it allows the valve to open fully at a relatively low flow.

The body-guided feature of Edward piston-lift check valves is an advantage in most services, because it assures good alignment of the disk with the valve seat and minimizes lateral vibration and wear. However, this feature may lead to sticking problems due to foreign-material entrapment in unusually dirty systems. Another inherent characteristic is that large piston-lift check valves may not respond rapidly to flow reversals and may cause water-hammer problems in systems where the flow reverses quickly [see the Pressure Surge and Waterhammer section (1.4.2)]. Since smaller valves display inherently faster response, historic files have shown no water-hammer problems with small forged-steel check valves.

Edward Stop-Check Valves
Stop-check valves offer the same tight sealing performance as a globe stop valve and at the same time give piston-lift check valve protection in the event of backflow. A stop-check valve is nearly identical to a stop valve, but the valve stem is not connected to the disk. When the stem is in the "open" position, the disk is free to open and close in response to flow, just as in a piston-lift check valve. When serving as a check valve, stop-check valves display the same advantages and disadvantages as discussed above for piston-lift

check valves. Small forged-steel stop-check valves, except the Univalve® stop-check valves, employ a disk-return spring, and cast-steel stop-check valves have equalizer tubes that function in the same manner as those on comparable piston-lift check valves.

The stem in the stop-check valve may be driven either by a handwheel or an actuator, and it may be used either to (1) prevent flow in the normal direction when necessary for isolation or (2) supplement line pressure to enhance seat tightness in applications with pressure from the downstream side. Some users automate stop-check valves to give extra system protection against reverse flow and leakage. For example, an actuator may be signaled to close the valve when a pump is shut off; the disk closes quickly by normal check valve action, and the stem follows to seat the valve firmly a short time later.

Edward Ball Check Valves
Ball check valves are offered only in small forged-steel configurations (size 2 and smaller) with inclined-bonnet bodies and ball-return springs. These valves are recommended over piston check valves, for service with viscous fluids or where there is scale or sediment in the system. The bolted-bonnet versions offer flow performance that is generally similar to that of equivalent piston-lift check valves, and they are the preferred ball check valves for most industrial and power-piping applications.

The threaded-bonnet hydraulic ball check valves are used primarily in very high pressure, low-flow applications with viscous fluids. They have lower flow coefficients that have proven acceptable for those services. These valves sometimes exhibit chattering tendencies when handling water, so they are not recommended for low-viscosity fluids.

A unique feature of the ball check valve is that the ball closure element is free to rotate during operation, allowing the ball and seat to wear

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relatively evenly. This feature, combined with the standard return spring, helps to promote positive seating even with heavy, viscous fluids.

Edward Tilting-Disk Check Valves

Tilting-disk check valves are particularly well-suited to applications where rapid response and freedom from sticking are essential. Fully open valves of this type also exhibit low pressure drop. They have flow coefficients comparable to those of Edward inclined-bonnet piston-lift (Flite-Flow[www]) check valves and only slightly lower than provided by many swing check valves.

Tilting-disk check valves provide rapid response, because the center of mass of the disk is close to the pivot axis. Just as in a pendulum, this characteristic promotes rapid motion of the disk toward its natural (closed) position whenever the force holding it open is removed. This response can be valuable in applications where relatively rapid flow reversals may occur, such as in pump-discharge service where multiple pumps discharge into a common manifold. In such cases, the flow may reverse quickly, and the rapid response of the tilting-disk check valve minimizes the magnitude of the reverse velocity and the resulting waterhammer pressure surge. This characteristic also minimizes impact stresses on the disk and body seats. However, an extremely rapid flow reversal, as might be produced by an upstream pipe rupture, could cause a problem. See the Pressure Surge and Water Hammer section (1.4.2) for further discussion.

Size-6 and larger tilting-disk check valves have totally enclosed torsion springs in their hinge pins to help initiate the closing motion, but the disk is counterweighted to fully close without the springs. With the free pivoting action of the disk, this type of valve is highly immune to sticking due to debris in the system.

Tilting-disk check valve are superficially similar to swing check valves in that both operate on a pivoting-disk principle. However, the

pivot axis in a swing check valve is much farther from the disk's center of mass, and this increases the "pendulum period" and hence the time required for closure in services with flow reversal. In addition, the one-piece disk in the tilting-disk check valve avoids the necessity of internal fasteners and locking devices, which are required to secure disks to pivot arms in most swing check valves. However, like swing check valves, tilting-disk check valves have hinge pins and bearings that are subject to wear due to disk flutter if the valve is not fully open and/or there are flow disturbances or instabilities. Such wear may product eccentricity of the disk and seat when the valve closes, leading to a degradation of seat tightness (particularly at low differential pressures). Applications involving severely unstable flow or prolonged service without preventive maintenance can lead to failures in which the disk separates completely from the hinge pins and will not close. Other sections of this guide address the flow conditions which may lead to problems as well as maintenance recommendations.

Edward Elbow-Down Check and Stop-Check Valves
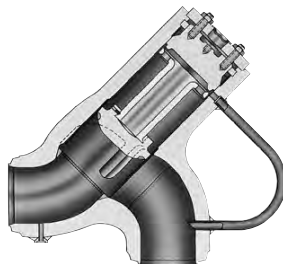
Elbow-down piston-lift check and stop-check valves are similar to Flite-Flow valves except that the valve outlet is in the form of an elbow to direct the flow downward. These valves were designed specifically for applications in controlled-circulation power plants, and they have special clearances and other design features. Because of these special features, the sizing and pressure-drop calculation methods given in the Flow Performance section of this catalog do not apply. However, special elbow-down valves can be furnished with conventional check valve design features for applications where this valve-body geometry is desirable.
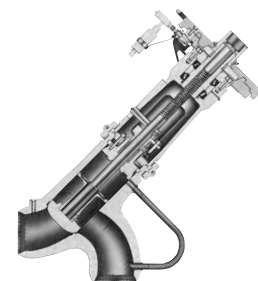
Edward Combinations of Check and Stop-Check Valves

As noted in the Foreword to this section (1.2), no single type of check valve achieves ideal performance characteristics. The advantages and disadvantages noted in the Check Valve Applications Chart (section 1.2.2) and other information in this catalog should assist in selection of the best valve size and type for any specific application. However, the selection of any single valve may require undesirable compromises.

Some system designers and users specify two check valves in series for critical applications, and this does give some insurance that at least one valve will close even if the other valve fails. However, if two identical valves are used, a system characteristic that is troublesome to one valve could produce problems with both. In such cases, use of two valves does not assure double safety or double life. Sometimes it is worth considering the selection of two different types of check valve, each with advantages to offset disadvantages of the other.

One specific check valve combination has been used in applications of Flowserve Edward valves to provide advantages that no single valve can offer. A tilting-disk check valve in series with a piston-lift check valve offers minimum waterhammer and freedom from sticking (from the tilting-disk) and good seat tightness (from the piston-lift check). The disadvantage is added pressure drop and cost, but the pressure-drop penalty is minor if the Flite-Flow inclined-bonnet piston-lift check valve is used. Even the cost penalty may be offset if a stop-check valve is used, because it may be able to take the place of a stop valve that would be required otherwise for isolation.

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1.2.2 Check Valve Applications Chart (For Large Valves, See Cast Steel Catalog)

Type	Advantages	Disadvantages	Applications	Limitations
Piston Lift Check	• Very low pressure drop in inclined bonnet valves • Relatively low pressure drop in angle valves • Larger valves incorporate an external equalizer • Minimum chatter due to flow disturbances • Good seat tightness • Forged steel valves with spring can be mounted in any orientation	• Relatively high pressure drop in 90° bonnet valves • Subject to "sticking" in very dirty systems	• Class 300-4500 service • High temperature steam and water • Refining, petrochmical, chemical, etc. • Oilfield production • Can be used in series with Tilting Disk Check to provide maximum line protection (advantages of both types).	• Sizes ¼ through **24** • For orientation limits see valve installation guidelines • For flow limits see Flow Performance section of this catalog
Ball Check	• Wear on body seat and check element evenly distributed • Long service life • Forged steel valves with spring can be mounted in any orientation • Available with either integral or threaded seat for hydraulic valve • Low cost	• High pressure drop • Available only in small sizes	• Class 600 and Series 1500 service • Water, steam, refining, petro-chemical, chemical, etc. • Service where scale and sediment exist • Viscous fluids	• Sizes ¼ through **2** • For orientation limits see valve installation guidelines • Not recommended for gas service at low flow rates • For flow limits see Flow Performance section of this catalog
Tilting Disk Check	• Very low pressure drop • Straight through body design • Very fast closing • Minimizes disk slamming and waterhammer pressure surges • Will not "stick" in dirty systems	• Not recommended for service with rapidly fluctuating flow • Seat tightness may deteriorate at low differential pressure	• Class 600-4500 service • High temperature steam and water • Refining, petrochemical, chemical, etc. • Oilfield production • Can be used in series with Piston Lift check or Stop-Check to provide maximum line protection (advantages of both types)	• Sizes **2½** through **24** • For orientation limits see valve installation guidelines • For flow limits see Flow Performance section of this catalog
Stop Check	• See Piston Lift Check above • Can be used for Stop valve service • Stem can be lowered onto disk to prevent chatter at low flow • Stem force can overcome "sticking"	• See Piston Lift Check valve above	• See Piston Lift Check above	• See Piston Lift Check above

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1.3 Check and Stop-Check Valve Installation Guidelines

Unlike stop valves, which can be installed in any position with little or no effect on performance, most check and stop-check valves have limitations as to their installed orientation. Although the normal installation is in a horizontal or vertical line (depending on valve type), check and stop-check valves can be installed in other orientations. It should be noted, however, that valves installed in other than the normal positions may exhibit a degradation of performance, service life and resistance to sticking, depending on the flow conditions and cleanliness of the line fluid. For maximum reliability, it is recommended that piston-lift check valves and stop-check valves be installed with flow axis horizontal (vertical inlet and horizontal outlet for angle valves) with the bonnet above the valve in a vertical plane. Following are maximum out-of-position orientations that may be used for less critical applications and which should never be exceeded.

• All Edward forged-steel check and stop-check valves (except Univalve® stop-check valves) are normally furnished with spring-loaded disks and may be installed in any position. The spring-loaded disk enables positive closure regardless of valve position. However, installed positions in which dirt or scale can accumulate in the valve neck should be avoided. An example of this would be an inclined-bonnet valve installed in a vertical pipeline with downward flow. If forged-steel valves are ordered without springs, the limitations below should be observed.

• Edward cast-steel Flite-Flow®, forged-steel Univalve, and inclined-bonnet check and stop-check valves without springs, when installed in vertical or near vertical lines, should be oriented such that the fluid flow is upward and the angle of incline of the line is not more than 5° past the vertical in the direction of the bonnet. When installed in horizontal or near horizontal lines, the valve bonnet should be up and the angle of incline of the line should be not more than 5° below the horizontal. See Figure 1A. Also, the roll angle of the valve bonnet should not be more than 20° from side to side for either vertical or horizontal installations. See Figures 1B and 1C. Consult your Flowserve Edward Valves representative concerning installation limits of bolted-bonnet forged-steel check valves without springs.

Figure 1
45° Inclined Bonnet Piston Lift Check Valves
Maximum Check Valve Orientation Limits

Figure 1A
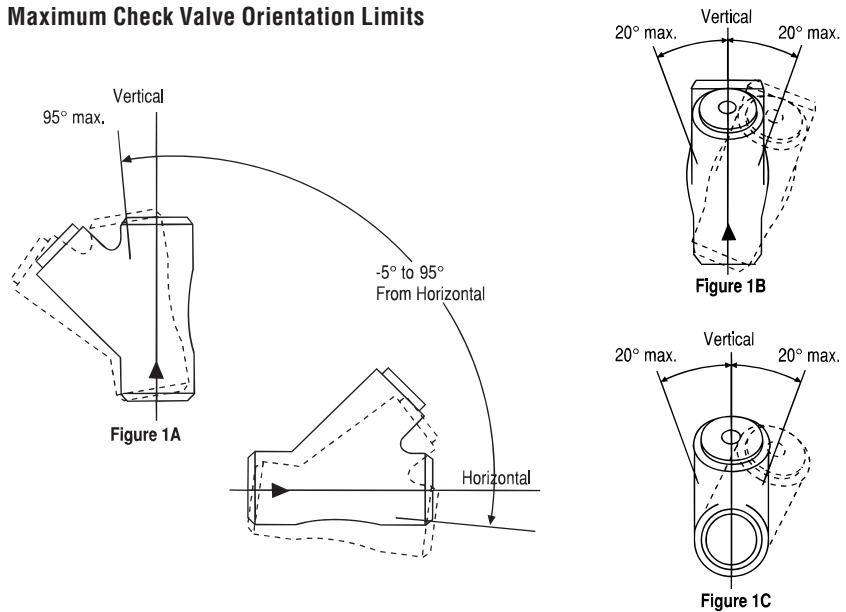
Figure 1B

Figure 1C

Figure 2
90° Bonnet Piston Lift Check Valves
Maximum Valve Orientation Limits

Figure 2A

Figure 2B
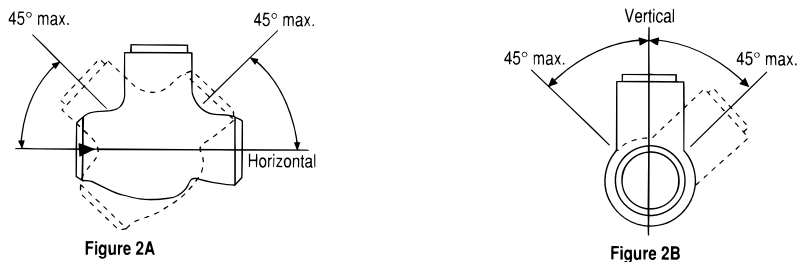
Note: For piston lift check valves, any installation resulting in combined out of position orientation, such as a valve in an inclined line with a rollover angle as well, should limit the angle of the bonnet to the following:

• 45° from vertical for angle and 90°bonnet valves.

• 50° from vertical for inclined bonnet valves.

• Edward cast-steel and forge-steel 90°-bonnet check and stop-check valves without springs should be installed with the bonnet up, and the angle of incline of the line should not be more than 45° form the horizontal. Also, the roll angle of the valve bonnet should not be more than 45° from side to side. See Figures 2A and 2B.

• Edward cast-steel and forged-steel angle check and stop-check valves without springs should be oriented such that the incoming flow is upward, and the angle of incline of the line should not be more than 45° in either direction. See Figure 3A and 3B.

• Edward tilting-disk check valves may be installed in horizontal lines and vertical lines and at any incline angle in between. When the incline angle is not horizontal, flow should always be up. The roll angle of the valve should not be more than 30° from side to side. See Figures 4A and 4B. Also, when installed in other than vertical lines, the bonnet should always be oriented up.

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**Figure 3
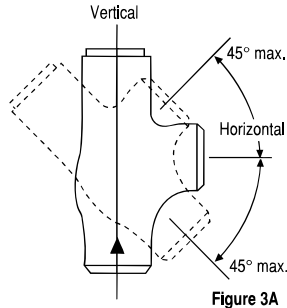Angle Piston Lift Check Valves
Orientation Limits**

Figure 3A
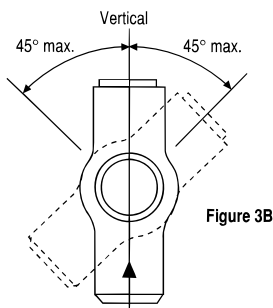
Figure 3B
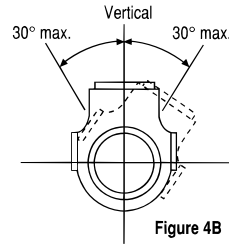
**Figure 4
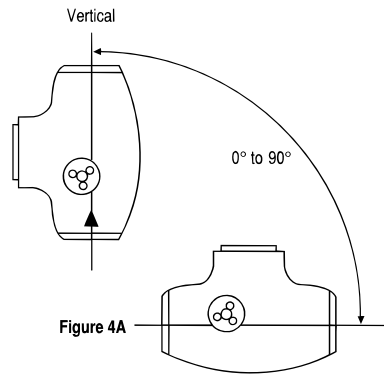Tilting Disk Check Valves
Orientation Limits**

Figure 4B

Figure 4A

**Figure 5
Pipe fittings near valves may produce instability because of velocity profile distortion**

**Figure 7
Elbows in two places cause swirl which can promote instability.**

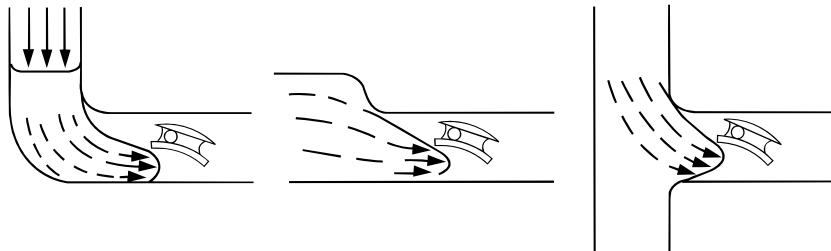In each case described above, the limitations given for line inclination and bonnet roll angle should not be combined.

It should be understood that the information given in the section of this catalog entitled Flow Performance is based on traditional horizontal orientations. For other orientations, the pressure drop and flow required for full lift may be affected. In addition, seat tightness, particularly at low differential pressures, may be adversely affected.

Orientation restrictions may also exist for power-actuated stop-check valves. Most linear valve actuators are designed to be mounted upright and nearly vertical, although they can usually be modified for mounting in any position. When selecting a stop-check valve and power actuator, be sure to specify the mounting position desired if not vertical and upright.

1.3.1 Adjacent Flow Disturbances

Check valves, like other valve types, are generally tested for performance and flow capacity in long, straight-pipe runs. Flow coefficients obtained from these tests are then used to predict the flow rate or pressure drop that will be experienced in actual applications. The
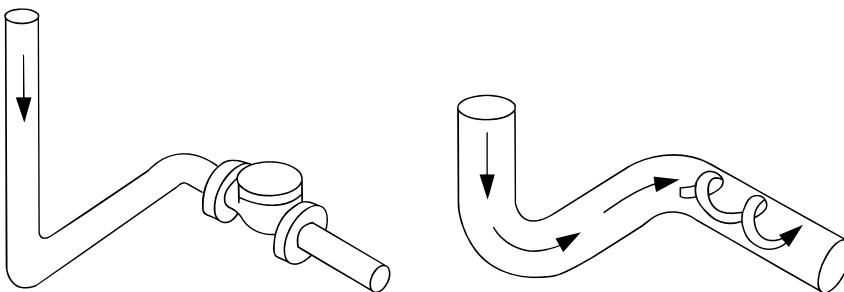
**Figure 6
Non-uniform velocity profile at blower or pump discharge can affect stability.**
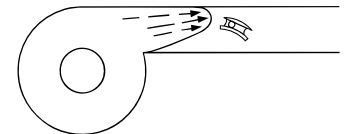
ideal installation of a check valve in a plant would be in a long run of straight pipe so that performance would correspond to the test conditions. Since space limitations involved with many installations preclude such ideal straight-pipe runs, the effects of adjacent pipe fittings, control valves, pumps and other flow disturbances must be considered.

Previously published data have indicated that flow disturbances, particularly up-stream disturbances, may significantly affect check valve performance. It has been reported that valve flow capacity may be significantly reduced as compared to that measured in straight-pipe tests, and there have been strong suggestions that such disturbances aggravate check valve flutter and vibration. Since these conditions could degrade valve performance and contribute to rapid wear and premature valve failure, they

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are important factors in evaluating check valve applications. Figure 5 illustrates how upstream pipe fittings may alter the flow profile entering a check valve, crowding it to one side or the other. A similar distortion occurs in a valve located near the discharge of a centrifugal pump or blower, as shown in Figure 6. Elbows in two planes cause a flow stream to swirl, which might produce unusual effects on a check valve installed as shown in Figure 7.

Since there was no known way to predict the effects of flow disturbances on check valves by mathematical models, Flowserve conducted extensive testing of size 2, 4, 8 and 10 check valves in straight-pipe runs and in piping with upstream flow disturbances. Figures 8 and 9 illustrate typical flow-test setups.

Figure 8
Size 4 Class 600 90° bonnet piston lift check valve with two upstream elbows (out of plane). This arrangement produces swirl as shown in Figure 7.

Figure 9
Size 10 Class 1500 Flite-Flow® inclined bonnet piston lift check valve with two upstream elbows. Test loop capacity permitted tests with line velocity over 20 ft/s (6 m/s).

