CHECK VALVES

TECHNICAL CATALOGUE

GOODWIN INTERNATIONAL LTD

Dual Plate

Axial

www.checkvalves.co.uk

Goodwin International
Company Overview

Goodwin International is globally recognised and approved for its design, manufacture and supply of Dual Plate Check Valves and Axial Check Valves to the world's hydrocarbon, energy and process industries.

Located in the heart of England in Stoke-on-Trent, Goodwin International is an engineering company of diverse skills, capabilities and products, and is a wholly owned subsidiary and member of the Goodwin PLC group of companies. The Group's core activities lie in engineering, refractories and investment powders and is trans-global in its activities.

The history and pedigree of Goodwin dates back to 1883. The initial company established in that year was its foundry, Goodwin & Sons. The foundry exists to this day operating under the name of Goodwin Steel Castings, and is one of the foremost nickel alloy foundries in Europe. It too is located in Stoke-on-Trent.

Publicly quoted on the London Stock Exchange, Goodwin PLC is family managed. Currently the group is headed by the fifth generation of the Goodwin family with members of the sixth generation now in management positions within its operating companies.

With over 1.5 million valves in service from over 35 years of supply to the global hydrocarbon, energy and process industries, Goodwin International Ltd provides a comprehensive level of customer service supported by a comprehensive representative network and its own overseas offices in Brazil, Dubai, Korea, China and Japan.

Goodwin International

Goodwin Steel Castings

Company Commitment...

To maintain an underlying commitment to engineering by investing in the design, manufacture and sale of technically advanced products.

The company's philosophy is to supply well designed products fit for purpose that are internationally competitive, whilst being superior to our competitors' be it by product performance or efficiency always ensuring the highest level of quality in everything we do.

Through investment in its people and markets the company aims to maintain its market position, to become a world leader in its technologies and provide exemplary customer service.

Matthew Goodwin
Managing Director

Pioneers in Check Valve Innovation

Goodwin International, by having two check valve products, the Goodwin Dual Plate Check and the Goodwin Non-Slam Axial Check Valve, can offer a cost effective solution to meet the vast majority of customer requirements and applications.

Dual Plate Check Valves

The Dual Plate Check Valve is widely accepted as the "check valve of choice" for new build hydrocarbon, energy and process projects by end-users and engineering contractors alike.

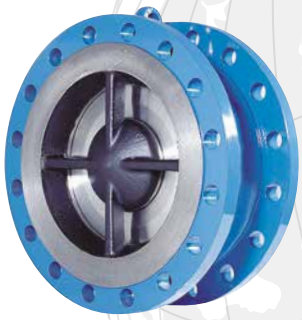
The Goodwin Dual Plate Check Valve is used in standard, regular, "bulk" applications where unwanted phenomena such as "slam" and "waterhammer" are not anticipated. It is available in different body styles to meet customers' specifications.

Axial Check Valves

The Non-Slam Axial Check Valve is the next level in check valve technology. It is specifically used for those critical /severe applications where reliability and high performance are an absolute necessity. Its speed of response and dynamic behaviour is such that unwanted phenomena such as "slam" and "waterhammer" are prevented from occurring.

The Goodwin Non-Slam Axial Check Valve is available in solid disc and ring disc designs.

The Goodwin Dual Plate and Non-Slam Axial Check Valves are complementary check valves enabling Goodwin International to address almost all check valve applications.



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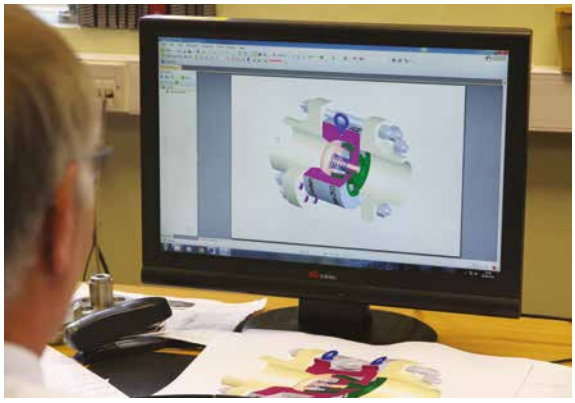
GOODWIN INTERNATIONAL LTD

Goodwin International:
Facilities & Resources

Goodwin International's Check Valve manufacturing plant in Stoke-on-Trent, England, comprises a well equipped CNC machine shop with full design, fabrication, inspection and test facilities. These facilities are complemented by sister company Goodwin Steel Castings Ltd, a world class foundry. It was the first steel foundry worldwide to be registered by the British Standards Institution to BS5750 (now BS EN ISO 9001) and is also accredited to ISO14001 and OHSAS 18001.