In most tests, room temperature water was the flow medium, but limited straight-pipe testing was performed with air. The valves tested included Edward piston-lift check (inclined-bonnet, angle and 90°-bonnet), tilting-disk check valves and a size-4 swing check valve manufactured by another company. The tests were designed to evaluate the effects of flow disturbances on (1) valve stability, particularly when partially open; (2) flow rate required to open the valve fully; and (3) the flow coefficient (C_V) of the valve. The flow disturbances evaluated included single and double (out of plane) 90° elbows in various orientations immediately upstream of the check valves. In addition, the effects of a throttled, upstream control valve were simulated with an offset-disk butterfly valve (at various throttle positions) mounted immediately upstream, as well as at five and eleven pipe diameters upstream, of the check valves.

With few exceptions, tests with ten or more diameters of straight pipe upstream of check valves produced little cause for concern. In water flow tests, visual position indicators usually showed only minor disk "wobble" or very small open-close flutter (e.g. less than 1° total rotation of a tilting disk), even at very low flows and small valve openings. The only conditions that produced severe instability were those involving air flow at very low pressures (below 50 psi or 3.4 bar) and valve openings less than 20%. Such conditions produced significant cyclic motion, with disks bouncing on and off the body seats. In view or the many uncertainties in applying laboratory test results to service conditions, it is considered prudent to avoid operating conditions which produce check valve openings of less than 25%, even in ideal straight-pipe applications.

Highlights of the results of the Flowserve tests with flow disturbances are given in Table A on page 95. The test program clearly showed that upstream flow disturbances do affect check valve performance, but the effect is not always predictable. The magnitude of the effect can vary, depending on the type and even the size of the valve. In some cases, even the direction of the effect (improvement or degradation) varies from valve to valve. Nevertheless, some general observations on the results of these tests are:

• Single and double upstream elbows produced less severe effects on check valve performance than had been expected, and some valves displayed no discernible effects.

For example, Edward angle piston-lift check valves exhibited the same stability, lift and flow coefficients (C_V) with upstream elbows as with straight pipe. In tests of other types of valves, upstream elbows produced both beneficial and adverse effect to various degrees.

• In each case where a check valve was tested with a throttled butterfly valve immediately upstream, there were significant effects on performance. The effects included increased disk flutter and reduced valve opening at a given flow, as compared to straight-pipe performance. In some cases, full check valve opening could not be achieved at any flow within the capabilities of the test loop.

Even where full opening was obtained, some valves continued to flutter on and off their stops. These effects were worst when the butterfly valve was most severely throttled (smallest opening and highest pressure drop). In the worst cases, the butterfly valve exhibited audible cavitation, but it is not clear whether the adverse effects resulted from simple flow distortion or the two-phase flow stream from the cavitating butterfly valve.

In similar tests with the butterfly valve moved 5 diameters upstream of the check valve (but with similar throttling), the adverse performance effects were decreased significantly but not eliminated. When the butterfly valve was moved 11 diameters upstream of the check valve, normal check valve performance was restored.

The results of these tests were enlightening, but they must be combined with observations based on field experience. For example, while upstream elbows produced less severe effects than expected, there were still adverse effects on some valves. It is difficult to extrapolate a laboratory test to years of service in a plant installation, but Flowserve service files include an interesting and relevant incident. Two size-12 tilting-disk check valves in one plant had hinge-pin failures over a time period of several months after 25 years of service. While this incident might best be cited as a case for more inspection and preventive maintenance, the details of the installation were investigated. It was determined that the flow rates were in a range that should have assured full disk opening, but the valves were installed close to upstream elbows.

Users of this catalog may wish to refer to EPRI Report No. NP 5479 (see the Sources for Additional Information section of this

catalog) for further data on the performance of swing check valves in tests similar to those conducted by Flowserve. The size-4 swing check valve used in the Flowserve test program had a stop positioned to restrict the disk-opening angle to about 38°. This valve opened fully at a relatively low flow and exhibited reasonably stable performance. The tests sponsored by EPRI showed that other swing check valves (with less restrictive stops) exhibited larger amplitudes of flutter than were observed in comparable Flowserve tests.

The following guidelines are based on Flowserve tests and field experience, combined with other published information:

• If possible, check valves near flow disturbances should be sized to be fully open, preferably by a good margin, even at the lowest sustained flow rate anticipated for each application. The Flow Performance section of this catalog provides methods for sizing Edward check valves for new installations or for evaluating existing applications. When flow-induced forces load a valve closure ele-

ment firmly against a stop, it is less likely to flutter and suffer from rapid wear.

Full opening does not guarantee freedom from problems if the margin is not sufficient to provide a firm load against the stop. Equalizers on Edward cast-steel piston-lift check and stop-check valves enhance this margin and provide good stop loading, but flow disturbances may cause other valve disks to bounce on and off their stops. This "tapping" phenomenon may cause faster wear than flutter about a partially open position. For this reason, the minimum sustained flow rate through a tilting-disk check valve near flow disturbances should be about 20% greater than the flow rate required to just achieve full opening.

If it is not possible to ensure full opening of a check valve at minimum flow conditions, at least 25% opening should be ensured. Valves operating at partial opening for significant periods of time should be monitored regularly to determine if there is instability or wear.

• In view of uncertainties associated with long-term effects of flow disturbances, it is

recommended that a minimum of 10 diameters of straight pipe be provided between the inlet of a check valve and any upstream flow disturbance (fittings, pumps, control valves, etc.), particularly if calculations indicate that the check valve will not be fully open for a substantial portion of the valve service life. There should be a minimum of 1 to 2 diameters of pipe between the check valve and the nearest downstream flow disturbance.

• In the specific case of upstream elbows, reasonably successful performance should be attainable with 5 diameters of straight pipe between an upstream elbow and a check valve if the valve will not be partially open for a significant portion of its service life. Tests described in EPRI Report No. NP 5479 indicate that elbows installed 5 diameters or more upstream had a negligible effect on swing check valves, and this is expected to be true for other check valve types. Even less straight pipe may be satisfactory, but such close spacing should be reserved for applications with very tight space constraints. More frequent inspection and preventive maintenance should be planned for valves in such installations.

Table A – Effects of Upstream Flow Disturbances on Check Valve Performance

Valve Size and Type	Single Elbow at Valve Inlet[1]	Double Elbows (Out of Plane) at Valve Inlet	Throttled Butterfly Valve		
			At Valve Inlet	5 Diam. Upstream	11 Diam. Upstream
Size 2, Inclined-Bonnet, Piston-Lift Check	Higher Lift for Same Flow; Disk Flutter at Lower Lifts[2]	Higher Lift for Same Flow	NA	NA	NA
Size 4, Angle, Piston-Lift Check	No Effect	No Effect	NA	NA	NA
Size 4, 90°-Bonnet, Piston-Lift Check	Same, Lower or Higher Flow for Full Lift	No Effect	Disk Flutter and Chatter: Failure to Achieve Full Open	NA	NA
Size 4, Swing Check	Smaller Opening for Same Flow	Smaller Opening for Same Flow	Larger Opening for Same Flow; Disk Flutter	NA	NA
Size 8, Angle, Piston-Lift Check	No Effect	NA	NA	NA	NA
Size 8, 90°-Bonnet, Piston-Lift Check	Disk Flutter at Partial Lift	NA	NA	NA	NA
Size 10, Inclined-Bonnet, Piston-Lift Check	Same or Lower Lift for Same Flow; Slight Disk Wobble	No Effect	Failure to Achieve Full Open; Disk Flutter and Chatter	Failure to Achieve Full Open	No Effect
Size 10, Tilting-Disk Check	No Effect	Minor Flutter	Same, Lower or Higher Lift for Same Flow; Disk Flutter and Chatter	Minor Flutter	No Effect

1: Tests were conducted with single 90° elbows in the horizontal plane and in the vertical plane (with flow both from above and below).
2: One size-2 valve exhibited flutter at lower lifts; another was stable.

• In the specific case of throttled upstream control valves, the minimum requirement of 10 upstream pipe diameters should be adhered to rigidly. Calculations indicating full valve opening based on straight-pipe tests cannot be trusted to prevent problems, because severe flow disturbances may prevent full opening. Even greater lengths of straight pipe should be considered if the control valve operates with very high pressure drop or significant cavitation.

• Users with existing check valve installations that do not meet these guidelines should plan more frequent inspection and preventive maintenance for such valves. If a check valve is installed close to an upstream control valve that operates with a high pressure drop, considerations should be given to a change in piping or valve arrangements.

1.3.2 Other Problem Sources

In addition to the fundamentals of check valve selection, sizing and installation, several other potential sources of check valve problems should be considered in applications engineering or, if necessary, in solving problems with existing installations:

• **Piping-System Vibration**
In other sections of this guide, it has been noted that check valve damage or performance problems may result from flow-induced flutter or vibration of the closure element. Very similar damage may result from piping-system vibration. Such vibration may originate at pumps, cavitating control valves or other equipment. Check and stop-check valves are susceptible to vibration damage, because the check element is "free floating" when partially open, with only the forces due to fluid flow to balance the moving weight. Impact damage and internal wear may result if the valve body vibrates while internal parts attempt to remain stationary. This condition may be avoided by adequately supporting the piping system near the check valve or by damping vibration at its source. Of course, it is helpful to assure that the check element opens fully, because flow forces at the disk-stop help to inhibit relative motion.

• **Debris in Line Fluid**
Debris in the flow stream can cause damage and performance problems in check and stop-check valves. Debris entrapped between the disk and seat may prevent full closure and lead directly to seat leakage. If hard particles or chips are in the debris, they may damage the seating surfaces and contribute to seat

leakage even after they are flushed away. Debris caught between the disk and the body bore of a piston-lift check valve can cause the disk to jam and prevent full opening or closing. To ensure best check valve performance and seat tightness, line fluids should be kept as clean as practical. As noted before, tilting-disk check valves are particularly resistant to sticking or jamming, but they are no more resistant to seat damage than other types.

• **Unsteady (Pulsating) Flow**
An unsteady flow rate can lead to rapid check valve damage, particularly if the minimum flow during a cycle is not sufficient to hold the valve fully open. The valve may be damaged just because it does what a check valve is designed to do – open and close in response to changes in flow. As an example, a check valve installed too close to the outlet of a positive displacement pump may attempt to respond to the discharge of each cylinder. If the mean flow during a cycle is low, the disk may bounce off the seat repeatedly in a chattering action. If the mean flow is higher, the disk may bounce on and off the full-open stop. Such pulsating flows may be difficult to predict. For example, a steam leak past the seat of an upstream stop valve may produce a "percolating" action in a line filled with condensate and cause a check valve to cycle. Such problems may only be discovered by preventive maintenance inspections.

• **Vapor Pockets in Liquid Piping Systems**
Unusual phenomena are sometimes observed in piping systems containing hot water that partially vaporizes downstream of a closed check valve. Vapor pockets at high points may collapse suddenly when the check valve opens (due to the start-up of a pump, for example). This collapse may be remote from the check valve and have no effect on the check valve performance. However, if a vapor pocket exists in the upper part of a piston-lift check or stop-check valve body (above the disk), the collapse may generate unbalanced forces in the direction of disk opening. Since the vapor offers little fluid resistance, rapid acceleration of the disk toward the fully open position may occur. In extreme cases, the disk or bonnet stops may be damaged due to impact. Such thermodynamic quirks are difficult to anticipate when designing a piping system and are sometimes as difficult to diagnose if they occur in an existing installation. Changes in piping arrangements or operating procedures may be necessary if severe problems occur. It is possible that similar problems may occur during low-pres-

sure start-up operations in unvented liquid-piping systems.

1.4 Check Valve Performance

1.4.1 Check Valve Seat Tightness

Edward check valves are factory-tested with water in accordance with MSS SP-61 (Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.) at an overseat pressure of 1.1 times the pressure ratings of the valve. While check valves are allowed leakage rates up to 40 ml/hr per unit of nominal valve size by MSS SP-61, Flowserve allows no more than 5% of this leakage for cast-steel valves and no visible leakage for forged-steel valves. Tilting-disk and forged-steel check valves are then tested again at a reduced pressure with allowable leakage rates which are less than the MSS SP-61 requirements.

Closed check valve closure elements (disk, ball, flapper, etc.) are acted on by a combination of forces produced by gravity, springs (where applicable) and reversed differential pressure. While gravity and spring forces help to position the closure element into the substantially closed position, metal-to-metal seating check valves typically rely on pressure forces to produce the seating loads necessary for good seat tightness.

Some metal-seated check valves do not produce good seat tightness at low differential pressures, particularly when the pressure increases from zero. A threshold level of differential pressure is required to produce uniform metal-to-metal contact and restrict leakage to a reasonable rate. An even higher level is required to ensure that a valve meets leakage-rate criteria like those in MSS SP-61. Unfortunately, these levels of differential pressure are difficult to predict; they vary with valve type, condition and orientation (and with cleanliness of line fluid).

Tests of new valves in horizontal lines show that cast-steel inclined-bonnet and 90°-bonnet piston-lift check and tilting-disk check valves seal off reasonably well at under 50 psi (3.4 bar) when differential pressure increases from zero. Small forged-steel ball and piston-lift check valves are less consistent, sometimes seating at less than 50 psi (3.4 bar) and sometimes requiring 250 psi (17 bar) or more. This "seating" action often occurs suddenly when the pressure forces shift the closure element into good metal-to-metal contact with the body seat, and leakage generally continues to decrease as

the pressure is increased. Once seated, most valves seal well if pressure is reduced below the threshold required for initial seating, but the seat tightness with reducing pressure is also difficult to predict.

Some of the Edward check valves described in this catalog have been manufactured with "soft seats" to provide improved seat tightness at low differential pressures. This design feature includes an elastomeric or plastic sealing member on the valve closure element to supplement the basic metal-to-metal seating function. Since the design and material selection for these sealing members are very sensitive to pressure, temperature and compatibility with the line fluid, there are no standard, general-purpose, soft-seated valves. Consult Flowserve for further information about specific applications.

Foreign material in the flow medium is a major source of leakage problems in many valves. Because of the limited seating forces in check valves, dirt has a far greater effect on the tightness of these valves than other types. Attention to cleanliness of the fluid is necessary where good check valve seat tightness is desired.

Incorrect sizing or misapplication of a check valve can also lead to leakage problems. Chattering of the closure element on its seat due to insufficient flow or pressure can cause damage to the seat or closure element and result in leakage.

In applications where check valve leakage is a problem, a stop-check valve may offer the solution. Stem load from a handwheel or actuator can provide the necessary seating force independent of pressure. Of course, the stem must be returned to the "open" position to allow flow in the normal direction. Consult Flowserve about applications that are usually sensitive to leakage.

A complete treatment of the subject of pressure surge and waterhammer is beyond the scope of this catalog, but some discussion is provided so that application engineers may appreciate the significance of the problem as it relates to check valves.

1.4.2 Pressure Surge and Waterhammer

One part of the problem is that the terminology or jargon is not consistently used. For example, "waterhammer" or "steam hammer" is sometimes used to describe the implosion which occurs when water enters a hot, low pressure region and causes a steam void to collapse. This has occurred in systems with a failed check valve, where the water came back from a large reverse flow through the check valve. However, the more common "waterhammer" problem associated with check valves occurs as a result of the check valve closing and suddenly terminating a significant reversed flow velocity. This problem is generally associated with valves handling water or other liquids. A similar pressure surge phenomenon may be encountered with steam or gas, but it is generally much less serious with a compressible flow medium.

Waterhammer is a pressure surge produced by the deceleration of a liquid column, and it involves pressure waves that travel at close to the velocity of sound through the fluid. It is commonly illustrated in texts by an example involving rapid closure or a valve in a long pipe. For such a case, it can be shown that instantaneous closure of a valve in a room-temperature water line will produce an increase in pressure of about 50 psi (3.4 bar) above the steady-state pressure for every 1 ft/sec (0.30 m/sec) decrease in water velocity. Even if the valve does not close instantaneously, the same pressure increase would develop if the upstream pipe is long enough to prevent reflected pressure waves from reaching the valve before it closes. The waves of increasing pressure that are generated by the closing valve "reflect" from a constant-pressure reservoir or vessel, if present in the system, and return to the valve as inverted waves that decrease pressure. A solution to the "textbook problem" is to slow down the valve closure so that the reflected pressure waves attenuate the surge. However, this is not necessarily the best approach in the case of a check valve.

In a check valve, the fluid velocity is forward before the valve starts to close, but it reduces due to some system action (e.g., a pump is shut off). If the velocity reverses before the valve closes, a waterhammer surge will be produced by a conventional check valve that is nearly proportional to the magnitude of the maximum reversed velocity. Figure 10 provides curves illustrating flow transients associated with different types of systems and flow interruptions. The graphs illustrate velocity in the pipe, forward and reverse, versus time on arbitrary scales. The following discussions describe each of the curves:

• **Curve A** illustrates flow coast-down in a simple circulating loop, such as a cooling system, following switch-off of pump power. The momentum of the pump impeller and the fluid keeps the fluid going forward until it is decelerated and finally stopped by friction. There would be no need for a check valve to prevent reverse flow in this system, but one might be included to permit pump maintenance without draining other equipment. In normal operation of this system, the check valve could produce no waterhammer.

• **Curve B** illustrates an application with a pump feeding a high-pressure system with a fairly large volume. It might represent a boiler feed system of a pump feeding a high reservoir. In this case, assuming similar momentum in the pump and fluid, forward flow continues for a while after the pump is switched off, but the downstream pressure decelerates the flow more rapidly and then reverses its direction. Without a check valve, the reverse flow would increase and stabilize at some value, unless the downstream system pressure declined. In the illustration, the magnitude of the maximum reverse velocity is drawn less than the initial forward velocity, but it might be higher in some systems.

• **Curve C** illustrates what would happen in the system described for Curve B with a fast-response check valve (e.g., a tilting-disk type) installed. As discussed in the Foreword to this guide, an "ideal" check valve would allow no reverse flow and would close exactly at the time the velocity curve passes through zero; there would be no waterhammer. A "real" check valve starts closing while the flow is still forward, but it lags the velocity curve. With fast response, it closes before a high reverse velocity develops, thus minimizing the waterhammer surge.

• **Curve D** illustrates the same system with a check valve that responds just a bit slower. It shows that just a small increase in check valve lag may allow a large increase in reverse velocity (and a corresponding increase in waterhammer surge pressure).

• **Curve E** illustrates an accidental situation that might develop with a severely worn valve or a dirty system. If a check valve in the system described above should stick open, it might allow the reverse velocity to build up so as to approach that which would occur without a check valve. If the reverse flow forces should then overcome the forces that caused the sticking, the resulting valve stem could cause a damaging waterhammer surge.

• **Curve F** illustrates what might happen in the system described for Curve B if there were a major pipe rupture just upstream of the check valve. With free discharge through the open

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Figure 10 - Flow Reversal Transients

FORWARD FLOW VELOCITY

REVERSED FLOW VELOCITY

Description of Curves
A - Pump Trip in Circulating Loop with or without Check Valve
B - Pump Trip in Boiler Feed Line - No Check Valve
C - Same as B but with Fast Response Check Valve
D - Same as B but with Slow Response Check Valve
E - Same as C or D but Check Valve Sticks then Unsticks and Slams Closed
F - Upstream Feed Line Rupture - No Check Valve
G - Same as F but with Fast Response Check Valve
H - Same as F but with Controlled Closure Check Valve

Note: In liquid flow lines, sudden velocity changes as at C, D, E and G produce pressure surges proportional to velocity change.

TIME OF PUMP TRIP OR PIPE RUPTURE

TIME

Figure 11 - Controlled Closure Check Valve (CCCV)

Dashpot chamber

Normal flow direction

end, the flow would decelerate much more rapidly and, without a check valve, reach a much higher reverse velocity.

• **Curve G** shows the response of the system in Curve F if even a fast-response conventional check valve were to be used. With a flow deceleration this rapid, even a small lag may result in a very high reverse velocity to be arrested and a correspondingly high waterhammer surge.

Fortunately, it is not necessary to design every piping system with a check valve to cope with a pipe rupture. However, this requirement has emerged in some power-plant feedwater piping systems. Flowserve analyses and tests have shown that even the

most rapid-responding conventional check valve could produce unacceptable waterhammer surges. This led to the development of the special controlled-closure check valve (CCCV–see Figure 11). Since high reverse velocities are inevitable, the CCCV solves the problem the way the "textbook problem" discussed above is solved–by closing slowly. The CCCV is a piston-lift check valve, but it has an internal dashpot which slows the closing speed of the valve. Closing speed depends on the rate at which water is squeezed out of the dashpot chamber, through flow paths that are sized for each application.

• **Curve H** illustrates the velocity variation in the pipe-rupture situation described for Curve F, but with a CCCV in the line. In this case, the maximum reverse velocity might even be higher than in Curve G, but it is decelerated back to zero slowly, allowing reflected reducing-pressure waves to minimize the resulting waterhammer surge. Figure 12 provides a comparison between a conventional check valve and a CCCV for a specific pipe-rupture situation. Note that the conventional check valve closes in 0.07 seconds as compared to 1.0 seconds for CCCV. As a result, the conventional check valve produced a surge of 3000 psi (207 bar) while the CCCV limits the surge to 600 psi (41 bar). These characteristics have been demonstrated in tests and can be duplicated
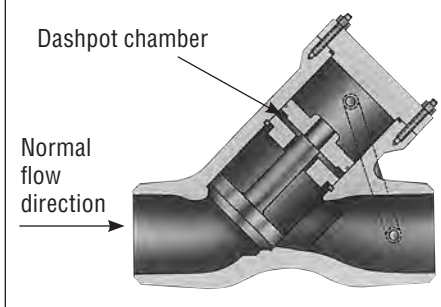
in computer-based dynamic analysis simulations of specific valves and systems.

While the CCCV solves a special problem, even this sophisticated product does not fulfill the definition of an ideal check valve. By closing slowly, it allows significant reverse blow before it seats. This characteristic might be undesirable in common pump-discharge applications, because the reverse flow might have adverse effects on pumps or other equipment. Studies of systems designs sometimes show that fast-response check valves, such as the tilting-disk type, should be retained at pump discharge points where an upstream pipe rupture is unlikely, with CCCVs applied at locations where an upstream pipe rupture could cause serious consequences (e.g., in feedwater lines inside the containment vessel of a nuclear power plant).

In Curves C, D, E, and G of Figure 10, it may be noted that the final terminations of reverse velocity are shown as substantially vertical lines. This does not imply that the valve closes instantaneously. However, tests of conventional check valves show that the reverse velocity in the pipe containing the valve does terminate almost instantaneously. This apparent contradiction may be understood by referring to Figure 13, which illustrates a check valve approaching the closed position with reverse flow (while the illustration depicts a swing check valve, the flow condition discussed here would be much the same with a poppet or disk in a conventional lift check or piston-lift check valve).

The key observation from Figure 13 is that a column of fluid follows the closure element at roughly the same velocity that the closure element has as it approaches its seating surface in the valve body. While the valve may start to close while the flow velocity is still forward (see Figure 10), an undamped check valve has little effect on pipe flow during closure, and the disk velocity is about the same as the reverse flow velocity in the pipe at the instant just before closure. Since the disk is stopped substantially instantaneously when it makes metal-to-metal contact with the body seat, the reverse flow velocity in the pipe must also be arrested instantaneously. Because of this characteristic, the surge produced by the slam of a conventional check valve cannot be attenuated significantly by reflected reducing-pressure waves, and the surge tends to be relatively insensitive to system pipe lengths.

Figure 12 - Example Comparison of Closure Time and Surge Pressure Conventional vs Controlled Closure Check Valves

Figure 13 - Reverse Flow in Conventional Swing Check Valve - Just Before Closing

In some check valve applications, problems have been observed due to a phenomenon that is related to waterhammer but not as widely recognized. When a high-pressure wave is produced on the downstream side of a check valve at closure, a reverse low-pressure wave is produced on the upstream side. If this low-pressure wave reduces the fluid pressure to below the saturation pressure of the fluid, a vapor pocket can form. This can be compared to a tensile failure of the flow stream, and it is sometimes referred to as column separation or column rupture. This vapor pocket is unstable and will collapse quickly, with an implosion that produces a high-pressure "spike." It is possible for this

pressure surge to exceed the one initially produced on the downstream of the check valve. Instrumented laboratory tests have shown that the upstream pressure spike sometimes causes the disk to reopen slightly and "bounce" off its seat once or twice. In very rare occasions, sometimes involving systems with multiple check valves, this characteristic has been known to amplify, leading to damaging pipe vibrations.

In summary, waterhammer can produce complex problems in check valve applications. Numerical solutions to these problems require sophisticated computer-based dynamic analyses of both the check valve and

the fluid in the piping system. This catalog does not provide the methods for making such analyses; instead, the information in this section is intended to assist fluid-system designers in avoiding the problem.

Users who already have check valves in liquid flow lines that emit loud "slams" when they close should be aware that the noise is probably associated with pressure surges that could lead to fatigue problems in the valve, piping or other components. Where the existing check valve is a piston-lift check or stop-check valve, the solution could be to add a tilting-disk check valve in series with the existing check valve to gain the advantages of both valve types. Where the existing valve is a swing check valve, replacement by a tilting-disk check valve might be considered. See the section of this catalog entitled Check Valve Types and Typical Uses (1.2.1) for a discussion of the strengths and weaknesses of the various valve types.

1.4.3 Check Valve Accessories and Special Features

Edward Check valves can be provided with various accessories which are used to induce check-element motion (exercise) or indicate check-element position. Some of the features available are as follows:

- Visual disk-position indicator for tilting-disk check valve

- Electrical open/close position indicator for tilting-disk or cast-steel piston-lift check valve

- Manual or pneumatic actuator to partially open tilting-disk check valve under zero differential pressure

- CCCVs can be furnished with an injection port which allows the valve disk to be exercised by injecting water into the dashpot chamber when the valve is under a zero differential pressure.

1.4.4 Check/Stop-Check Valve Periodic Inspection and Preventive Maintenance

Periodic inspection and preventive maintenance of check and stop-check valves should be performed to ensure that the valves are operating properly. Bonnet-joint leakage and packing leakage on stop-check valves are easy to detect. Seat leakage of a check or stop-check valve might be indicated by one of the following: a definite pressure loss on

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the high-pressure side of the valve; continued flow through an inspection drain on the low-pressure side; or, in hot water or steam lines, a downstream pipe that remains hot beyond the usual length of time after valve closure. Leakage of steam through a valve which is badly steam-cut has a whistling or sonorous sound. If the valve is only slightly steam-cut, however, leakage is identified by subdued gurgling or weak popping sounds. These sounds can often be heard through a stethoscope.

Excessive vibration, noise or humming coming from within a piston-lift check or stop-check valve indicates the possibility that the disk-piston assembly is wedged inside the body. Such sticking may be caused by uneven body-guide rib wear on the downstream side. Sticking rarely occurs with tilting-disk check valves.

"Tapping," "thumping" or "rattling" noises detected from or near a check valve may indicate disk instability or cavitation. Instability could lead to rapid wear and possible valve failure. Audible cavitation is also detrimental. It may produce damage to the valve or the downstream piping. While the noise symptoms may be transmitted through the pipe from other equipment, prompt investigation is required if the check valve's performance is critical to plant reliability.

No specific inspection/preventive maintenance schedule can be given to cover all check valves. It is suggested that small valves be sampled by size and type (there may be hundreds in a large installation). Schedules for audit of larger valves should

consider the criticality of the valve service. It is wise to open some critical valves for internal inspection at intervals even if no suspicious noises are detected.

Where check valves are installed close to pumps, control valves, pipe fittings or other flow disturbances, they should have more frequent inspection [see the section of this catalog entitled Adjacent Flow Disturbances (1.3.1)]. In addition, attention should be given to valves in installations with significant pipe vibration.

Users of this guide may wish to consider non-intrusive check valve monitoring methods as a supplement to periodic visual inspection and measurement of check valve internals. Noise and vibration, acoustic emission, ultrasonic and radiographic methods have been studied and demonstrated. EPRI Report No. NP 5479 provides an evaluation of the state of the art, but users are advised to obtain the most current information available on these emerging technologies.

If problems are found through any of the inspections discussed above, refer to section J: Maintenance.

2. Flow Performance

2.1 Choose the Best Valve Size for Your Service Conditions

The most economical valve is the valve correctly sized for the service flow conditions. Too small a valve will have a high pressure drop and will incur expensive energy costs in service. Too large a valve wastes money at the time of purchase, and it may require excessive effort or an excessively large and expensive actuator for operation.

Piping-system designers sometimes optimize the size of valves and piping systems to minimize the sum of investment costs and the present value of pumping power costs. While this may not be practical for selection of every valve, it is a goal that should be kept in mind. This catalog provides information necessary to evaluate the various types and sizes of Edward valves for stop (isolation), stop-check and check valve applications.

In the case of stop-check and check valves, another consideration is that an oversized valve may not open completely. Obviously, if a valve is not fully open, the pressure drop will be increased. Also, if the disk operates too close to the seat, unsteady flow may cause flutter that may damage valve seats, disks or guides.

System designers should also address "turn-down" if service conditions involve a broad range of flow rates (e.g., high flow in normal operation but low flow during start-up and standby conditions). For these reasons,

selection of check valves requires extra steps and care in calculations.

This section includes equations for the calculation of pressure drop, required flow coefficient, flow rate or inlet flow velocity. Procedures are also provided to check and correct for cavitation and flow choking. The equations in this section assume that the fluid is a liquid, a gas or steam. Two-component flow (e.g. slurries, oil-gas mixtures) is not covered by the equations. Consult Flowserve for assistance in evaluating such applications.

Tables in this section contain performance data for all Edward stop, stop-check and check valves. Flow coefficients and cavitation/choked-flow coefficients are given for all fully open Edward valves. In addition, for check and stop-check valves, the tables provide minimum pressure drop for full lift, crack-open pressure drop, and a novel "sizing parameter" that is helpful in selecting the proper valve size for each application.

Caution: Pressure drop, flow rate and check valve lift estimates provided by Edward calculation methods are "best estimate" valves. Calculations are based on standard equations of the Instrument Society of America (ISA), flow rate and fluid data provided by the user, and valve flow coefficients provided by Flowserve.

Flow rate and fluid data are often design or best-estimate values. Actual values may differ from original estimates. Flow and check valve lift coefficients are based on laboratory testing. Valves of each specific type are tested, and results are extended to sizes not tested using model theory. This approach is fundamentally correct, but there is some uncertainty because of geometric variations between valves.

These uncertainties prevent a guarantee with respect to valve pressure drop, flow rate and lift performance, but we expect results of calculations using Flowserve methods to be at least as accurate as comparable calculations involving flow and pressure drop of other piping system components.

2.1.1 Pressure Drop, Sizing and Flow Rate Calculations – Fully Open Valves – All Types

This section is divided into two parts. The Basic Calculations section (2.2) covers most applications where pressure drops are not excessive. This is generally the case in most Edward valve applications, and the simple equations in this section are usually sufficient for most problems.

When the pressure drop across a valve is large compared to the inlet pressure, refer to the Corrections Required with Large Pressure Drops section (2.3). Various fluid effects must be considered to avoid errors due to choked flow of steam or gas – or flashing or cavitation of liquids. While use of these more detailed calculations is not usually required, it is recommended that the simple checks in that section always be made to determine if correction of the results of the Basic Calculations is necessary. With experience, these checks can often be made at a glance.

Note: In preliminary calculations using the following equations, a piping geometry factor, F_p = 1.0, may be used, assuming that the valve size is the same as the nominal pipe size. However, if an application involves installing a valve in a larger-sized piping system (or piping with a lower pressure rating than the valve, which will have a larger inside diameter), determine F_p from the Pipe Reducer Coefficients section when final calculations are made.

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2.2 Basic Calculations

The following equations apply to FULLY OPEN gate and globe valves of all types. They also apply to stop-check and check valves if the flow is sufficient to open the disk completely. The Check Valve Sizing section (2.4) must be used to determine if a check valve is fully open and to make corrections if it is not.

The following simple methods may be used to calculate pressure drop, required flow coefficient, flow rate or inlet flow velocity for fully open Edward valves in the majority of applications. Always check Basic Calculations against the $\Delta P/p_1$ criteria in Figure 14 to see if corrections are required. This check is automatically made when using the Proprietary Edward Valves Sizing Computer Program.

2.2.1 Pressure Drop

KNOWN:
Flow rate (w or q)
Fluid specific gravity (G) or
Density (ρ)
For water, steam or air, see Figures 22-24

FIND: Valve flow coefficient (C_V) from appropriate table

CALCULATE: Pressure drop (ΔP)

When flow rate and fluid properties are known, determine required coefficients for a specific valve and calculate the pressure drop from the appropriate equation (see Nomenclature table for definition of terms and symbols):

Equation 1a (U.S.)

$$\Delta P = G\left(\frac{q}{F_P C_V}\right)^2$$

Equation 1b (metric)

$$\Delta P = G\left(\frac{q}{0.865 F_P C_V}\right)^2$$

Equation 1c (U.S.)

$$\Delta P = \frac{1}{\rho}\left(\frac{w}{63.3 F_P C_V}\right)^2$$

Equation 1d (metric)

$$\Delta P = \frac{1}{\rho}\left(\frac{w}{27.3 F_P C_V}\right)^2$$

If the resulting pressure drop is higher than desired, try a larger valve or a different type with a higher C_V. If the pressure drop is lower than necessary for the application, a smaller and more economical valve may be tried.

2.2.2 Required Flow Coefficient

KNOWN:
Flow rate (w or q)
Allowable pressure drop (ΔP)
Fluid specific gravity (G) or density (ρ)
For water, steam or air, see Figures 22-24

CALCULATE: Minimum required valve flow coefficient (C_V)

When the flow, fluid properties and an allowable pressure drop are known, calculate the required valve flow coefficient from the appropriate equation:

Equation 2a (metric)

$$C_V = \frac{q}{F_p}\sqrt{\frac{G}{\Delta P}}$$

Equation 2b (metric)

$$C_V = \frac{q}{0.865 F_p}\sqrt{\frac{G}{\Delta P}}$$

Equation 2c (U.S.)

$$C_V = \frac{w}{63.3 F_P \sqrt{\Delta P \rho}}$$

Equation 2d (metric)

$$C_V = \frac{w}{27.3 F_P \sqrt{\Delta P \rho}}$$

Results of these calculations may be used to select a valve with a valve flow coefficient that meets the required flow and pressure-drop criteria. Of course, valve selection also required prior determination of the right valve type and pressure class, using other sections of this catalog. The tabulated C_V of the selected valve should then be used in the appropriate pressure drop or flow-rate equation to evaluate actual valve performance. At this stage, the checks described in section

Nomenclature (metric units in parentheses)

C_V	Valve flow coefficient	
d	Valve inlet diameter, inches (mm)	
F_L	Liquid pressure recovery coefficient, dimensionless	
F_p	Piping geometry factor, dimensionless	
G	Liquid specific gravity, dimensionless	
G_v	Gas compressibility coefficient, dimensionless	
k	Ratio of specific heats, dimensionless	
K_i	Incipient cavitation coefficient, dimensionless	
ΔP	Valve pressure drop, psi (bar)	
ΔP_{CO}	Valve crack-open pressure drop, psi (bar)	
ΔP_{FL}	Minimum valve pressure drop for full lift-psi (bar)	
p_1	Valve inlet pressure, psia (bar, abs)	
p_v	Liquid vapor pressure at valve inlet temperature-psia (bar, abs)	
q	Volumetric flow rate, U.S. gpm (m³/hr)	

R_F	Ratio of sizing parameter to sizing parameter for full lift
R_p	Ratio of valve pressure drop to minimum pressure drop for full lift
R_1	Pressure drop ratio (gas or steam)
R_2	Pressure drop ratio (liquids)
SP	Valve sizing parameter
SP_{FL}	Valve sizing parameter for full lift
V	Fluid velocity at valve inlet, ft/sec (m/sec)
w	Weight flow rate-lb/hr (kg/hr)
x_T	Terminal value of $\Delta P/p_1$ for choked gas or steam flow, dimensionless
Y	Gas expansion factor, dimensionless
ρ	Weight density of fluid at valve inlet conditions, lb/ft³ (kg/m³)
Conversion factors are provided in the Conversion Factors section at the end of this catalog.		

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2.2 should be made to correct for effects of large pressure drops if required.

As discussed below under flow-rate calculations, the flow-coefficient equations assume that the allowable pressure drop is available for the valve. Piping pressure drop should be addressed separately.

Caution: *In applications of stop-check or check valves, the results of these equations will apply only if the valve is fully open. Always use the methods given in the Check Valve Sizing section (2.3) to ensure that the valve will be fully open or to make appropriate corrections.*

2.2.3 Flow Rate

KNOWN:
Pressure drop (ΔP)
Fluid specific gravity (G) or density (ρ)
For water, steam or air, see Figures 22-24

FIND: Valve flow coefficient (C_V) from appropriate table

CALCULATE: Flow rate (w or q)

When the fluid properties and an allowable pressure drop are known, determine required coefficients for a specific valve and calculate the flow rate from the appropriate equation:

Equation 3a (U.S.)

$$q = F_P\, C_V \sqrt{\frac{\Delta P}{G}}$$

Equation 3b (metric)

$$q = 0.865 F_P\, C_V \sqrt{\frac{\Delta P}{G}}$$

Equation 3c (U.S.)

$$w = 63.3 F_P\, C_V \sqrt{\Delta P \rho}$$

Equation 3d (metric)

$$w = 27.3 F_P\, C_V \sqrt{\Delta P \rho}$$

2.2.4 Inlet Flow Velocity

KNOWN:
Flow rate (w or q)
Fluid specific gravity (G) or density (ρ)
For water, steam or air, see Figures 22-24

FIND: Valve inlet diameter (d) from appropriate table

CALCULATE: Fluid velocity at valve inlet (V)

While not normally required for valve sizing and selection, the fluid velocity at the valve inlet may be calculated from the appropriate equation:

Equation 4a (U.S.)

$$V = \frac{0.409q}{d^2}$$

Equation 4b (metric)

$$V = \frac{354q}{d^2}$$

Equation 4c (U.S.)

$$V = \frac{0.0509w}{\rho d^2}$$

Equation 4d (metric)

$$V = \frac{354w}{\rho d^2}$$

These valve flow-rate calculations are used less frequently than pressure drop and flow-coefficient calculations, but they are useful in some cases.

Caution: *These equations assume that the pressure drop used for the calculation is available for the valve. In many piping systems with Edward Valves, flow is limited by pressure drop in pipe and fittings, so these equations should not be used as a substitute for piping calculations.*

Use of these flow-rate equations for stop-check and check valves is not recommended unless the allowable pressure drop is relatively high (e.g., over about 10 psi or 0.7 bar). At lower values of ΔP, two or more different flow rates might exist, depending on whether or not the disk is fully open. Flow would vary depending on whether the pressure drop increased or decreased to reach the specified value.

Note: If a specific pipe inside diameter is known, that diameter may be used as the "d" value in the equation above to calculate the fluid velocity in the upstream pipe.

2.3 Corrections Required with Large Pressure Drops

While most Edward valves are used in relatively high-pressure systems and are usually sized to produce low pressure drop at normal flow rates, care is necessary to avoid errors (which may be serious in some cases) due to flow "choking" (or near-choking). Problems arise most often at off-design flow conditions that exist only during plant start-up, shutdown, or standby operation.

Since steam and gas are compressible fluids, choking (or near-choking) may occur due to fluid expansion which causes the fluid velocity to approach or reach the speed of sound in reduced-area regions. While liquids are normally considered to be incompressible fluids, choking may also occur with liquid flow due to cavitation or flashing. In each case, simple calculations can be made to determine if a problem exists. Relatively simple calculations are required to correct for these effects. In some cases, these calculations may require a change in the size of type of valve required for a specific application.

The flow parameters K_i, F_L and x_T in the valve data tables assume that the valve is installed in pipe of the same nominal size. This is a fairly good assumption for preliminary calculations, but refer to the Pipe Reducer Coefficients section if there is a mismatch between valve and pipe diameters (also see instructions relative to F_p calculations in section 2.1) and make the appropriate corrections when final calculations are made.

Note: Because large pressure drop problems are not encountered frequently, equations are presented in terms of weight flow rate (w) and density (ρ) only. See the Conversion of Measurement Units section for converting other units of flow rate to weight flow rate.

2.3.1 Gas and Steam Flow

2.3.1.1 Pressure Drop
To determine if corrections are needed for compressible flow effects, use the data from the Basic Calculations to determine the ratio of the calculated pressure drop to the absolute upstream pressure:

Equation 5

$$R_1 = \frac{\Delta P}{p_1}$$

If the ratio R_1 is less than the values in Figure 14, the results of the Basic Calculations will usually be sufficiently accurate, and further calculations are unnecessary.

Figure 14 – Maximum ΔP/P₁ for use of Basic Calculations Without Correction

Valve Type	Max. ΔP/P1
Gate	0.01
Inclined Bonnet Globe Angle Tilting-Disk Check	0.02
90° Bonnet Globe	0.05

If the pressure-drop ratio R₁ exceeds that tabulated for the valve type under evaluation, the procedure described below should be used to check and correct for possible flow choking or near-choking.

(1) Calculate the gas compressibility coefficient:

Equation 6 (U.S. or metric)

$$G_y = \frac{0.467}{kX_T}\left(\frac{\Delta P}{p_1}\right)$$

Note: The ΔP in this equation is the uncorrected value from the Basic Calculations. Values of x_T are given in valve data tables, and values of k are given in Figure 21.