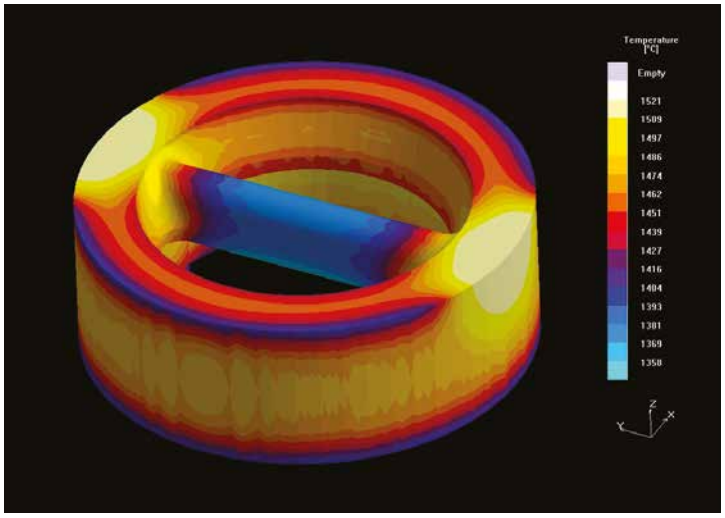
Specialising in producing high integrity pressure vessel castings from a few kilos to 18,000 kg in weight, the materials cast by Goodwin Steel Castings include carbon and low alloy steels, chrome steels, stainless steels, duplex stainless steels and super nickel alloys such as Hastelloy® and Alloy 625. Its ability to produce the special alloys is enhanced by its in-house 10 tonne AOD refining furnace.

Goodwin Steel Castings models all cast valve bodies using SOLIDWORKS® 3D Modelling. Casting methods are verified, i.e. method verification, using Magmasoft™ software.The Magmasoft™ program includes fluid dynamics, temperature profile, and x-ray simulation to predict where volumetric defects will occur in a given casting. Using this software enables defects to be "engineered out" by developing casting feeding and gating designs to ensure "right first time" production of high integrity castings. This optimisation process is a key feature of Goodwin Steel Castings' Quality Assurance System.



CAD facilities in Goodwin design office

12 tonne induction holding furnace at Goodwin Steel Castings



Magmasoft™ temperature profile

Super Duplex valve bodies with representative sized keel blocks undergoing heat treatment (From furnace to quenching in under 30 seconds)

Two station CNC vertical borer with live spindle and tool changer

Cryogenic test facility for helium leak testing

Goodwin International's BS EN ISO 9001 accredited design, machine, test and assembly bays cover some 30,000 m². The machine shop is equipped with 46 modern CNC machine tools, including robotic welding, which are the core of the valve production. These are further supplemented by a large number of conventional machine tools.

Valve design is carried out using 3D CAD and is verified on computers utilizing finite element analysis and Flow Simulation programs.

The test facilities include six hydraulic hydrostatic test rigs, the largest of which has a 2500 tonne hydraulic ram and can test valves up to 60". Cryogenic testing is also carried out on site where valves are submerged in liquid nitrogen at -196°C and leak tested with helium gas.

In addition to buying material from its own foundry, Goodwin International buys material on a global basis from a small number of foundries and forges with which it has long term association. All are ISO 9001 registered. To ensure its commitment to quality Goodwin has full-time in-country employees in the countries outside of Europe from which it sources to continually audit the quality of material sourced.

2500 tonne hydraulic test rig in Goodwin assembly bay

Twin pallet CNC machining centre with 60 tool changer

Goodwin International:
Certification & Testing

A Quality Management System registered by BSI in accordance with BS EN ISO 9001 is maintained.

The Standard GOODWIN Check Valve features:-

- Designed, manufactured, assembled and tested in accordance with Quality Assurance System registered by BSI to BS EN ISO 9001.
- Designed and tested to API 594, API 6D or "manufacturer's standard" (dependent on product).
- All bodies and plates/discs certified to BS EN 10204 3.1 as a minimum.
- All new castings are sample approved by dimensional checks (wall thickness etc.) and radiography, 100% coverage to ASTM E446/E186, Level 2 minimum, or ultrasonic testing to ASTM A609, Level "A".
- Surface finish to MSS SP 55 on cast components.
- Traceablilty per melt (not batch of ingot) is maintained throughout all manufacturing processes for bodies, plates/discs and trim.
- All valves are hydrostatically tested (Shell and Seat) to API 598 with unique traceability to certification.
- Firetest approved and certified to ISO 10497, API 6FA & API 6FD for pressure classes ASME 150 to ASME 2500.
- Additional testing to be specified on the enquiry and Purchase Order.