(2) The next step depends on the value of G_y determined in equation 6:

• If G_y < 0.148, *the flow is not fully choked*. Read the value of Y from Figure 15 and calculate the corrected pressure drop:

Equation 7 (U.S. or metric)

$$\Delta P_C = \frac{\Delta P}{Y^2}$$

• If $G_y \geq 0.148$, the *flow is choked*. The desired flow cannot be achieved at the specified upstream pressure and will be limited to the choked flow rate given by:

Equation 8a (U.S.)

$$W_{choked} = 35.67 F_P C_V \sqrt{kx_T\,p_1\rho}$$

Equation 8b (metric)

$$W_{choked} = 15.4 F_P C_V \sqrt{kx_T\,p_1\rho}$$

• When flow is choked, the actual pressure drop cannot be calculated using valve flow calculations alone. It can be any valve greater than the following minimum value for choked flow:

Equation 9 (U.S. or metric)

$$\Delta P_{min.\,choked} \geq 0.714 kx_T\,p_1$$

• The only way to determine the pressure downstream of a valve with choked flow is to calculate the pressure required to force the choked flow rate through the downstream piping. This may be done with piping calculations (not covered by this catalog).

2.3.1.2 Flow Rate
When calculating the flow rate through a valve, the actual pressure drop is known, but the flow may be reduced by choking or near-choking.

To check for high pressure-drop effects, calculate R₁, the ratio of pressure drop to absolute upstream pressure (see equation 5 above) noting that the pressure drop in this case is the known value.

(1) Flow rates determined using the Basic Calculations are sufficiently accurate if R₁ is less than about twice the value tabulated in Figure 14 for the applicable valve type (higher because actual pressure drop is used in the ratio). In this case, no correction is necessary.

(2) When corrections for higher values of R1 are required, calculate the gas expansion factor directly from:

Equation 10 (U.S. or metric)

$$Y = 1 - 0.467\left(\frac{\Delta P/p_1}{kx_T}\right)$$

(3) The calculation method to determine the flow rate depends on the calculated value of Y from equation (10):

• If Y is greater than 0.667 (but less that 1), the flow is not fully choked. Calculate the corrected flow rate as follows:

Equation 11 (U.S. or metric)

$$w_c = Yw$$

• If Y is equal to or less than 0.667, the valve flow is choked, and the results of the Basic Calculations are invalid. The actual flow rate may be calculated from the equation for w_{choked} [(8a) or (8b)] above.

Caution: Choked or near-choked flow conditions may produce significant flow-induced noise and vibration. Prolonged operation with flow rates in this region may also cause erosion damage within a valve or in downstream piping, particularly if the flow condition involve "wet" steam. Edward valves tolerate these conditions well in services involving limited time periods during plant start-up, shutdown, etc., but consult Flowserve about applications involving long exposure to such conditions.

2.3.2 Liquid Flow – Cavitation and Flashing

The fluid pressure in high-velocity regions within a valve may be much lower than either

Figure 15
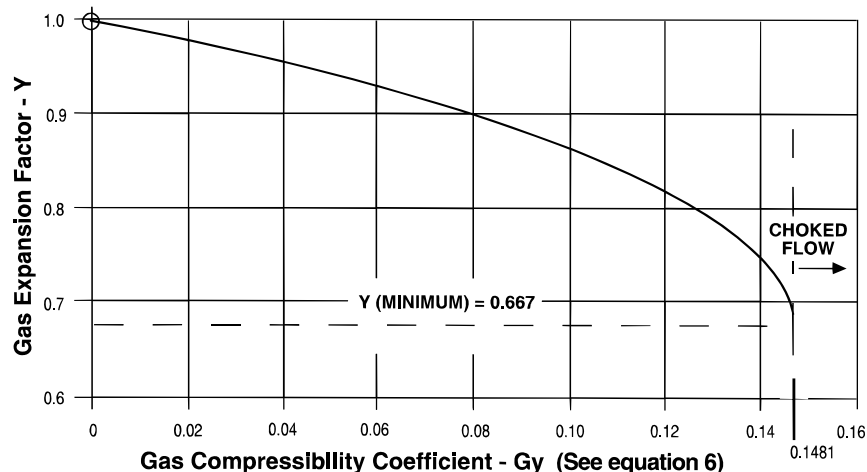
the upstream pressure or the downstream pressure. If the pressure within a valve falls below the vapor pressure (p_v) of the liquid, vapor bubbles or cavities may form in the flow stream. Cavitation, flashing and choking may occur. Use the equations and procedures in this section to evaluate these phenomena.

Cavitation and flashing are closely related, and they may be evaluated by calculating a pressure-drop ratio that is slightly different from that used for gas or steam:

Equation 12

$$R_1 = \frac{\Delta P}{(p_1 - p_v)}$$

To evaluate a particular valve and application, find values of K_i and F_L from the appropriate valve-data table, find P_v values for common liquids given in Figure 21, calculate R_2, and perform the following checks:

(1) Cavitation – the sudden and sometimes violent coalescence of the cavities back to the liquid state – occurs when the downstream pressure (within the valve or in the downstream pipe) recovers to above the vapor pressure.

• If $R_2 < K_i$, there should be no significant cavitation or effect on flow or pressure drop. Results of the Basic Calculations require no correction.

• If $R_2 > K_i$, cavitation begins. If the ratio is only slightly greater than K_i, it may be detected as an intermittent "ticking" noise near the valve outlet, although pipe insulation may muffle this sound. This stage of cavitation is usually related to tiny vapor cavities that form near the center of vortices in the flow stream, and it generally produces neither damage nor effects on flow characteristics. However, as the pressure drop ratio R_2 increases, the noise progresses to a "shh," then a "roar."

• If $R_2 > (K_i + FL_2)/2$, approximately, larger vapor cavities develop and the risk of cavitation damage (pitting) in the valve or downstream pipe may be a concern if this flow condition is sustained for significant periods of time. Noise may also pose a problem. Still, at this stage, there is usually no significant effect on valve flow characteristics. Results of the Basic Calculations require no correction.

As the pressure-drop ration increases beyond this point, some valves suffer slight reductions in their C_v values, but there is no practical way of correcting pressure drop

or flow calculations for this effect. Vibration and noise increase, ultimately sounding like "rocks and gravel" bouncing in the pipe at about the point where flow becomes choked.

(2) Flashing – the persistence of vapor cavities downstream of the valve — occurs when the pressure downstream of the valve remains below the vapor pressure.

• If $R_2 > 1$, flashing occurs, and the flow is choked due to vapor cavities in the flow stream.

(3) Liquid choking – A slightly different ratio may be used to predict the minimum pressure drop at choked flow conditions. Choking occurs due to vapor cavities near the minimum-area region in the flow stream when:

Equation 13

$$\frac{\Delta P}{(p_1 - 0.7p_v)} \geq F_L^2$$

Thus, the minimum pressure drop which will produce choked liquid flow is given by:

Equation 14

$$\Delta P \geq F_L^2 (p_1 - 0.7p_v)$$

Note that flow may be choked by either sever cavitation or flashing.

2.3.2.1 Predicting Choked Flow Rate
If the result of a Basic Calculation to determine pressure drop exceeds the value determined from equation (13), the Basic Calculation is invalid. the flow used for input cannot be obtained at the specified upstream pressure and temperature. In such a case, of if it is necessary to calculate liquid flow rate through a valve with high pressure drop, the choked flow rate at specified conditions may be calculated from:

Equation 15a (U.S.)

$$W_{choked} = 63.3 F_P C_V F_L \sqrt{\rho(p_1 - 0.7p_v)}$$

Equation 15b (metric)

$$W_{choked} = 27.3 F_P C_V F_L \sqrt{\rho(p_1 - 0.7p_v)}$$

When flow is choked due to either cavitating or flashing flow, the actual pressure drop cannot be determined from valve calculations. It may be any value greater than the minimum value for choked flow [equation (14)]. As in the case of choked gas or steam flow, the pressure downstream of a valve

must be determined by calculating the pressure required to force the choked flow through the downstream piping. This may be done with piping calculations (not covered by this catalog).

• If the pressure drop from a Basic Calculation was used to determine flow rate, and the pressure drop exceeds the pressure drop of choked flow, the result is invalid. The corrected flow rate may be calculated from equation (15a) or (15b) above.

2.4 Check Valve Sizing

The most important difference between check (including stop-check) valves and stop valves, from a flow performance standpoint, is that the check valve disk is opened only by dynamic forces due to fluid flow. The preceding calculation methods for flow and pressure drop are valid only if it can be shown that the valve is fully open.

The primary purpose of this section is to provide methods to predict check valve disk opening and to make corrections to pressure-drop calculations if the valve is not fully open. These methods are particularly applicable to sizing valves for new installations, but they are also useful for evaluation of performance of existing valves.

In selecting a stop-check or check valve for a new installation, the first steps require selecting a proper type and pressure class. The Stop and Check Valve Applications Guide section of this catalog should be reviewed carefully when the type is selected, noting advantages and disadvantages of each type and considering how they relate to the requirements of the installation. Other sections of this catalog provide pressure ratings to permit selection of the required pressure class.

2.4.1 Sizing Parameter

The first step in evaluating a stop-check or check valve application is to determine the Sizing Parameter based on the system flow rate and fluid properties:

Equation 16 (U.S. or metric)

$$SP = \frac{w}{\sqrt{\rho}}$$

Tables in this section provide a Sizing Parameter for full lift (SP_{FL}) for each Edward stop-check and check valve. The amount of opening of any check valve and its effect

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on pressure drop can be checked simply as follows:

• If SP_{FL} < SP, the valve is fully open. Pressure drop may be calculated using the equations given previously for fully open valves (including corrections for large pressure drops if required).

• IF SP_{FL} > SP, the valve is not fully open. A smaller size valve or another type should be selected if possible to ensure full opening. If that is not feasible, three additional steps are required to evaluate the opening and pressure drop of the valve under the specified service conditions.

Note: EPRI Report No. NP 5479 (Application Guideline 2.1) uses a "C" factor to calculate the minimum flow velocity required to fully open a check valve. The sizing procedures in this catalog do not employ the "C" factor, but values are given in the valve data tables for readers who prefer to use the EPRI methods. Since the EPRI methods are based on velocity, a flow area is required as a basis. Valve Inlet Diameters presented in data tables are the basis for correlation between flow rate and velocity.

2.4.2 Calculations for Check Valves Less Than Fully Open

If the preceding evaluation revealed an incompletely open check valve, perform the following additional calculations:

Calculate the flow-rate ratio:

Equation 17 (U.S. or metric)

$$R_F = \frac{SP}{SP_{FL}}$$

Determine the disk operating position:
Using the R_F value calculated above, determine the valve operating position from Figure 16. Performance curve numbers for individual cast-steel stop-check and check valves are given in the tabulations with other coefficients. Evaluate the acceptability of the operating position based on recommendations in the Check Valve Applications Guide and in the specific sizing guidelines below.

Calculate the pressure drop:
Again using the R_F value calculated above, determine the pressure drop ratio R_P from Figure 16, and calculate the valve pressure drop at the partially open position:

Equation 18 (U.S. or metric)

$$\Delta P = R_P \Delta P_{FL}$$

Values for ΔP_{FL} for all stop-check and check valves are given in Valve Tables 1 to 5 and 9 with other coefficients.

Note: The values of the various valve coefficients given in the tabulations are based on testing of a substantial number of valves. Most are applicable to any line fluid, but those involving check valve lift are influenced by buoyancy. Tabulated values are based on reference test conditions with room-temperature water. SP_{FL} and ΔP_{FL} are slightly higher in applications involving lower-density line fluids. Considering the expected accuracy of these calculations, the following corrections may be considered:

• For water at any temperature and other common liquids – No correction required.

• For steam, air and other common gases at normal operating pressures and temperatures – Increase SP_{FL} by 7% and increase ΔP_{FL} by 14%.

2.4.3 Sizing Guidelines

Considering the recommendations in the Check Valve Applications Guide section of this catalog and the calculation methods described above, the following specific steps are recommended for sizing check valves for optimum performance and service life (it is assumed that the check valve type and pressure class have already been selected before starting this procedure):

(1) Constant flow rate – If the application involves a substantially constant flow rate during all operating conditions, the check valve should be sized to be fully open. This may be accomplished by the following procedure:

• Calculate the check valve sizing parameter (SP) for the application from equation (15). Values of density for water, steam, and air are available in Figures 18-20.

If the flow rate is not given in lb/hr (or kg/hr), refer to the Conversion of Measurement Units section of this catalog to make the necessary calculation.

• Select the valve size with the next smaller SP_{FL} value from valve data tables (Tables 1-5 for forged-steel valves). Make note of the C_V, ΔP_{CO}, ΔP_{FL}, K_i, F_L and x_T values for use in later calculations.

Note: Preferably, there should be a good margin between SP and SP_{FL} to be sure the valve will be fully open. In the specific case of tilting-disk check valves, it is recommended that SP_{FL} be less than 0.83 (SP) to be sure that the disk is fully loaded against its stop (particularly if it is close to a flow disturbance).

• Calculate the pressure drop using the Basic Calculation method in equation (1) and the Cxx value of the valve size selected above. Make the simple checks described above in section 2.2 (Corrections Required With Large Pressure Drops), and make appropriate corrections in necessary (this is rarely needed for a valve sized for constant flow rate, but the check is desirable).

• Evaluate the pressure drop. If it is too high, a larger size or another check valve type should be tried. If it is lower than necessary for the application, a smaller and more economical valve (with a lower SP_{FL}) may be evaluated with assurance that it would also be fully open.

• Evaluate the crack-open pressure drop (ΔP_{CO}) to be certain that the system head available at the initiation of flow will initiate valve opening. Note that, for some valves, the crack-open pressure drop exceeds the pressure drop for full lift. Preceding calculations might indicate no problem, but it is possible that a valve might not open at all in a low-head application (e.g., gravity flow).

(2) Variable flow rate – If the application involves check valve operation over a range of flow rates, additional calculations are necessary to ensure satisfactory, stable performance at the lowest flow rate without causing excessive pressure drop at the maximum flow condition. This required careful evaluation of specific system operating conditions (e.g., are the minimum and maximum flow rates normal operating conditions or infrequent conditions that occur only during start-up or emergency conditions?).

The following options should be considered in selecting the best stop-check or check valve size for variable flow applications:

• The best method, if practical, is to size the valve to be fully open at the minimum flow condition. This may be done by following the first two steps listed above for the constant flow-rate case, but using the minimum flow rate in the sizing parameter (SP) calculation.

The only difference is that the pressure-drop calculations and evaluations in the third and fourth steps must be repeated at normal and maximum flow rates. If the selected valve size is fully open at the minimum flow rate and has an acceptable pressure drop at the maximum flow condition, it should give good overall performance.

• Sometimes a change in valve type provides the best cost-effective solution for variable-flow applications (e.g. use a smaller Flite-Flow® stop-check or check valve instead of a 90°-bonnet type to provide full lift at the minimum flow condition, but a high C_V for low pressure drop at maximum flow).

• Operation at less than full lift may have to be considered.

(3) Operation at less than full lift – "High Turndown" applications sometimes exist on

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boilers and other process systems that must swing through periodic flow changes from start-up, to standby, to maximum, and back again. In such cases, calculations may not reveal any single valve that will offer a satisfactory compromise assuring full lift and an acceptable pressure drop at both minimum and maximum flow conditions.

It may be acceptable to permit a check valve to operate at less than fully open at the minimum flow condition if such operation is infrequent or not expected to be sustained continuously for long periods. A valve may be sized by following the methods above using the lowest expected normal sustained flow rate in the sizing parameter (SP) calculation. Pressure drop at normal and maximum flow rates should then be calculated and evaluated.

The acceptability of valve operation at the minimum flow condition should be evaluated as follows:

• Calculate the sizing parameter (SP) at the minimum flow rate and the flow-rate ratio R_F from equation (17). The valve operating position (% open) should be determined from the proper performance curve (Figure 16).

Caution: *Check valve operation at less than 25% opening is not recommended. Any check valve that operates for sustained periods at partial openings should be monitored or inspected periodically for evidence of instability or wear.*

• If the minimum operating position is considered satisfactory, the pressure drop at the minimum flow condition may be calculated from equation (18), using the pressure-drop ratio (R_p) determined from the proper performance curve.

(4) Alternatives for high turndown applications – If the preceding steps show that the range of flow rates is too large for any single standard check valve, consult Flowserve. Several alternatives may be considered:

• Either 90°-bonnet or angle-type stop-check or piston-lift check valves may be furnished with a special disk with an extended "skirt" as illustrated in Figure 15A. This skirt increases flow resistance at low flow rates, producing additional lifting force to help prevent operation at small openings.

Of course, the skirt also reduces the C_V of the valve somewhat when it is fully open and increases pressure drop at maximum flow. Nevertheless, a special disk sometimes solves difficult high turndown problems. A

special disk also permits solution of some problems with existing valves that are "oversized."

• A stop-check valve may be used with the stem lifted just enough to provide a positive stop for the disk at very low flows (e.g., short-term start-up conditions). The stem should be lifted with increasing flow rate to maintain the disk-stopping action while preventing excessive pressure drop. At normal flow rates, the stem can be lifted to its fully open position, permitting normal check valve function. The stem may be actuated manually for infrequent start-up operations, or a motor actuator may be furnished for convenience if large flow rate variations are expected to be frequent.

Caution: *This arrangement could produce cavitation or flow-choking problems if the flow rate is increased substantially without lifting the valve stem to compensate.*

• A small check or stop-check valve may be installed in parallel with a larger stop-check valve. The smaller valve may be sized for the minimum flow condition, and the larger stop-check may be held closed with the stem until the flow is sufficient to ensurev adequate lift. If necessary, the stem on the larger valve may be opened gradually with increasing flow to maintain disk-stopping action as in the example above. The smaller valve may be allowed to remain open at higher flow rates or, if a stop-check type is used, it may be closed if preferred. Either or both valves may be manually actuated or furnished with a motor actuator for convenience.

2.5 Pipe Reducer Coefficient

The equations in the Flow Performance section of this catalog use a piping geometry factor, F_p, to account for the effect of pipe reducers attached directly to the valve. This permits the valve and pipe reducers to be treated as an assembly, i.e., F_pC_V is the flow coefficient of the valve/pipe reducer combination. Then, the pressure drop in the flow equations is the pressure drop of the assembly.

This method is also applicable when valves are furnished with oversized ends to fit larger diameter pipe. It should also be used to evaluate line-size valves used in pipe with a lower pressure rating than the valve, because such pipe may have less wall thickness and a larger inside diameter than the valve inlet diameter given in the valve data tabulations.

This section provides equations for calculation of the piping geometry factor, F_p, which should be used even in Basic Calculations when there is a significant difference between the pipe diameter and valve inlet diameter (d).

In addition, other coefficients (K_1, F_L, x_T) are affected by the presence of pipe reducers. Equations are also provided for correction of these terms, which are required only when evaluating significant valve-to-pipe diameter mismatch.

Note: These equations apply only where the valve diameter is less than the connecting pipe diameter.

Figure 15A

normal flow direction

Disk Skirt
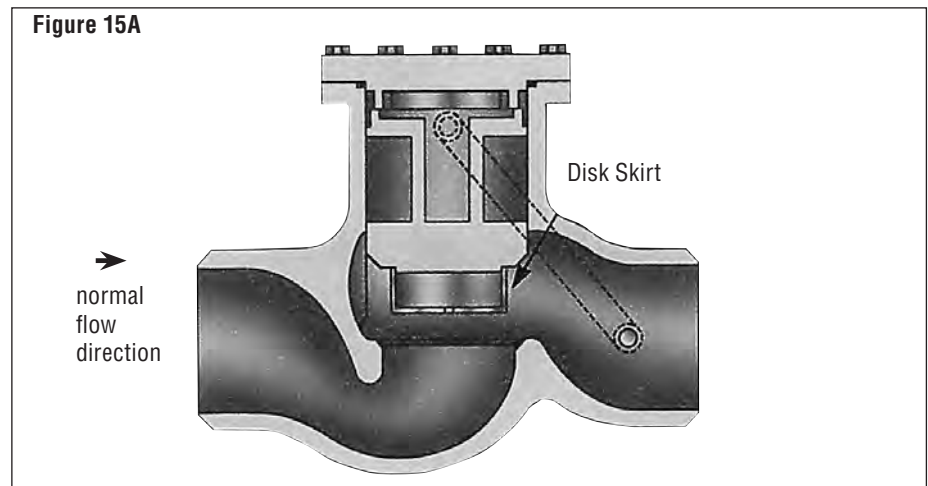
2.5.1 Pipe Geometry Factor

Calculate upstream loss coefficient:

Equation 1-1 (U.S. or metric)

$$K_1 = 0.5\left[1 - \left(\frac{d}{D_1}\right)^2\right]^2$$

Calculate downstream loss coefficient:

Equation 1-2 (U.S. or metric)

$$K_2 = \left[1 - \left(\frac{d}{D_2}\right)^2\right]^2$$

Summation:

Equation 1-3 (U.S. or metric)

$$\sum K = K_1 + K_2$$

Equation 1-4a (U.S.)

$$F_P = \sqrt{\frac{1}{1 + \frac{\sum K}{890}\left(\frac{C_v}{d^2}\right)^2}}$$

Equation 1-4b (metric)

$$F_P = \sqrt{\frac{1}{1 + 486 \sum K\left(\frac{C_v}{d^2}\right)^2}}$$

Note: If D_1 and D_2 are not the same, use of F_P calculated in this manner accounts for energy losses associated with flow contraction and expansion, and the pressure drop calculated using this factor represents energy loss. Bernoulli effects may cuase a different static pressure change between upstream and downstream pipes.

2.5.2 Other Coefficients

Correction of values of K_1, F_L and x_T requires an initial calculation of a Bernoulli coefficient to account for static pressure change in the inlet reducer:

Equation 1-5 (U.S. or metric)

$$K_{B1} = 1 - \left(\frac{d}{D_1}\right)^4$$

Then, corrected values of each coefficient may be calculated, using the corresponding value from valve data tables as input:

Equation 1-6a (U.S.)

$$K_{ii} = \frac{1}{F_P^2\left[\frac{1}{K_i} + \left(\frac{K_1 + K_{B1}}{890}\right)\left(\frac{C_v}{d^2}\right)^2\right]}$$

Equation 1-6b (metric)

$$K_{ii} = \frac{1}{F_P^2\left[\frac{1}{K_i} + 468(K_1 + K_{B1})\left(\frac{C_v}{d^2}\right)^2\right]}$$

Equation 1-7a (U.S.)

$$F_{LL} = \frac{1}{F_P \sqrt{\frac{1}{F_L^2} + \left(\frac{K_1 + K_{B1}}{890}\right)\left(\frac{C_v}{d^2}\right)^2}}$$

Equation 1-7b (metric)

$$F_{LL} = \frac{1}{F_P \sqrt{\frac{1}{F_L^2} + 468(K_1 + K_{B1})\left(\frac{C_v}{d^2}\right)^2}}$$

Equation 1-8a (U.S.)

$$x_{TT} = \frac{x_T}{F_P^2\left[1 + \frac{x_T(K_1 + K_{B1})}{1000}\left(\frac{C_v}{d^2}\right)^2\right]}$$

Equation 1-8b (metric)

$$x_{TT} = \frac{x_T}{F_P^2\left[1 + 416 x_T(K_1 + K_{B1})\left(\frac{C_v}{d^2}\right)^2\right]}$$

where: K_i, F_L and x_T are values from valve data tables; K_{ii}, F_{LL} and x_{TT} are corrected values for valve/reducer assembly.

Nomenclature

C_v	valve flow coefficient. See Valve Reference Data.
d	valve-end inside diameter, inches, (mm). See Valve Reference Data.
D_1	inside diameter of upstream pipe, inches, (mm). See Pipe Data Section.
D_2	inside diameter of downstream pipe, inches, (mm). See Pipe Data Section.
F_L	liquid-pressure recovery coefficient, dimensionless*
F_p	piping-geometry factor, dimensionless
K_1	pressure-loss coefficient for inlet reducer, dimensionless
K_2	pressure-loss coefficient for outlet reducer, dimensionless
K_{B1}	pressure change (Bernoulli) coefficient for inlet reducer, dimensionless
$\sum K$	$K_1 + K_2$, dimensionless
K_i	incipient-cavitation coefficient, dimensionless*
x_T	terminal value of $\Delta P/p_1$ for choked gas or steam flow, dimensionless

Double subscripts (e.g. K_{ii}) represent values corrected for effects of pipe reducers.

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Table 1 – Forged Steel Angle Univalve® Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		All Stop and Check Valves						Check Valves* with Springs (Std.)					Check Valves* without Springs				
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C	ΔP_{FL}		SP_{FL}		C

Class 1690 (PN 290) *All Stop valves, all Stop-Check valves, all Piston Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C	ΔP_{FL}		SP_{FL}		C
0.50	15	10.5				0.68	17.3			887	101	179			468	53	165
0.75	20	10.5				0.68	17.3			1522	172	179			804	91	165
1.00	25	10.5				0.68	17.3			1522	172	179			804	91	165
1.25	32	31	0.80	0.41	0.16	1.19	30.2	6.0	0.41	5326	604	179	1.5	0.103	2810	318	164
1.50	40	31				1.19	30.2			5066	574	179			2670	303	164
2.00	50	50				1.50	38.1			8620	977	180			4550	516	166
2.50	65	90				2.00	50.8			13,916	1580	179			7360	834	165
3.00	80	90				2.00	50.8			12,715	1440	179			6690	758	165

Class 2680 (PN 460) *All Stop valves, all Stop-Check valves, all Piston Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C	ΔP_{FL}		SP_{FL}		C
0.50	15	10.5				0.68	17.3			729	83	179			385	44	165
0.75	20	10.5				0.68	17.3			625	71	179			330	37	165
1.00	25	10.5				0.68	17.3			1140	129	179			604	68	165
1.25	32	19	0.80	0.41	0.16	0.94	23.9	6.0	0.41	3120	354	177	1.5	0.103	1650	187	163
1.50	40	19				0.94	23.9			2910	330	177			1540	175	163
2.00	50	50				1.50	38.1			7290	826	180			3850	436	166
2.50	65	89				2.00	50.8			10,400	1180	179			5490	622	165
3.00	80	89				2.00	50.8			10,400	1180	179			5490	622	165

NOTES: See Table 9 for ΔP_{CO}. See notes following paragraph 2.4.1, page 106, for discussion of C factor.
* Stop-check valves are only furnished without springs.

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Table 1A – Forged Steel Univalve®
Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		All Stop and Check Valves						Check Valves* with Springs (Std.)				Check Valves* without Springs			
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C	ΔP_{FL}		SP_{FL}		C

Class 1690 (PN 290) *All Stop valves, all Stop-Check valves, all Piston Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d (black)	d (color)	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C
0.50	15	7.0				0.464	11.8		886	100	210		443	50.2	105
0.75	20	12				0.612	15.5		1520	172	207		760	86.0	103
1.00	25	12				0.815	20.7		1520	172	117		760	86.0	58
1.25	32	42				1.160	29.5		5320	602	201		2660	301	101
1.50	40	40	0.66	0.27	0.16	1.338	34.0	4.0 0.28	5060	574	144	1.0 0.069	2530	287	72
2.00	50	68				1.687	42.8		8610	975	154		4300	488	77
2.50	65	110				2.125	54.0		13,900	1580	157		6960	789	79
3.00	80	100				2.624	66.6		12,700	1430	94		6330	717	47
4.00	100	85				3.438	87.3		10,800	1220	46		5380	609	23

Class 2680 (PN 460) *All Stop valves, all Stop-Check valves, all Piston Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d (black)	d (color)	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C
0.50	15	7.0				0.464	11.8		886	100	210		443	50.2	105
0.75	20	12				0.612	15.5		760	86.0	103		380	43.0	52
1.00	25	11				0.599	15.2		1390	158	198		696	78.9	99
1.25	32	30				0.896	22.8		3800	430	241		1900	215	121
1.50	40	28	0.63	0.24	0.15	1.100	28.0	4.0 0.28	3540	401	149	1.0 0.069	1770	201	75
2.00	50	70				1.503	38.2		8860	1000	200		4430	502	100
2.50	65	100				1.771	45.0		12,700	1430	206		6330	717	103
3.00	80	100				2.300	58.4		12,700	1430	122		6330	717	61
4.00	100	90				3.152	80.1		11,400	1290	58		5700	645	29

Class 4500 (PN760) *All Stop valves, all Stop-Check valves, all Piston Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d (black)	d (color)	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C	ΔP_{FL}	SP_{FL} (black)	SP_{FL} (color)	C
0.50	15	2.0				0.252	6.4		253	28.7	203		127	14.3	102
0.75	20	6.0				0.434	11.0		760	86.0	205		380	43.0	103
1.00	25	12				0.599	15.2		1520	172	216		760	86.0	108
1.25	32	12				0.808	20.5		1520	172	117		760	86.0	59
1.50	40	11	0.64	0.25	0.15	0.926	23.5	4.0 0.28	1390	158	82	1.0 0.069	696	78.9	41
2.00	50	48				1.156	29.4		6080	688	230		3040	344	115
2.50	65	62				1.400	35.6		7850	889	202		3920	444	101
3.00	80	60				1.700	43.2		7600	860	132		3800	430	66
4.00	100	55				2.200	55.9		6960	789	76		3480	394	37

NOTES: See Table 9 for ΔP_{CO}. See notes following paragraph 2.4.1, page 106, for discussion of C factor.
* Stop-check valves are only furnished without springs.

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Table 1B – Forged Steel PressurCombo Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		Pressurseat (DS)					Pressureater (DE)					PressurCombo (DC)				
NPS	DN	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d

Class 1690 (PN 290) *36124, 36128, 36224, 36228*

NPS	DN	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d
0.50	15	5.0				0.464 11.8	5.0				0.464 11.8	4.1				0.464 11.8
0.75	20	6.1				0.612 15.5	5.9				0.612 15.5	4.5				0.612 15.5
1.00	25	6.1				0.815 20.7	5.6				0.815 20.7	4.4				0.815 20.7
1.25	32	12				1.160 29.55	11				1.160 29.5	8.0				1.160 29.5
1.50	40	12	.85	.50	.27	1.338 34.0	11	.80	.45	.24	1.338 34.0	8.0	.80	.45	.24	1.338 34.0
2.00	50	30				1.687 42.3	28				1.687 42.8	22				1.687 42.8
2.50	65	53				2.125 54.0	51				2.125 54.0	39				2.125 54.0
3.00	80	51				2.624 66.6	47				2.624 66.6	37				2.624 66.6
4.00	100	49				3.438 87.3	43				3.438 87.3	35				3.438 87.3

Class 2680 (PN 460) *66124, 66128, 66224, 66228*

NPS	DN	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d
0.50	15	5.0				0.464 11.8	5.0				0.464 5.0	4.1				0.464 11.8
0.75	20	4.6				0.612 15.5	4.5				0.612 4.5	3.8				0.612 15.5
1.00	25	6.0				0.599 15.2	5.7				0.599 5.7	4.5				0.599 15.2
1.25	32	12				0.896 22.8	12				0.896 12	8.9				0.896 22.8
1.50	40	12	.85	.50	.27	1.100 28.0	11	.80	.45	.24	1.100 11	8.3	.80	.45	.24	1.100 27.9
2.00	50	31				1.502 38.2	30				1.502 30	23				1.502 38.2
2.50	65	52				1.771 45.0	56				1.771 56	41				1.771 45.0
3.00	80	52				2.300 58.4	48				2.300 48	38				2.300 58.4
4.00	100	50				3.152 80.1	44				3.152 44	36				3.152 80.1

Class 4500 (PN 760) *96124, 96128, 96224, 96228*

NPS	DN	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d	C_V	F_L	x_T	K_i	d
0.50	15	1.9				0.252 6.4	1.5				0.252 6.4	1.4				0.252 6.4
0.75	20	4.6				0.434 11.0	4.4				0.434 11.0	3.8				0.434 11.0
1.00	25	6.1				0.599 15.2	5.8				0.599 15.2	4.5				0.599 15.2
1.25	32	6.1				0.808 20.5	5.6				0.808 20.5	4.4				0.808 20.5
1.50	40	5.9	.85	.50	.27	0.926 23.5	5.3	.80	.45	.24	0.926 23.5	4.3	.80	.45	.24	0.926 23.5
2.00	50	28				1.156 29.4	29				1.156 29.4	22				1.158 29.4
2.50	65	30				1.400 35.6	30				1.400 35.6	23				1.400 35.6
3.00	80	30				1.700 43.2	28				1.700 43.2	22				1.700 43.2
4.00	100	29				2.200 55.9	25				2.200 55.9	21				2.200 55.9

Table 2 – Forged Steel Inclined Bonnet, Bolted Bonnet Valve Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		All Stop and Check Valves						Check Valves* with Springs (Std.)					Check Valves* without Springs				
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C	ΔP_{FL}		SP_{FL}		C

Class 800 (PN 130) *Figure No. 848/848Y Stop valve, 868/868Y Stop-Check valve, 838/838Y Piston Check valve*

NPS	DN	C_V	F_L	x_T	K_i	d(US)	d(metric)	ΔP_{FL}(US)	ΔP_{FL}(m)	SP_{FL}(US)	SP_{FL}(m)	C	ΔP_{FL}(US)	ΔP_{FL}(m)	SP_{FL}(US)	SP_{FL}(m)	C
0.25	8	1.4				0.364	9.2			198	22.4	76			68.6	7.77	26
0.38	10	3.3				0.493	12.5			467	52.9	98			162	18.3	34
0.50	15	3.3				0.546	13.9			467	52.9	80			162	18.3	28
0.75	20	5.7	0.72	0.30	0.20	0.742	18.8			722	81.8	67			250	28.3	23
1.00	25	13.5				0.957	24.3	5.0	0.34	1910	216	106	0.6	0.041	662	75.0	37
1.25	32	23.5				1.278	32.5			3330	377	104			1150	131	36
1.50	40	37.5				1.500	38.1			5290	600	120			1830	208	42
2.00	50	48.5				1.939	49.3			6860	778	93			2380	269	32

Series 1500 Figure No. 1048/1048Y Stop valve, 1068/1068Y Stop-Check valve, 1038/1038Y Piston Check valve

NPS	DN	C_V	F_L	x_T	K_i	d(US)	d(metric)	ΔP_{FL}(US)	ΔP_{FL}(m)	SP_{FL}(US)	SP_{FL}(m)	C	ΔP_{FL}(US)	ΔP_{FL}(m)	SP_{FL}(US)	SP_{FL}(m)	C
0.25	8	1.7				0.302	7.7			241	27.3	134			83.4	9.45	47
0.38	10	3.9				0.423	10.7			552	62.5	157			191	21.7	54
0.50	15	3.8				0.464	11.8			538	60.9	127			186	21.1	44
0.75	20	6.8	0.75	0.34	0.20	0.612	15.5			963	109	131			333	37.8	45
1.00	25	10.5				0.815	20.7	5.0	0.34	1490	168	114	0.6	0.041	515	58.3	39
1.25	32	28				1.160	29.5			3960	449	150			1370	155	52
1.50	40	26.5				1.338	34.0			3750	425	107			1300	147	37
2.00	50	41.5				1.687	42.8			5870	665	105			2030	230	36

NOTES: See Table 9 for ΔP_{CO}. See note following paragraph 2.4.1, page 106, for discussion of C factor.

Table 3 – Forged Steel Angle, Bolted Bonnet Valve Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		All Stop and Check Valves				Check Valves* with Springs (Std.)			Check Valves* without Springs		
NPS	DN	C_V	F_L	x_T	K_i	d	ΔP_{FL}	SP_{FL}	C	ΔP_{FL}	SP_{FL}	C

Class 600 (PN 110) *Figure No. 829 Stop valves, 847 Stop-Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}	SP_{FL}		C
0.50	15	3.3				0.546	13.9		512	58.0	87		187	21.2	32
0.75	20	5.7				0.742	18.8		884	100	82		323	36.5	30
1.00	25	17.5	0.55	0.19	0.11	0.957	24.3	6.0 0.41	2710	307	151	0.8 0.055	991	112	55
1.25	32	36				1.278	32.5		5580	632	174		2040	231	64
1.50	40	35				1.500	38.1		5430	615	123		1980	224	45
2.00	50	45.5				1.939	49.3		7050	799	96		2580	292	35

Class 800 (PN 130) *Figure No. 849/849Y Stop valves, 869/869Y Stop-Check valves*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}	SP_{FL}		C
0.25	8	2.6				0.364	9.2		403	45.7	155		147	16.7	57
0.38	10	2.9				0.493	12.5		450	50.9	94		164	18.6	34
0.50	15	2.8				0.546	13.9		434	49.2	74		159	18.0	27
0.75	20	4.8	0.64	0.25	0.16	0.742	18.8	6.0 0.41	744	84.3	69	0.8 0.055	272	30.8	25
1.00	25	10.5				0.957	24.3		1630	184	91		595	67.3	33
1.25	32	31				1.278	32.5		4810	544	150		1760	199	55
1.50	40	30				1.500	38.1		4650	527	105		1700	192	38
2.00	50	38.5				1.939	49.3		5970	676	81		2180	247	30

Series 1500 Figure No. 1049/1049Y Stop valves, 1069/1069Y Stop-Check valves

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}	SP_{FL}		C
0.25	8	1.9				0.302	7.7		295	33.4	165		108	12.2	60
0.38	10	2.9				0.423	10.7		450	50.9	128		164	18.6	47
0.50	15	2.9				0.464	11.8		450	50.9	106		164	18.6	39
0.75	20	5.0	0.61	0.22	0.14	0.612	15.5	6.0 0.41	775	87.8	105	0.8 0.055	283	32.1	39
1.00	25	7.7				0.815	20.7		1190	135	92		436	49.4	33
1.25	32	20				1.160	29.5		3100	351	117		1130	128	43
1.50	40	20				1.338	34.0		3100	351	88		1130	128	32
2.00	50	33.5				1.687	42.8		5190	588	93		1900	215	34

Series 1500 Figure No. 1029 Stop valves, 1047 Stop-Check valves

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}	SP_{FL}		C
0.50	15	2.7				0.464	11.8		419	47.4	99		153	17.3	36
0.75	20	4.7				0.612	15.5		729	82.5	99		266	30.1	36
1.00	25	7.5	0.65	0.24	0.16	0.815	20.7	6.0 0.41	1160	132	89	0.8 0.055	425	48.1	33
1.25	32	21				1.160	29.5		3260	369	123		1190	135	45
1.50	40	21				1.338	34.0		3260	369	93		1190	135	34
2.00	50	31.5				1.687	42.8		4920	557	88		1790	203	32

NOTES: See Table 9 for ΔP_{CO}. See note following paragraph 2.4.1, page 106, for discussion of C factor. See Table 10 page 120 for Hermavalves.

Table 4 – Edward Forged Steel Vertical Stem, Bolted Bonnet Globe Valve and 90° Bonnet Piston Check Valve Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Size		C_V	All Stop and Check Valves					Check Valves with Springs (Std.)			Check Valves without Springs		
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}	C	ΔP_{FL}	SP_{FL}	C

Series 600 (PN 110) *Figure No. 828 Stop valve, 846 Stop-Check valve, 858 Piston Check valve*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}		SP_{FL}		C
0.50	15	2.4				0.546	13.9		430	48.7	73			166	18.8	28
0.75	20	4.2				0.742	18.8		752	85.2	70			291	33.0	27
1.00	25	13.5	0.63	0.29	0.15	0.957	24.3	8.0 0.55	2400	272	133	1.2 0.083		929	105	52
1.25	32	27.5				1.278	32.5		4920	558	154			1910	216	59
1.50	40	27				1.500	38.1		4830	548	109			1870	212	42
2.00	50	35.5				1.939	49.3		6360	720	86			2460	279	33

Series 1500 Figure No. 1028 Stop valve, 1046 Stop-Check valve, 1058 Piston Check valve

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}		C	ΔP_{FL}		SP_{FL}		C
0.50	15	3.6				0.464	11.8		645	73.0	153			250	28.3	59
0.75	20	6.2				0.612	15.5		1110	126	151			430	48.7	58
1.00	25	6.2	0.68	0.27	0.17	0.815	20.7	8.0 0.55	1110	126	85	1.2 0.083		430	48.7	33
1.25	32	18				1.160	29.5		3220	365	122			1250	141	47
1.50	40	17.5				1.338	34.0		3130	355	89			1210	137	35
2.00	50	24.5				1.687	42.8		4390	497	79			1700	192	30

NOTES: See Table 9 for ΔP_{CO}. See note following paragraph 2.4.1, page 106, for discussion of C factor.