Extensive in-house testing and laboratory facilities are available including:

- Hydrostatic Pressure Testing to 25000 psig (1725 barg)
- High Pressure Gas Testing to 20000 psig (1380 barg)
- Low Temperature (-46°C) and cryogenic temperature (-196°C) Pressure Testing
- High Temperature Pressure Testing to 550°C
- Helium Leak Testing (Mass Spectrometer)
- Tensile / Bend / Impact / Hardness Testing (ISO 17025 Accredited)
- Corrosion Testing
- Metallography
- Magnetic Particle
- Dye Penetrant
- Ultrasonic Examination
- Radiography
- Chemical Analysis
- Alloy Verification / Positive Material Identification (PMI)
- Co-ordinate Measuring Machines (CMM)
- Feritscope Verification
- Laser Measurement

Other examination Methods or Acceptance criteria to comply with the customer's own specification may be substituted if agreed with the Company at the time of quotation.

Radiography

Radiography is conducted in-house using Dual Voltage 6/9 MeV Linear Accelerator X-Ray machine with developing and viewing facilities.

Method	ASME V Art 2 or ASME B16.34 App 1
Options	100% of All castings 100% of 10% of castings Critical Areas* of All castings Critical Areas* of 10% of castings
Acceptance	ASME VIII Div 1 App 7 or ASME B16.34 App 1

*Critical Areas as defined by ASME B16.34

The Company's operators for all forms of Non-Destructive Testing are qualified to ASNT Level 2 or PCN Level 2.

Magnetic Particle / Dye Penetrant

Method	MPI to ASME V Art 7 or ASME B16.34 App II DPI to ASME V Art 6 or ASME B16.34 App III
Options	1. 100% of All castings/forgings 2. 100% of 10% of castings/forgings 3. 100% of all machined surfaces
Acceptance	MPI to ASME VIII Div 1 App 7 or ASME B16.34 App II DPI to ASME VIII Div 1 App 7 or ASME B16.34 App III

Magnetic Particle / Dye Penetrant

Ultrasonic Examination

Method	ASME V Art 5 or ASME B16.34 App IV
Options	1. 100% of All castings/forgings 2. 100% of 10% of castings/forgings 3. Critical Areas* of All castings/forgings 4. Critical Areas* of 10% castings/forgings
Acceptance	ASME B16.34 App IV

*Critical Areas as defined by ASME B16.34

Ultrasonic Examination

Chemical Analysis

- Routine chemical analysis by one of two optical emission spectrometers: Hilger 28 Channel Spectrometer and ARL 35 channel spectrometer
- Carbon, Sulphur, Nitrogen and Hydrogen determination by a combination of Leco and Eltra combustion analysers
- Oxygen determination by Celox direct measurement
- Portable PMI (Positive Material Identification) by XRF hand held analyser
- Typical material analysed:
  - Carbon/Low Alloy Steels/Chrome Steels
  - Stainless/Duplex/6Mo Steels
  - Nickel alloys
  - Cobalt alloys

Chemical Analysis

Corrosion Testing & Metallography

- Intercrystalline corrosion
- Strauss and Huey tests
- Crevice corrosion
- Pitting corrosion
- Typical Standards - ASTM G48, A262, G31, G36, A923
- Ferrite counting
- Phase checks
- Grain size/inclusion counts
- Macro and Micro photography
- Typical Standards - ASTM E562, E112, E45
- Scanning Electron Microscope

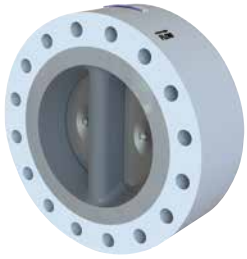
Corrosion Testing & Metallography

GOODWIN INTERNATIONAL LTD

Goodwin International
Dual Plate Check Valves - Types

Wafer
Type BR

Flanged
Type BFR



Solid Lug
Type BSR

Buttweld End
Type BWR

Buttweld End with Access
Type BWA

Hub-End
Type BHR

6 Different Body Styles

Wafer (BR)
Flanged (BFR)
Solid Lug (BSR)
Buttweld End (BWR)
Buttweld End with access (BWA)
Hub-End (BHR)

Sizes

2″ - 144″ (50mm - 3600mm)

Pressure Classes

ASME 150 - 2500
API 2000 - 20000
PN 10 - PN 400
JIS 10K & 20K (available on request)

Materials

Ductile and Ni-Resist® Irons
Carbon Steels; Stainless Steels
Duplex Stainless Steels
Aluminium Bronzes
High Nickel Alloys
Titanium

Features

Designed, manufactured, assembled and tested in accordance with Quality Assurance System accredited by BSI to BS EN ISO 9001.