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Table 5 – Forged Steel Ball Check Valve Flow Coefficients

Size		Check Valve Flow Coefficients						Check Valves with Springs (Std.)				
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C

Class 800 (PN 130) *Figure No. 832/832Y Ball Check valve*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C
0.25	8	1.5				0.364	9.2			233	26.3	89
0.38	10	3.5				0.493	12.5			543	61.5	114
0.50	15	3.5				0.546	13.9			543	61.5	93
0.75	20	6.1	0.53	0.16	0.11	0.742	18.8	6.0	0.41	946	107	88
1.00	25	14				0.957	24.3			2170	246	121
1.25	32	25				1.278	32.5			3880	439	121
1.50	40	39.5				1.500	38.1			6120	694	139
2.00	50	51.5				1.939	49.3			7990	904	108

Series 1500 Figure No. 1032/1032Y Ball Check valve

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C
0.25	8	1.1				0.302	7.7			171	19.3	95
0.38	10	2.5				0.423	10.7			388	43.9	110
0.50	15	2.4				0.464	11.8			372	42.1	88
0.75	20	4.3	0.77	0.37	0.16	0.612	15.5	6.0	0.41	667	75.5	91
1.00	25	6.6				0.815	20.7			1020	116	79
1.25	32	17.5				1.160	29.5			2710	307	103
1.50	40	17				1.338	34.0			2640	299	75
2.00	50	26.5				1.687	42.8			4110	465	74

5000 CWP (345 Bar) *Figure No. 5160 Hydraulic Check valve*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C
2.00	50	14	0.96	0.57	0.24	1.502	38.2	20	1.4	3960	449	89

10000 CWP (690 Bar) *Figure No. 160/160Y Hydraulic Check valve, 9160 Hydraulic Check valve*

NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}		SP_{FL}		C
0.25	8	0.40				0.133	3.4			113	12.8	326
0.38	10	0.80				0.205	5.2			227	25.7	275
0.50	15	1.3				0.252	6.4			368	41.7	295
0.75	20	3.5	0.96	0.57	0.24	0.434	11.0	20.0	1.4	991	112	268
1.00	25	2.9				0.599	15.2			821	93.0	117
1.25	32	3.5				0.808	20.5			991	112	77
1.50	40	3.5				0.926	23.5			991	112	58
2.00	50	14				1.156	29.4			3960	449	150

NOTES: See Table 9 for ΔP_{CO}. See note following paragraph 2.4.1, page 106, for discussion of C factor.

Table 6 – Hydraulic Stop Valve Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

5,000 PSI CWP (345 BAR) *Figure No. 5158 Hydraulic Stop Valves*
10,000 PSI CWP (690 BAR) *Figure No. 158/158Y, 9158 Hydraulic Stop Valves*

Size		All Stop Valves					Check Valves with Springs (Std.)			Check Valves without Springs		
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}	C	ΔP_{FL}	SP_{FL}	C
0.25	8	1.6				0.133	3.4					
0.38	10	1.6				0.205	5.2					
0.50	15	1.6				0.252	6.4					
0.75	20	3.6	0.48	0.30	.024	0.434	11.0	N/A				
1.00	25	5.7				0.599	15.2					
1.25	32	9.1				0.808	20.5					
1.50	40	19				0.926	23.5					
2.00	50	33				1.156	29.4					

Table 7 – Inclined Bonnet Blow-Off Valve Flow Coefficients

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Class 300 (PN 50) *Figure No. 1441/1441Y*

Size		All Stop Valves					Check Valves with Springs (Std.)			Check Valves without Springs		
NPS	DN	C_V	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}	C	ΔP_{FL}	SP_{FL}	C
1.50	40	44	0.49	0.32		1.610	40.9					
2.00	50	67	0.69	0.44	0.20	2.067	52.5	N/A				
2.50	65	100	0.53	0.34		2.469	62.7					

Class 600 (PN 110) *Figure No. 1641/1641Y*

Size		All Stop Valves					Check Valves with Springs (Std.)			Check Valves without Springs		
1.50	40	43	0.55	0.35		1.500	38.1					
2.00	50	68	0.71	0.44	0.20	1.939	49.3	N/A				
2.50	65	110	0.56	0.35		2.323	59.0					

Table 8 – Angle Blow-Off Valve Flow Coefficients

Size		All Stop Valves						Check Valves with Springs (Std.)			Check Valves without Springs		
NPS	DN	C_v	F_L	x_T	K_i	d		ΔP_{FL}	SP_{FL}	C	ΔP_{FL}	SP_{FL}	C

Class 300 (PN 50) *Figure No. 1443/1443Y*

NPS	DN	C_v	F_L	x_T	K_i	d							
1.50	40	45	0.48	0.31		1.610	40.9						
2.00	50	80	0.48	0.31	0.15	2.067	52.5			N/A			
2.50	65	110	0.53	0.34		2.469	62.7						

Class 600 (PN 110) *Figure No. 1643/1643Y*

NPS	DN	C_v	F_L	x_T	K_i	d							
1.50	40	41	0.60	0.38		1.500	38.1						
2.00	50	81	0.50	0.31	0.15	1.939	49.3			N/A			
2.50	65	110	0.56	0.35		2.323	59.0						

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Table 9 – Crack-Open ΔP for Edward Forged Steel Check Valves, ΔP_{CO} – PSI (BAR)

Black numerals are in U.S. customary units or dimensionless
Colored numerals are in metric units

Valve Type	Installation Orientation		Valves with Springs (Std.)		Valves without Springs	
Inclined, Bolted Bonnet, Piston Lift	Horizontal	Bonnet up	0.7 – 0.9	0.05 – 0.06	0.1 – 0.5	0.007 – 0.03
		Bonnet sideways*	0.3 – 0.8	0.02 – 0.06	—	—
		Bonnet down*	0.05 – 0.7	0.003 – 0.05	—	—
	Vertical	Bonnet up	0.7 – 1.0	0.05 – 0.07	0.1 – 0.3	0.007 – 0.02
		Bonnet down*	0.05 – 0.7	0.003 – 0.05	—	—
90°, Bolted Bonnet, Piston Lift	Horizontal	Bonnet up	0.8 – 1.0	0.06 – 0.07	0.1 – 0.6	0.007 – 0.04
		Bonnet sideways*	0.4 – 0.8	0.03 – 0.06	—	—
		Bonnet down*	0.05 – 0.6	0.003 – 0.04	—	—
	Vertical		0.4 – 0.8	0.03 – 0.06	—	—
Inclined, Univalve®, Piston Lift	Horizontal	Bonnet up	1.0 – 1.5	0.07 – 0.10	0.4 – 0.8	0.03 – 0.06
		Bonnet sideways*	0.5 – 1.2	0.03 – 0.08	—	—
		Bonnet down*	0.05 – 1.1	0.003 – 0.08	—	—
	Vertical	Bonnet up	1.0 – 1.5	0.07 – 0.10	0.4 – 0.8	0.03 – 0.06
		Bonnet down*	0.05 – 1.1	0.003 – 0.08	—	—
Inclined, Ball Lift	Horizontal	Bonnet up	0.9 – 1.7	0.06 – 0.10	—	—
		Bonnet sideways*	0.7 – 1.4	0.05 – 0.10	—	—
		Bonnet down*	0.5 – 1.2	0.03 – 0.08	—	—
	Vertical	Bonnet up	0.9 – 1.7	0.06 – 0.10	—	—
		Bonnet down*	0.5 – 1.2	0.03 – 0.08	—	—

Not recommended because of possible accumulation of debris in valve neck.

Figure 16 – Edward Forged Steel Check Valve Flow Performance Curves

Figure 16A
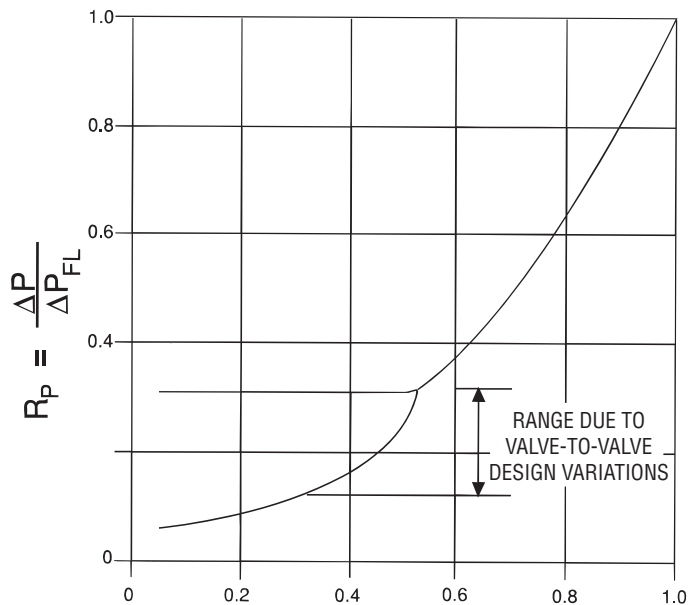
$$R_F = \frac{SP}{SP_{FL}}$$

Figure 16B
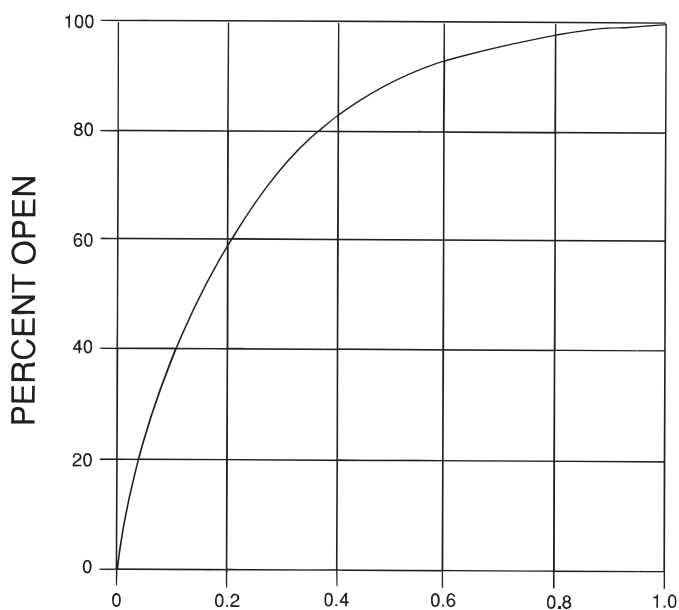
$$R_F = \frac{SP}{SP_{FL}}$$

Table 10 – Edward Forged Steel Hermavalve® Flow Coefficients

NPS	DN	Regular Port Hermavalves Fig. No. 15004/15104, 15008/15108, 16004, 16008				Reduced Port Hermavalves Fig. No. 15014/15114, 15018/15118, 16014, 16018				d	
		C_V	F_L	X_T	K_i	C_V	F_L	X_T	K_i		
0.05	15	4.9	0.46	0.31	0.07	—	—	—	—	0.464	11.8
0.75	20	6.1	0.52	0.36	0.09	—	—	—	—	0.612	15.5
1.00	25	11	0.55	0.38	0.10	6.1	0.51	0.36	0.09	0.815	20.7
1.50	40	32	0.62	0.39	0.13	11	0.53	0.37	0.09	1.338	34.0
2.00	50	50	0.68	0.40	0.15	32	0.57	0.37	0.11	1.687	42.8
2.50	65	—	—	—	—	50	0.59	0.37	0.12	2.125	54.0

Figure 17 – Ratio of Specific heats (k) for some gasses

k = 1.3	Ammonia	Carbon Dioxide	Dry Steam	Methane	Natural Gas
k = 1.4	Air	Carbon Monoxide	Hydrogen	Nitrogen	Oxygen

Figure 18A – Saturated Water - Temperature, Pressure & Density (U.S. Units)

Water Temp. °F	32	70	100	200	300	400	500	550	600	650	700	705
Vapor Pressure, p_v	0.09	0.36	0.95	11.5	67	247	681	1045	1543	2208	3094	3206
Water Density, ρ	62.4	62.3	62.0	60.1	57.3	53.7	49.0	46.0	42.3	37.4	27.3	19.7

P = Pressure in psia, ρ = Density in lb./ft³

Figure 18B – Saturated Water - Temperature, Pressure & Density (Metric)

Water Temp. °C	0	25	50	100	150	200	250	300	350	370	374
Vapor Pressure, p_v	.006	.032	.123	1.01	4.76	15.6	39.8	85.9	165.4	211	221
Water Density, ρ	1000	997	988	958	917	865	799	712	574	452	315

P = Pressure in Bar Absolute, ρ = Density in Kg/m³

Figure 19 – Density of Steam
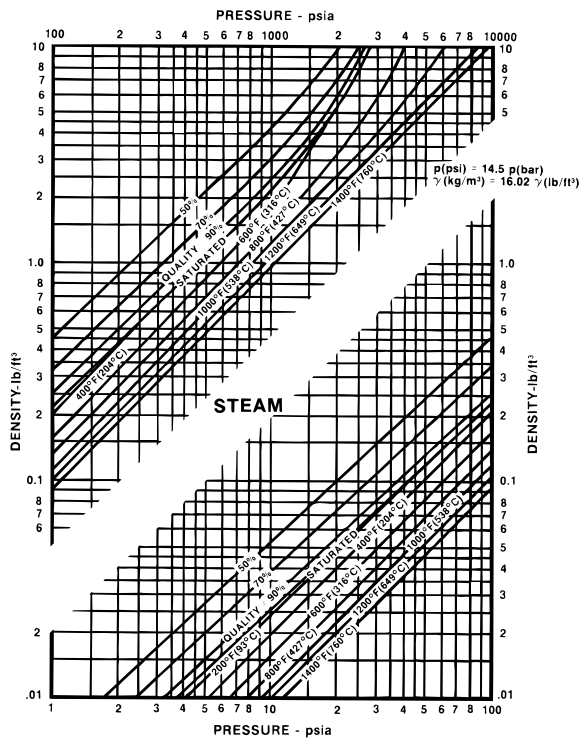
Figure 20 – Density of Air
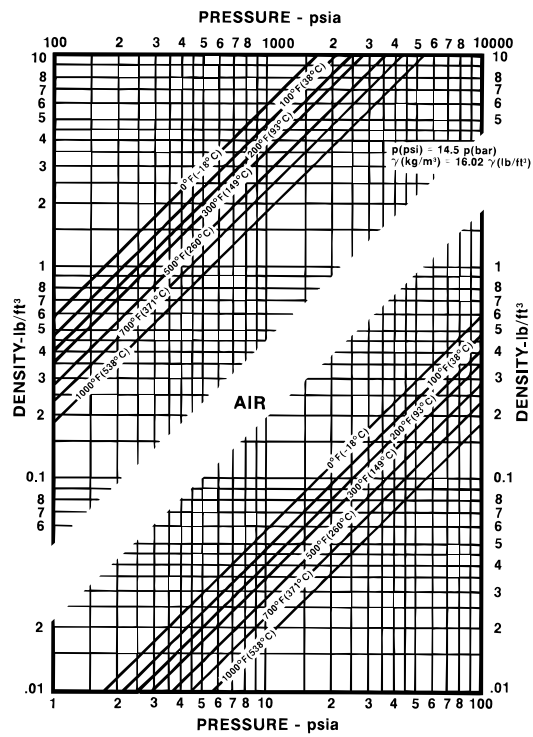
Figure 21 – Vapor Pressure of Liquid

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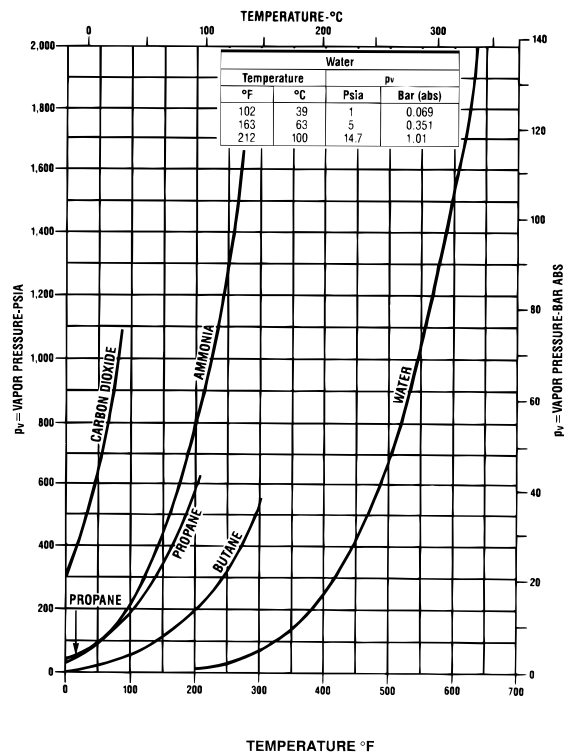
Conversion of Measurement Units

Length
1 in. = 25.4 mm   1 mile = 5280 ft
1 in. = 2.54 cm   1 mile = 1.609 km
1 in. = 0.0254 m   1 km = 3281 ft
1 ft = 0.3048 m   1 m = 39.37 in.

Area
1 in.^{2} = 645.2 mm^2 1 m^2 = 10.76 ft^2
1 in.^{2} = 6.452 cm^2 1 m^2 = 1550 in.^{2}
1 ft^2 = 144 in.^{2}

Volume
1 in.^{3} = 16.39 cm^3 1 m^3 = 35.31 ft^3
1 ft^3 = 1728 in.^{3} 1 m^3 = 264.2 U.S. gal.
1 U.S. gal. = 231 in.^{3} 1 m^3 = 220 Imp. gal.
1 U.S. gal. = 0.1337 ft^3 1 m^3 = 1000 liters
1 U.S. gal. = 0.8327   1 liter = 61.02 in.^{3}
       Imp. gal.
1 U.S. gal. = 3.7854   1 liter = 1000 cm^3
       liters
1 ft^3 = 28.32 liters   1 ml = 1 cm^3

Density
1 lb/ft^3 = 16.02 kg/m^3
1 lb/ft^3 = 0.01602 g/cm^3
1 lb/in^3 = 1728 lb/ft^3
density = specific gravity x reference density
density = 1/specific volume

Specific Volume
specific volume = 1/density

Temperature
T(°C) = T(°F -32) / 1.8
T(°F) = 1.8 T(°C) + 32
T(°R) = T(°F) + 460
T(°K) = T(°C) + 273
T(°R) = 1.8 T(°K)

where:
°C = degrees Celsius
°F = degrees Fahrenheit
°K = degrees Kelvin (absolute temperature)
°R = degrees Rankine (absolute temperature)

Specific Gravity – Liquids

$$G_l = \frac{\text{density of liquid}}{\text{density of water at reference condition}}$$

Commonly used relations are:

$$G_l = \frac{\text{density ofl iquid}}{\text{density of water at 60°F and atmospheric pressure}}$$

$$G_l = \frac{\rho\ (\text{lb/ft}^3)}{62.38\ (\text{lb/ft}^3)}$$

$$G_l = \frac{\text{density of liquid}}{\text{density of water at 4°C and atmospheric pressure}}$$

$$G_l = \frac{\rho\ (\text{kg/m}^3)}{1000\ (\text{kg/m}^3)}$$

For practical purposes, these specific gravities may be used interchangeably, as the reference densities are nearly equivalent.

Specific gravities are sometimes given with two temperatures indicated, e.g.,

$$G_l\ \frac{60°F}{60°F}\ ,\ G_l\ \frac{15.5°C}{4°C}\ ,\ G_l\ 60°F/60°$$

The upper temperature is that of the liquid whose specific gravity is given, and the lower value indicates the water temperature of the reference density. If no temperatures are shown, assume that the commonly used relations apply.

For petroleum liquids having an "API degrees" specification:

$$G_l\, 60°F/60° = \frac{141.5}{131.5 + \text{API degrees}}$$

Pressure
1 Mpa = 145 psi   1 psi = 6895 Pa
1 pond = 1 gf   1 psi = 6895 N/m^2
1 std atm = 14.696 psi 1 Pa = 1 N/m^2
1 std atm = 1.0133 bar 1 bar = 14.50 psi
1 std atm = 1.0133 x   1 bar = 100,000 N/m^2
       10^5 N/m^2
1 kgf/cm2 = 14.22 psi
1 std atm =
       760 torr absolute pressure =
       gage pressure + atmospheric pressure

Specific Gravity – Gases

$$G_g = \frac{\begin{array}{c}\text{density of gas}\\ \text{(at pressure and temperature of interest)}\end{array}}{\begin{array}{c}\text{density of air}\\ \text{(at same pressure and temperature)}\end{array}}$$

Because the relation between density, pressure and temperature does not always behave in an ideal way (i.e., ideally, density is proportional to pressure divided by temperature, in absolute units), use of the above relation requires that the pressure and temperature of interest be specified. This means that the specific gravity of a gas as defined may vary with pressure and temperature (due to "compressibility" effects).

Frequently, specific gravity is defined using:

$$G_g = \frac{\text{molecular weight of gas}}{\text{molecular weight of air}} = \frac{M_w}{28.96}$$

If this relation is used to calculate density, one must be careful to consider "compressibility" effects.

When the pressure and temperature of interest are at or near "standard" conditions (14.73 psia, 60°F) or "normal" conditions (1.0135 bar abs, 0°C), specific gravities calculated from either of the above relations are essentially equal.