Certifiable in compliance with European Pressure Directive (PED) 2014/68/EU and/or ATEX Directive 2014/34/EU to meet customer requirements when specified.

Designed and tested to API 594 / API 6D

All bodies and plates certified to BS EN 10204 3.1 as a minimum.

Retainerless design as standard. No screwed body plugs - no leakpath to atmosphere - no fugitive emissions.

Firetested design. Firetest approved and certified to BS EN ISO 10497, API 6FA and API 6FD.

Dual Plate Check Valves
Technical Features & Benefits

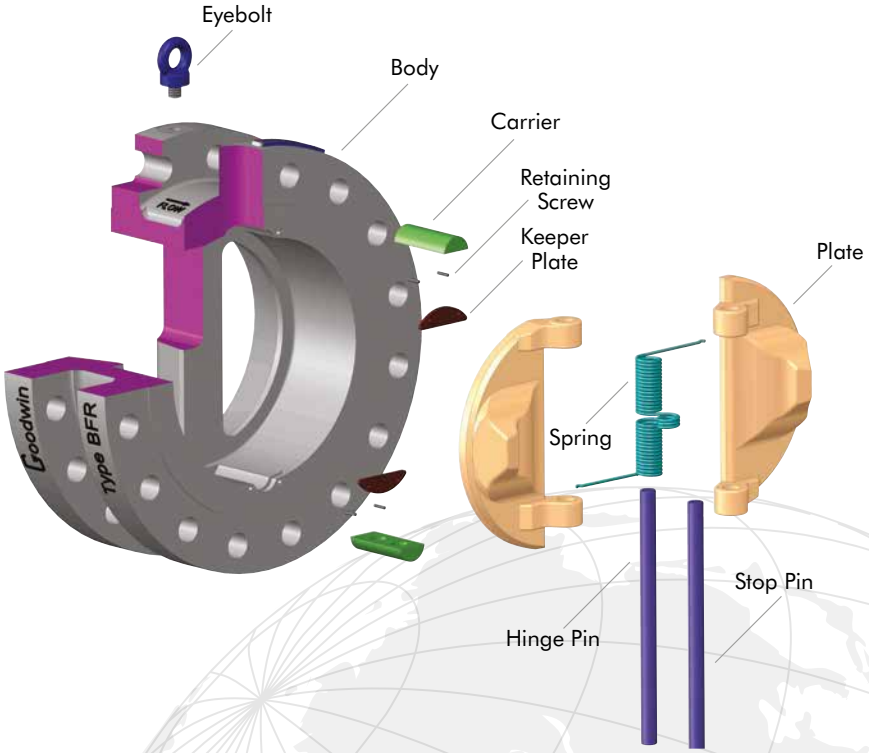
Retainerless Design

Goodwin International first offered a retainerless design in the mid-1980s with its current design being in use since the mid-1990s . "Retainerless" has subsequently become an industry standard for dual plate check valves throughout the hydrocarbon, energy and process industries.

Goodwin Dual Plate Check Valves are offered as "retainerless" as standard* in its wafer, flanged, hub-end and buttweld end body styles. Having no screwed body plugs, and an unbroken pressure envelope, the Goodwin retainerless design provides:

- Higher integrity pressure vessel than "retainered" designs
- Fugitive emission free design
- No thread corrosion risk (as in "retainered" designs with screwed body plugs)
- Tamperproof Design
- No plug blow out risk
- Ease of disassembly - only an Allen Wrench required

There is no intrusion into the gasket sealing element surface by the retaining mechanism on Goodwin Dual Plate Check Valves.



* RETAINING PLUGS: On occasion, for technical reasons, e.g. compact flange and lined types, out of design necessity, Goodwin will provide its Dual Plate Check Valve with retaining plugs. Retaining plugs have been successfully utilised on Dual Plate Check Valves for over 50 years but, obviously, do not afford the same high integrity as retainerless design.