Pressure Head
1 foot of water at 60°F = 0.4332 psi

$$p\,(\text{psi}) = \frac{\rho\,(\text{lb/ft}^3) \times h\,(\text{feet of liquid})}{144}$$

$$p\,(\text{N/m}^2) = \frac{\rho\,(\text{kg/m}^3) \times h\,(\text{meters of liquid})}{0.1020}$$

$$p\,(\text{bar}) = \frac{\rho\,(\text{kg/m}^3) \times h\,(\text{meters of liquid})}{10200}$$

1 meter of water at 20°C = 9.790 kN/m2
1 meter of water at 20°C = 97.90 mbar
1 meter of water at 20°C = 1.420 psi

Flow Rate
• mass units
1 lb/hr = 0.4536 kg/hr
1 metric tonne/hr = 2205 lb/hr

• liquid volume units
1 U.S. gpm = 34.28 BOPD
BOPD = barrels oil per day
1 U.S. gpm = 0.8327 Imp. gpm
1 U.S. gpm = 0.2273 m^3/hr
1 U.S. gpm = 3.785 liters/min
1 m^3/hr = 16.68 liters/min
1 ft^3/s = 448.8 U.S. gpm

• mixed units
w(lb/hr) = 8.021 q(U.S. gpm) x ρ(lb/ft^3)
w(lb/hr) = 500 q(U.S. gpm of water at 70°F or less)

In the following:
STP (standard conditions) refers to 60°F, 14.73 psia
NTP (normal conditions) refers to 0°C, 1.0135 bar abs

$$G_g = \frac{\text{molecular weight of gas}}{\text{molecular weight of air}} = \frac{M_w}{28.96}$$

w(lb/hr) = 60 q(scfm of gas) x ρ(lb/ft^3) at STP
w(lb/hr) = q(scfh of gas) x ρ(lb/ft^3) at STP
w(lb/hr) = 4.588 q(scfm of gas) x G_g
w(lb/hr) = 0.07646 q(scfh of gas) x G_g
w(lb/hr) = 3186 q(MMscfd of gas) x G_g
Mmscfd = millions of standard cubic feet per day
w(kg/hr) = q(normal m^3/hr of gas) x ρ(kg/m^3 at NTP)
w(kg/hr) = 1.294 q(normal m^3/hr of gas) x G_g

3. Edward Valve Design Standards and Features

Engineering and research efforts – both ana-lytical and experimental – have contributed to innovative leadership by Flowserve Edward Valves through the introduction or practical development of some major industrial valving features:

• Integral hardfaced seats in globe and angle valves to permit compact valve designs and to resist erosion and wear.

• Impactor handwheels and handles to permit tight shutoff of manually operated globe and angle valves.

• Body-guided globe and angle valve disks to minimize wear and ensure alignment with seats for tight sealing.

• Inclined-bonnet globe valves with streamlined flow passages to minimize pressure drop due to flow.

• Equalizers for large check and stop-check valves to ensure full lift at moderate flow rates and to prevent damage due to instability.

• Compact pressure-seal bonnet joints to eliminate massive bolted flanges on large, high-pressure valves:

 – First with wedge-shaped metal gaskets with soft coatings, optimized over more than four decades to provide tight sealing in most services.

 – Now, for the severest services, with composite gaskets using flexible graphite and special anti-extrusion rings to ensure tight sealing, even with severe tempera-ture transients – overcomes need for field re-tightening and eases disassembly for maintenance.

• Optimized stem-packing chambers and packing-material combinations to ensure tight stem sealing:

 – First with asbestos-based materials and then with asbestos-free materials.

• Hermetically sealed globe valves with seal-welded diaphragm stem seals to prevent stem leakage in critical applications, including nuclear.

• Gate valves with flexible double-wedge construction to ensure tight sealing at both low and high pressures and to prevent sticking difficulties when opening.

• Qualified stored-energy actuators for quick-closing valves in safety-related nuclear-plant applications – and qualified valve-actuator combinations that are used in main-steam isolation service throughout the world.

Flowserve valve expertise, acquired over more than 85 years, is shared with national and international codes-and-standards com-mittees and other technical societies and groups whose activities influence industrial valves. This cooperation has included partici-pation in the development of every issue of ASME/ANSI B16.34 as well as most issues of ASME/ANSI B16.5 (Pipe Flanges and Flanged Fittings), which applied to steel valves before ASME/ANSI B16.34 was first issued in 1973. Flowserve representatives have also been ac-tive in preparation of ISO (International Stan-dards Organization) standards. In addition, Flowserve representatives have participated where appropriate with trade organizations such as EPRI, INPO and various nuclear power-plant owners' groups in addressing valve issues.

3.1 Codes and Standards

Flowserve Edward valves are designed, rated, manufactured and tested in accordance with the following standards where applicable:

• ASME B16.34-2004 – Valves: flanged, threaded and welding end.

• ASME/ANSI B16.10-2000– Face-to-face and end-to-end dimensions of valves.

• ASME B16.11 – Forged Fittings, Socket-welding and Threaded.

• ASME Boiler and Pressure-Vessel Code – Applicable sections including Nuclear Section III.

• ASME and ASTM Material Specifications – Applicable sections.

• MSS Standard Practices – Where appropriate: Edward sealability acceptance criteria are equal to or better than those in MSS SP-61.

Users should note that ASME/ANSI B16.34-2004 has a much broader scope than the previous editions. While this standard previously covered only flanged-end and butt welding-end valves, the 1988 edition covered socket welding-end and threaded-end valves as well. With this revision, the standard now addresses practically all types, materials and end configurations of valves commonly used in pressure-piping systems. All Edward valves in this catalog with a listed class number (e.g. Class 1500) comply with ASME B16.34.

In addition to the standards listed, special requirements such as those of API and NACE are considered on application.

3.2 Pressure Ratings

Flowserve Edward valve-pressure ratings are tabulated in pressure-versus-temperature format. The temperatures range from -20°F (-29°C) to the maximum temperature permit-ted for each specific design and pressure-boundary material. Typically, pressure rat-ings decrease with increasing temperature, approximately in proportion to decreases in material strength.

Valves in this catalog with a listed class number are rated in accordance with ASME B16.34-2004. This standard establishes allowable working pressure ratings for each class number and material. These ratings also vary with class definitions as described below.

Standard Class (Ref: Paragraph 2.1.2 of ASME B16.34-2004) – These lowest ratings apply to all flanged-end valves as well as any threaded-end or welding-end valves that do not meet the requirements for other classes. Typically, ratings for these valves are consistent with ratings listed for flanges and flanged fittings of similar materials in ASME/ANSI B16.5-2003.

Special Class (Ref: Paragraph 2.1.3 of ASME B16.34-2004) – These ratings apply to threaded-end or welding-end valves which meet all requirements for a Standard Class rating and in addition meet special nonde-structive examination (NDE) requirements. Valve bodies and bonnets are examined by volumetric and surface examination methods and upgraded as required. Pressure ratings for Special Class valves are higher than those for Standard Class valves (particularly at elevated temperatures) because of the im-proved assurance of soundness of pressure boundaries and because they are not subject to the limitations of flanged and gasketed end joints.

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Limited Class (Ref: Paragraph 2.1.3 of ASME B16.34-2004) – These ratings apply only to threaded-end or welding-end valves in sizes 2-½ and smaller, with generally cylindrical, internal-wetted pressure boundaries. Limited Class valves meet all requirements for Standard Class valves, and body designs must also satisfy special reinforcement rules to compensate for irregularities in shape. Typically, the regions of minimum wall thickness in these valves are very localized, so minor plasticity in such regions at high temperature will not adversely affect valve geometry. Pressure ratings for Limited Class valves are the same as those for Special Class valves at lower temperatures, but Limited Class ratings are higher at very high temperatures [above 900°F (482°C) for ferritic steels and above 1050°F (565°C) for austenitic steels].

It should be understood that flanged-end valves can be supplied only as Standard Class valves with numerically even pressure-class designations (300, 600, 900, 1500, 2500), for consistency with mating flanges in piping systems. Threaded-end or welding-end valves can be supplied with the same designations or as Class 4500 (for which there is no standard for flanged-end connections). In addition, threaded-end or welding-end valves can be furnished with intermediate ratings or class designations (ref: paragraph 2.1.4 of ASME B16.34-2004), up to Class 2500 for threaded ends and up to Class 4500 for welding-ends. For example, Class 2680 welding-end Univalves, can be applied in superheater-drain applications that could not be satisfied with a Class 2500 valve rating.

Series or CWP
A few valves in this catalog with "Series" or "CWP" designations are designed, rated, manufactured and tested to Flowserve Edward Valves proprietary standards. These valve designs, qualified by decades of successful field performance, will provide safe and reliable service in applications where an ASME/ANSI rating is not required by a piping code or other specifications.

These valve designs and ratings are generally, but not completely, in conformance with recognized national standards (e.g., some employ high-strength materials not listed in standards). These valves have a history of excellent performance and safety, and they may be applied with confidence in applications where ASME/ANSI ratings are not required.

Notes:
1. While Edward cast-steel valves described in this catalog have even listed ratings (e.g., 1500), many designs provide more wall thickness than required in critical areas. Accordingly, welding-end valves can often be offered with intermediate ratings (ref: Paragraph 6.1.4 of ASME B16.34-2004) moderately higher than the nominal class ratings. With appropriate revisions to testing procedures, this can allow somewhat higher pressure ratings than those listed in the tabulations. Consult Edward Valves and provide information on specific required design pressure and temperature conditions.
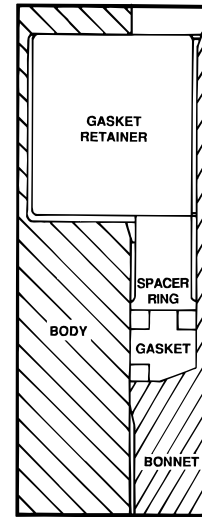
2. Pressure ratings for carbon steel (A105 and A216 WCB) valves are tabulated for temperatures through 1000°F (538°C), which is consistent with ASME B16.34-2004. As noted in that standard, these materials are permissible but not recommended for prolonged usage at above about 800°F (427°C). This precaution is related to the possibility that carbides in carbon steel may be converted to graphite.

3. Other codes or standards applicable to piping systems may be more restrictive than ASME B16.34-2004 in limiting allowable pressures for valves. For example, ASME B31.1-1995 (Power Piping) does not permit use of carbon steel (A105 and A216 WCB) at design temperatures above 800°F (427°C). Users must consider all codes or regulations applicable to their systems in selecting Edward Valves.
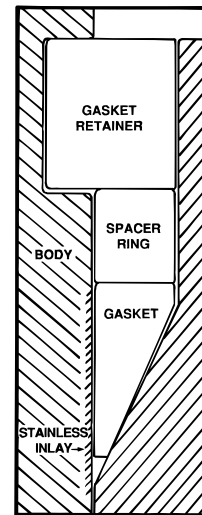
4. The maximum tabulated temperatures at which pressure ratings are given for Edward valves are in some cases less than the maximum temperatures given in ASME B16.34-2004 for valves of the same material. The maximum tabulated temperatures in this catalog may reflect limitations of materials used for other valve parts (e.g., stems). Use of Edward valves at temperatures above the maximum tabulated values may result in degradation and is not recommended.

3.3 Pressure-Seal Construction

The time-proven Edward pressure-seal bonnet seals more effectively as pressure increases, because the pressure forces the sealing elements into closer contact. Metal pressure-seal gaskets with soft plating employ optimum contact angles and materials for each applicable valve type, size and pressure-class rating. The gaskets yield initially

Composite Pressure-Seal Construction

Typical Pressure-Seal Construction

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under bolting load and then under pressure, to provide excellent sealing contact.

New designs for highest pressure/temperature services employ improved composite pressure-seal gaskets with flexible graphite rings. Flowserve leadership in proof-testing of Edward Valves flexible graphite stem packings clearly showed the superior sealing characteristics of this material, and continued research led to the development of a test-proven bonnet closure that provides highest sealing integrity. The composite pressure-seal provides excellent sealing at low and high pressures, even under severe pressure/temperature transients. It provides easier disassembly for maintenance, seals over minor scratches and does not depend on retightening under pressure after reassembly.

3.4 Hardfacing

Integrity of seating surfaces on bodies, wedges and disks in gate, globe, and check valves is essential for tight shutoff. Valve body seats must be hardfaced, and wedges and disks must either be hardfaced or made from an equivalent base material.

The standard seating material for most Edward valves is cobalt-based Stellite 21®, which has excellent mechanical properties and an exceptional performance history. As compared to Stellite 6®, which was used in many early Edward valves and is still used in many competitive valves, Stellite 21® is more ductile and impact resistant. These properties provide superior resistance to cracking of valve seating surfaces in service.

Stellite 21 is used either as a complete part made from a casting (as in Univalve® disks and small Equiwedge® gate valve wedges) or as a welded hardsurfacing deposit. Depending on valve size and type, hardsurfacing material is applied by a process that assures highest integrity (PTA, MIG, etc.).

While the as-deposited (or as-cast) hardness of Stellite 21 is somewhat lower than that of Stellite 6, Stellite 21 has a work-hardening coefficient that is five times that of Stellite 6. This provides essentially equivalent hardness after machining, grinding, and exposure to initial seating stresses. In addition, low friction coefficients attainable with Stellite 21 provide valuable margins in assuring valve operation with reasonable effort or actuator sizing.

The properties of Stellite 21 also provide an advantage to the user long after a valve

leaves the Edward plant. If a large valve seat is severely damaged in a localized area, as may occur due to closing on foreign objects, the seat may be repaired locally and refinished, in such cases, where a valve cannot be adequately preheated before welding, a Stellite 6 seat may crack during the repair process – requiring either removal of the valve from the line or in situ removal replacement of the complete seat.

Some Edward valves have used solid disks made of hardened ASTM A-565 Grade 616 or 615 stainless steel. This corrosion-resistant alloy has been proven in seating and erosion tests and in service. This material can be furnished in certain valves for nuclear-plant services where reduced cobalt is desirable. Similar iron-base trim materials are used in production of certain standard valves. Extensive research on other cobalt-free valve trim materials has also identified other alloys which provide good performance under many service conditions. Consult Flowserve about any special trim requirements.

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3.5 Valve-Stem Packing

Stem sealing is an extremely important valve performance feature, since seal leakage can represent energy loss, a loss of product and a potential environmental or safety hazard. Consequently, Edward stop and stop-check valves employ stem packings that have been qualified by extensive testing.

The search for improved sealing performance was a primary reason for seeking out new stem-packing materials to replace asbestos-based packings. The demand of many valve users to discontinue use of asbestos due to health risks was an important secondary reason. Since there are no simple laboratory tests that will predict sealing performance based on measurable properties of packing materials, hundreds of tests have been necessary with various packings in valves or valve mockups.

Some packings required frequent adjustments due to wear, extrusion or breakdown, and some could not be made to seal at all after relatively brief testing. All standard Edward stop and stop-check valves now employ flexible graphite packing which provides excellent stem sealing. However, the key to its success involves retaining the graphitic material with special, braided end rings to prevent extrusion. Various end rings are used, depending on the valve pressure class

and expected service-temperature range. All Edward valves assembled since January 1986 have been asbestos-free.

See V-REP 86-2 for more information.

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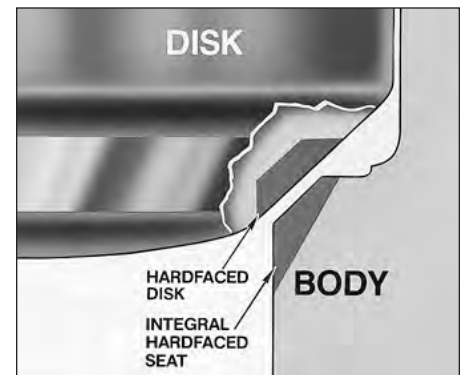
Maintenance

FLOWSERVE EDWARD VALVES ON-SITE FIELD SERVICE REPAIR CAPABILITIES

Flowserve is totally committed to customer service satisfaction. Our entire manufacturing operation guarantees we will stand behind all field service repair work to maximize customer support.

OUR FACILITY OFFERS

- Mobile machine shop trailer for on-site repairs
- After-hours plant-based service team for around-the-clock coverage
- Expertly trained field service personnel capable of handling any size field service job
- Special equipment for seat refinishing, body boring, welding and stress relieving
- In-house valve repair and return remanufacturing to original specifications with new valve warranty

- Experience in turnkey jobs to help the customer with one-stop shopping
- 180,000-sq.-ft. manufacturing facility with state-of-the-art machining and engineering capability and ISO 9001 certification
- Flowserve Raleigh is ISO 9001 certified
- Flowserve Raleigh is authorized by ASME to use the "NR" symbol

Phone Toll-Free
24 Hours a Day
365 Days a Year
(Day) 1-800-225-6989
(Night) 1-800-543-3927

STAYING ON-LINE WITH FLOWSERVE

We design and manufacture all our valves for 40 years' life in the field. That means not just building a reliable product, but one that is easy to maintain and service. It also means providing a team of experienced, dedicated professionals to keep your Flowserve valves operating at peak performance.

Highly Experienced Technicians

Flowserve brings unmatched experience to the field. Our service technicians have an average 20 years in the industry, and 15 years with Flowserve. Each has special skills, such as welding and machining, that we can target for the needs of the individual job.

Comprehensive Record-Keeping

Our files include original specifications for every Flowserve valve sold since 1908. All valves are coded for easy identification. On new and replacement orders, Flowserve stands ready to provide the complete lot-traceability required for nuclear and other critical services.

In-Line Service

We are dedicated to on-site service whenever possible. To this end, we not only provide highly experienced, expert personnel — we also support those technicians with field equipment, including portable boring, lapping, welding, and weld-cutting machines. Major parts, such as disks or bonnets, can be air-shipped back to the factory for service and repaired while service personnel perform other tasks.

Parts Replacement

Our comprehensive record-keeping system also facilitates replacement of parts. Our computer database can quickly tell us if we have the part in stock or on order, or how we can best coordinate raw materials and factory resources for the quickest possible turnaround time.

New 90-day Warranty

On all valves repaired to Flowserve's standards, we will issue a new 90-day warranty.

Factory Repair & Upgrading

Our After-Hours Coverage Team (AHCT) specialists are on-call around the clock, seven days a week, to deliver on our commitment to provide immediate response to our customers' requirements. Whether your requirements are for a planned outage, preventive maintenance or an emergency demand, Flowserve will remanufacture or upgrade valves to the original or most current specification. Our in-house engineering and quality assurance support is committed to meet the required turn-around time.

Planned & Emergency Outages

Our service managers will coordinate scheduled maintenance, and also get technical assistance to your facility quickly for emergency needs.

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Edward Valves
Catalog and Application Manual Appendix

End Configurations

American Steel Flange Standards ASME B16.5 Dimensions in Inches

Class	Nominal Pipe Size	O Outside Diameter of Flange	R Outside Diameter of Raised Face	C* Minimum Thickness of Flange	A Diameter of Bolt Circle	Number of Bolt Studs	Diameter of Bolt Studs	Diameter of Bolt Stud Holes
CLASS 600 VALVE FLANGES	½	3.75	1.38	0.56	2.62	4	½	0.62
	¾	4.62	1.69	0.62	3.25	4	5/8	0.75
	1	4.88	2.00	0.69	3.50	4	5/8	0.75
	1¼	5.25	2.50	0.75	3.88	4	5/8	0.75
	1½	6.12	2.88	0.81	4.50	4	¾	0.88
	2	6.50	3.62	0.88	5.00	8	5/8	0.75
	2½	7.50	4.12	1.00	5.88	8	¾	0.88
	3	8.25	5.00	1.12	6.62	8	¾	0.88
	4	10.00	6.19	1.25	7.88	8	¾	0.88
	5	11.00	7.31	1.38	9.25	8	¾	0.88
	6	12.50	8.50	1.44	10.62	12	¾	0.88
	8	15.00	10.62	1.62	13.00	12	7/8	1.00
	10	17.50	12.75	1.88	15.25	16	1	1.12
	12	20.50	15.00	2.00	17.75	16	1-1/8	1.25
	14	23.00	16.25	2.12	20.25	20	1-1/8	1.25
CLASS 600 VALVE FLANGES	½	3.75	1.38	0.56	2.62	4	½	0.62
	¾	4.62	1.69	0.62	3.25	4	5/8	0.75
	1	4.88	2.00	0.69	3.50	4	5/8	0.75
	1¼	5.25	2.50	0.81	3.88	4	5/8	0.75
	1½	6.12	2.88	0.88	4.50	4	¾	0.88
	2	6.50	3.62	1.00	5.00	8	5/8	0.75
	2½	7.50	4.12	1.12	5.88	8	¾	0.88
	3	8.25	5.00	1.25	6.62	8	¾	0.88
	4	10.75	6.19	1.50	8.50	8	7/8	1.00
	5	13.00	7.31	1.75	10.50	8	1	1.12
	6	14.00	8.50	1.88	11.50	12	1	1.12
	8	16.50	10.62	2.19	13.75	12	1-1/8	1.25
	10	20.00	12.75	2.50	17.00	16	1¼	1.38
	12	22.00	15.00	2.62	19.25	20	1¼	1.38
	14	23.75	16.25	2.75	20.75	20	1-3/8	1.50
CLASS 900 VALVE FLANGES**	2½	9.62	4.12	1.62	7.50	8	1	1.12
	3	9.50	5.00	1.50	7.50	8	7/8	1.00
	4	11.50	6.19	1.75	9.25	8	1-1/8	1.25
	5	13.75	7.31	2.00	11.00	8	1¼	1.38
	6	15.00	8.50	2.19	12.50	12	1-1/8	1.25
	8	18.50	10.62	2.50	15.50	12	1-3/8	1.50
	10	21.50	12.75	2.75	18.50	16	1-3/8	1.50
	12	24.00	15.00	3.12	21.00	20	1-3/8	1.50
	14	25.25	16.25	3.38	22.00	20	1½	1.62
CLASS 1500 VALVE FLANGES	½	4.75	1.38	0.88	3.25	4	¾	0.88
	¾	5.12	1.69	1.00	3.50	4	¾	0.88
	1	5.88	2.00	1.12	4.00	4	7/8	1.00
	1¼	6.25	2.50	1.12	4.38	4	7/8	1.00
	1½	7.00	2.88	1.25	4.88	4	1	1.12
	2	8.50	3.62	1.50	6.50	8	7/8	1.00
	2½	9.62	4.12	1.62	7.50	8	1	1.12
	3	10.50	5.00	1.88	8.00	8	1-1/8	1.25
	4	12.25	6.19	2.12	9.50	8	1¼	1.38
	5	14.75	7.31	2.88	11.50	8	1½	1.62
	6	15.50	8.50	3.25	12.50	12	1-3/8	1.50
	8	19.00	10.62	3.62	15.50	12	1-5/8	1.75
	10	23.00	12.75	4.25	19.00	12	1-7/8	2.00
	12	26.50	15.00	4.88	22.50	16	2	2.12
	14	29.50	16.25	5.25	25.00	16	2¼	2.38
CLASS 2500 VALVE FLANGES	½	5.25	1.38	1.19	3.50	4	¾	0.88
	¾	5.50	1.69	1.25	3.75	4	¾	0.88
	1	6.25	2.00	1.38	4.25	4	7/8	1.00
	1¼	7.25	2.50	1.50	5.12	4	1	1.12
	1½	8.00	2.88	1.75	5.75	4	1-1/8	1.25
	2	9.25	3.62	2.00	6.75	8	1	1.12
	2½	10.50	4.12	2.25	7.75	8	1-1/8	1.25
	3	12.00	5.00	2.62	9.00	8	1¼	1.38
	4	14.00	6.19	3.00	10.75	8	1½	1.62
	5	16.50	7.31	3.62	12.75	8	1¾	1.88
	6	19.00	8.50	4.25	14.50	8	2	2.12
	8	21.75	10.62	5.00	17.25	12	2	2.12
	10	26.50	12.75	6.50	21.25	12	2½	2.62
	12	30.00	15.00	7.25	24.38	12	2¾	2.88

*C dimensions include raised face in Class 300 values.
**Class 900 and 1500 standards are identical in all sizes below 2½.

A1

End Configurations (cont'd)

Socket Welding Ends ASME B16.11

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

NPS	¼	3/8	½	¾	1	1¼	1½	2	2½
DN	8	10	15	20	25	32	40	50	65
A Socket Diameter - min	0.56	0.69	0.86	1.07	1.33	1.68	1.92	2.41	2.91
	14	18	22	27	34	43	49	61	74
B Depth of Socket - min	0.38	0.38	0.38	0.50	0.50	0.50	0.50	0.62	0.62
	10	10	10	13	13	13	13	16	16

Standard Flange Facings & Extras

All Class 300 flanged valves are regularly furnished with 1/16-in. raised face with phonograph finish.

All Class 600, 900, 1500 and 2500 flanged valves are regularly furnished with ¼-in. raised face with phonograph finish.

An extra charge will be made for facings other than regularly furnished as above.

No deductions for valves ordered with flange faces only.

Flowserve will furnish valves with patented flange facings with the understanding that the purchaser must obtain from the patent owners a license to use these joints.

* C dimensions include raised face in Class 300 valves.
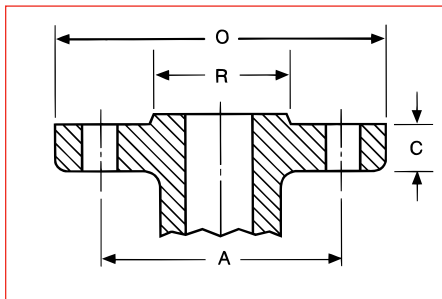*** Class 900 and 1500 standards are identical in all sizes below size 2½.*

Socket Welding Ends

Conforming to requirements of ASME/ANSI B16.11
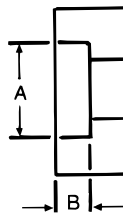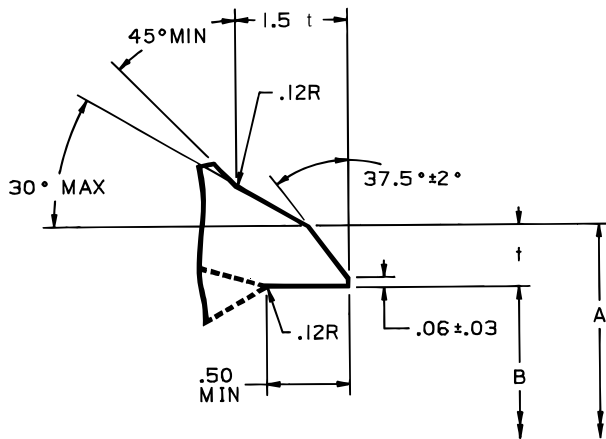
Threaded Ends

Threaded ends are provided with American National Standard Taper Pipe Threads per ANSI/ASME B1.20.1
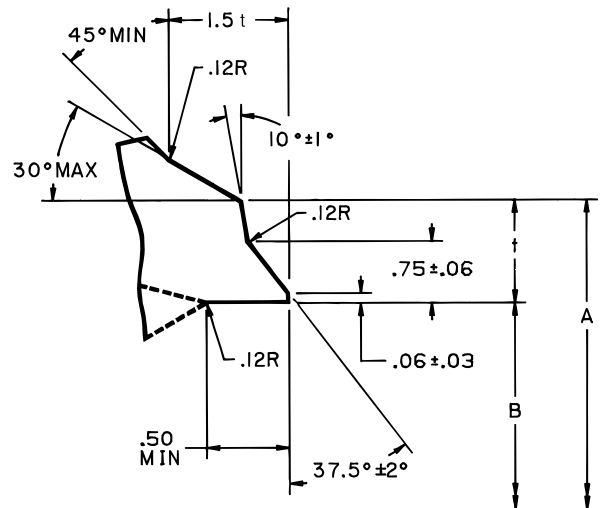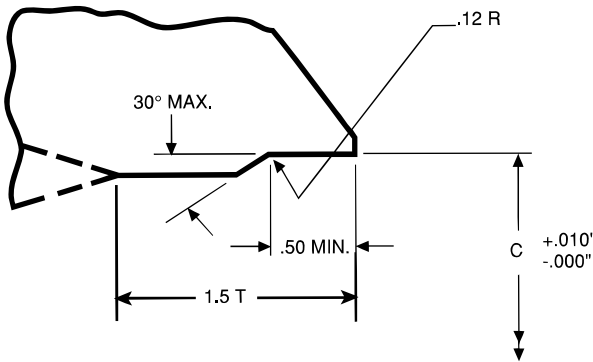
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End Preparations

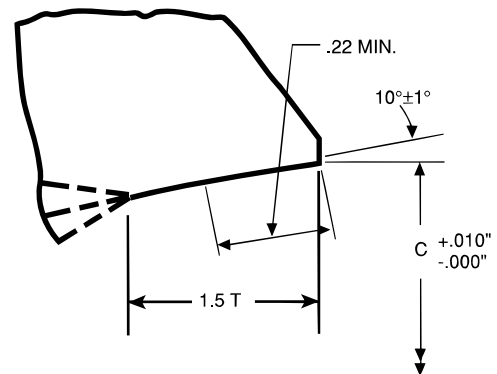## Buttwelding Ends

"**A**" For Wall Thickness (t) .1875" to .875" inclusive (ASME B 16.25 - Fig. 2A, 2B or 4)

"**B**" For Wall Thickness (t) Greater Than .875" (ASME B16.25 - Fig. 3A, 3B)

"**C**" Inside Contour for Use With Rectangular Backing Ring (ASME B16.25 - Fig. 2C, 3C)

"**D**" Inside Contour for Use With Taper Backing Ring (ASME B16.25 - Fig. 2D, 3D)

A – Nominal outside diameter of pipe	**C – A - 0.031" - 1.75t - 0.010"**
B – Nominal inside diameter of pipe	**t – Nominal wall thickness of pipe**

IMPORTANT:
When ordering buttwelding end valves, indicate type of weld prep desired from this page and give pipe schedule to be used from pages A4, A5, A6 or provide other complete instructions.

WARNING!
If weld prep information is not received at time of order placement, scheduled ship dates cannot be guaranteed.

Inside and outside of welding ends of both cast and forged steel valves to be finish machined and carefully inspected where the thickness of these ends is less than 1.15 t.

Flowserve standard practice is to machine the outside of the casting as shown to avoid sharp re-entrant angles and abrupt changes in slope. Runout of machined surface diameter of valve to have no abrupt change in section. Inside diameter of valve may be either larger or smaller than pipe inside diameter.

A3

End Preparation for Forged Steel Valves

Buttwelding Ends

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

NOMINAL PIPE SIZE	PIPE[1] SCH. NO.	FEATURES ARE PER ANSI B16.25							
		A OUTSIDE DIAMETER		B INSIDE DIAMETER		C BORE OF WELDING LIP		t WALL THICKNESS	
		INCHES	MM	INCHES	MM	INCHES	MM	INCHES	MM
½ 15	40	0.840	21	0.622	15.8	0.608	15.4	0.109	2.8
	80			0.546	13.9	0.542	13.8	0.147	3.7
	160			0.464	11.8	0.470	11.9	0.188	4.8
	XXS			0.252	6.4	0.285	7.2	0.294	7.5
¾ 20	40	1.050	27	0.824	20.9	0.811	20.6	0.113	2.9
	80			0.742	18.8	0.740	18.8	0.154	3.9
	160			0.612	15.6	0.626	15.9	0.219	5.6
	XXS			0.434	11.0	0.470	11.9	0.308	7.8
1 25	40	1.315	33	1.049	26.6	1.041	26.4	0.133	3.4
	80			0.957	24.3	0.961	24.4	0.179	4.5
	160			0.815	20.7	0.837	21.3	0.250	6.4
	XXS			0.599	15.2	0.648	16.5	0.358	9.1
1¼ 32	40	1.660	42	1.380	35.1	1.374	34.9	0.140	3.6
	80			1.278	32.5	1.285	32.6	0.191	4.9
	160			1.160	29.5	1.181	30.0	0.250	6.4
	XXS			0.896	22.8	0.951	24.2	0.382	9.7
1½ 40	40	1.900	48	1.610	40.9	1.605	40.8	0.145	3.7
	80			1.500	38.1	1.509	38.3	0.200	5.1
	160			1.338	34.0	1.367	34.7	0.281	7.1
	XXS			1.100	27.9	1.159	29.4	0.400	10.2
2 50	40	2.375	60	2.067	52.5	2.065	52.5	0.154	3.9
	80			1.939	49.3	1.953	49.6	0.218	5.5
	160			1.687	42.9	1.734	44.0	0.344	8.7
	XXS			1.503	38.2	1.571	39.9	0.436	11.1
2½ 65	40	2.875	73	2.469	63	2.479	62.95	0.203	5.15
	80			2.323	59	2.351	59.7	0.276	7
	160			2.125	54	2.178	55.3	0.375	9.55
	XXS			1.771	45	1.868	47.45	0.552	14
3 80	40	3.500	89	3.068	78	3.081	78.25	0.216	5.5
	80			2.900	74	2.934	74.5	0.300	7.6
	160			2.624	67	2.692	68.4	0.438	11.15
	XXS			2.300	58	2.409	61.2	0.600	15.25
4 100	40	4.500	114	4.026	102	4.044	102.7	0.237	6
	80			3.826	97	3.869	98.25	0.337	8.55
	120			3.624	92	3.692	93.8	0.438	11.15
	160			3.438	87	3.530	89.65	0.531	13.5
	XXS			3.152	80	3.279	83.3	0.674	17.1

XXS – Double extra-strong wall thickness.
1 – Designations per ANSI B36.10.

A4

End Preparations for Cast Steel Valves

Buttwelding Ends

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

NOMINAL PIPE SIZE	PIPE¹ SCH. NO.	VALVE² PRESSURE CLASS					FEATURES ARE PER ANSI B16.25							
		300	600	900	1500	2500	A OUTSIDE DIAMETER		B INSIDE DIAMETER		C BORE OF WELDING LIP		t WALL THICKNESS	
							INCHES	MM	INCHES	MM	INCHES	MM	INCHES	MM
2½ 65	40	X	X				2.875	73	2.469	63	2.479	62.95	0.203	5.15
	80	X	X	X	X				2.323	59	2.351	59.7	0.276	7
	160			X	X	X			2.125	54	2.178	55.3	0.375	9.55
	XXS					X			1.771	45	1.868	47.45	0.552	14
3 80	40	X	X				3.500	89	3.068	78	3.081	78.25	0.216	5.5
	80		X	X	X				2.900	74	2.934	74.5	0.300	7.6
	160			X	X	X			2.624	67	2.692	68.4	0.438	11.15
	XXS					X			2.300	58	2.409	61.2	0.600	15.25
4 100	40	X	X				4.500	114	4.026	102	4.044	102.7	0.237	6
	80		X	X	X				3.826	97	3.869	98.25	0.337	8.55
	120			X	X				3.624	92	3.692	93.8	0.438	11.15
	160				X	X			3.438	87	3.530	89.65	0.531	13.5
	XXS					X			3.152	80	3.279	83.3	0.674	17.1
5 125	40	X	X				5.563	141	5.047	128	5.070	128.8	0.258	6.55
	80		X	X	X				4.813	122	4.866	123.6	0.375	9.55
	120			X	X				4.563	116	4.647	118.05	0.500	12.7
	160				X	X			4.313	110	4.428	112.45	10.625	15.9
	XXS					X			4.063	103	4.209	106.9	0.750	19.05
6 150	40	X	X				6.625	168	6.065	154	6.094	154.8	0.280	7.1
	80		X	X	X				5.761	146	5.828	148.05	0.432	10.95
	120			X	X				5.501	140	5.600	142.25	0.562	14.25
	160				X	X			5.187	132	5.326	135.3	0.719	18.25
	XXS				X	X			4.897	124	5.072	128.85	0.864	21.95
8 200	40	X	X				8.625	219	7.981	203	8.020	203.7	0.322	8.2
	60		X						7.813	198	7.873	199.95	0.406	10.3
	80		X	X	X				7.625	194	7.709	195.8	0.500	12.7
	100		X	X	X				7.437	189	7.544	191.6	0.594	15.1
	120			X	X				7.187	183	7.326	186.1	0.719	18.25
	140				X				7.001	178	7.163	181.95	0.812	20.6
	XXS				X	X			6.875	175	7.053	179.15	0.875	22.25
	160				X	X			6.813	173	6.998	177.75	0.906	23
10 250	40	X	X				10.750	273	10.02	255	10.070	255.8	0.365	9.25
	60		X						9.750	248	9.834	249.8	0.500	12.7
	80		X	X	X				9.562	243	9.670	245.6	0.594	15.1
	100		X	X	X				9.312	237	9.451	240.05	0.719	18.25
	120			X	X				9.062	230	9.232	234.5	0.844	21.45
	140				X				8.750	222	8.959	227.55	1.000	25.4
	160				X	X			8.500	216	8.740	222	1.125	28.6
12 300	STD	X	X				12.750	324	12.000	305	12.053	306.15	0.375	9.55
	40	X	X						11.938	303	11.999	304.75	0.406	10.3
	XS	X	X						11.750	298	11.834	300.6	0.500	12.7
	60		X						11.625	298	11.725	297.8	0.562	14.25
	80		X	X	X				11.374	289	11.505	292.25	0.688	17.5
	100		X	X	X				11.062	281	11.232	285.3	0.844	21.45
	120			X	X				10.750	273	10.959	278.35	1.000	25.4
	140				X				10.500	267	10.740	272.8	1.125	28.6
	160				X	X			10.126	257	10.413	264.5	1.312	33.3

STD – Standard wall thickness.
XS – Extra-strong wall thickness.
XXS – Double extra-strong wall thickness.

1 – Designations per ANSI B36.10. 2 – The welding ends of valve bodies do not contain enough extra material to match the wall thickness of all pipe schedules. The "X" marks show the schedules that can be supplied for each size and pressure class of valve bodies. Many Class 1500 and 2500 valves can be machined to accommodate special high-pressure pipe with greater wall thickness and smaller inside diameter than schedule 160; consult your Edward Valves sales representative concerning such cases.

A5

End Preparations for Cast Steel Valves

Buttwelding Ends

Black numerals are in inches and pounds
Colored numerals are in millimeters and kilograms

NOMINAL PIPE SIZE	PIPE[1] SCH. NO.	VALVE[2] PRESSURE CLASS					A OUTSIDE DIAMETER (FEATURES ARE PER ANSI B16.25)		B INSIDE DIAMETER		C BORE OF WELDING LIP		t WALL THICKNESS	
		3000	6000	9000	1500	2500	INCHES	MM	INCHES	MM	INCHES	MM	INCHES	MM
14 / 350	STD	X					14.000	356	13.25	337	13.303	337.9	0.375	9.55
	40		X						13.124	333	13.192	335.1	0.438	11.15
	XS		X						13	330	13.084	332.35	0.5	12.7
	60		X						12.812	325	12.92	328.15	0.594	15.1
	80		X	X	X				12.5	318	12.646	321.2	0.75	19.05
	100		X	X	X				12.124	308	12.318	312.9	0.938	23.85
	120			X	X				11.812	300	12.044	305.9	1.094	27.8
	140				X				11.5	292	11.771	299	1.25	31.75
	160				X	X			11.188	284	11.498	292.05	1.406	35.7
16 / 400	STD	X					16.000	406	15.25	387	15.303	388.7	0.375	9.55
	40	X							15	381	15.084	383.15	0.5	12.7
	60	X							14.688	373	14.811	376.2	0.656	16.65
	80		X	X	X				14.312	364	14.482	367.85	0.844	21.45
	100		X	X	X				13.938	354	14.155	359.55	1.031	26.2
	120			X	X				13.562	344	13.826	351.2	1.219	30.95
	140				X				13.124	333	13.442	341.45	1.438	36.55
	160				X	X			12.812	325	13.17	334.5	1.594	40.5
18 / 450	40	X					18.000	457	16.876	429	16.975	431.15	0.562	14.25
	60	X							16.500	419	16.646	422.8	0.75	19.05
	80	X	X						16.124	410	16.318	414.5	0.938	23.85
	100	X	X	X					15.688	398	15.936	404.75	1.156	29.35
	120			X	X	X			15.250	387	15.553	395.05	1.375	34.95
	140			X	X	X			14.876	378	15.225	386.7	1.562	39.65
	160				X	X			14.438	367	14.842	377	1.781	45.25
20 / 500	40	X					20.000	508	18.812	478	18.92	480.55	0.594	15.1
	60	X							18.376	467	18.538	470.85	0.812	20.6
	80	X	X						17.938	456	18.155	461.15	1.031	26.2
	100	X	X	X					17.438	443	17.717	450	1.281	32.55
	120			X	X	X			17	432	17.334	440.3	1.5	38.1
	140			X	X	X			16.5	419	16.896	429.15	1.75	44.45
	160				X	X			16.062	408	16.513	419.45	1.969	50
22 / 550	STD	X					22.000	559	21.25	540	21.303	541.1	0.375	9.55
	XS	X							21	533	21.084	535.55	0.5	12.7
	60	X	X						20.25	514	20.428	518.85	0.875	22.25
	80	X	X						19.75	502	19.99	507.75	1.125	28.6
	100			X	X	X			19.25	489	19.553	496.65	1.375	34.95
	120			X	X	X			18.75	476	19.115	485.5	1.625	41.3
	140				X	X			18.25	464	18.678	474.4	1.875	47.65
	160								17.75	451	18.24	463.3	2.125	54
24 / 600	STD						24.000	610	23.25	591	23.303	591.9	0.375	9.55
	XS								23	584	23.084	586.35	0.5	12.7
	30	X							22.876	581	22.975	583.55	0.562	14.25
	40	X	X						22.624	575	22.755	578	0.688	17.5
	60	X	X						22.062	560	22.263	565.5	0.969	24.6
	80	X	X	X					21.562	548	21.826	554.4	1.219	30.95
	100	X	X	X					20.938	532	21.28	540.5	1.531	38.9
	120			X	X	X			20.376	518	20.788	528	1.812	46
	140			X	X	X			19.876	505	20.35	516.9	2.062	52.35
	160				X	X			19.312	491	19.857	504.35	2.344	59.55

STD – Standard wall thickness.
XS – Extra-strong wall thickness.
XXS – Double extra-strong wall thickness.

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