Dual Plate Check Valves
Slim Plate Design

Goodwin International's unique slim plate design gives improved flow efficiencies, lower seat leakage rates and faster response than are achievable with the traditional "flat" plate design employed by Goodwin's competitors.

Improved Flow Efficiencies

Benefits of the Goodwin slim plate include;

- Less restriction to flow in the full open position
- Larger throat areas in higher pressure class valves
- Less constriction to flow on the downstream side of the valve

All these factors contribute to a higher flow coefficient (C_V values) resulting in increased flow and/or lower pressure loss.

The images to the right show the substantially greater flow area through a Goodwin Dual Plate Check Valve compared with that of a major international competitor. The graph shows in value terms the greater pressure loss experienced in the competitor's valve. Higher pressure loss means higher energy costs resulting in high Total Life Cycle costs.

Lower Seat Leakage Rates - Metal to Metal Seats

The Goodwin slim plate exhibits differential stiffness which permits the centre of plate to remain rigid whilst the edges of the plate flex. With the plates closed, the geometry of the plate is such that the back pressure pushes the plate sealing surface onto the valve body sealing surface. This gives a far superior sealing performance compared to the traditional "flat" plate design.

Dual Plate Check Valves are tested to API 598 which for metal to metal seats has a permitted seat leakage of 3cc/inch of bore/minute with water. With the Goodwin slim plate design leakage rates of 1.5 cc/inch of bore/minute are achievable as standard. Near zero leakage can be economically achieved with metal-to-metal seats which is particularly useful on cryogenic or high temperature gas applications where it is not possible to use resilient seats.

In contrast to other dual plate check valves the seat sealing characteristics of the Goodwin valve are enhanced as line pressure increases unlike competitors' valves which can significantly deteriorate in higher pressure classes.

Faster Response Times

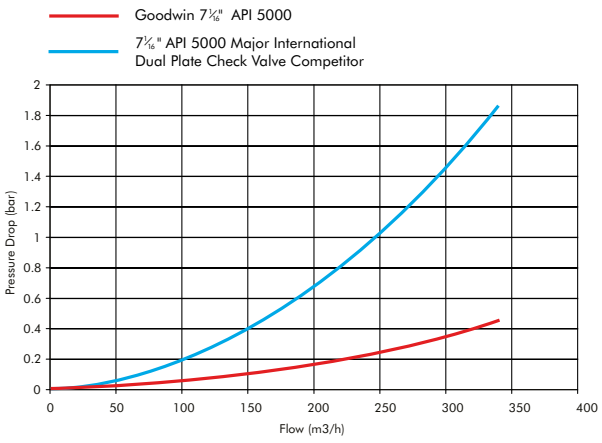
The Goodwin plate, by virtue of its design, has a lower mass; typically a Goodwin ASME 2500 plate weighs less than competitors' ASME 300 plates. This factor decreases both the inertia of the plates and the friction at the plates hinges providing an opportunity to improve the valve response time.

Flow areas through valves viewed from upstream

Goodwin Slim Plate

Competitor "Flat" Plate

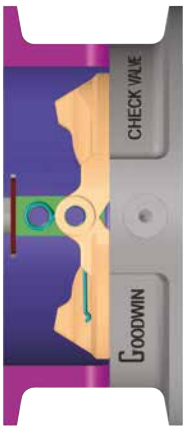
Pressure Loss Curve:
Goodwin vs Major International Competitor



Dual Plate Check Valves
Seat Life

Increased seat life is obtained by eliminating the problem of the plates dragging on the seat when opening. Due to the clearance between the plate hinge and the hinge pin, the heel of the plate lifts with the initial flow as the foot of the spring acts beyond the centre of pressure of the plate.

As the flow then increases through the valve the plates open without the heels of the plate scuffing the body seat.



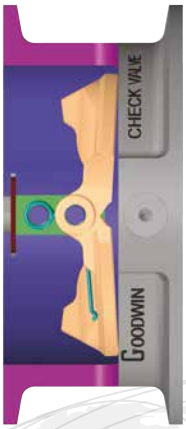
Plates closed

Plate Shock Bumpers

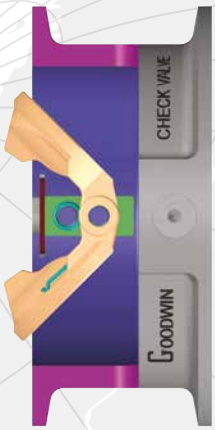
Goodwin's slim plate incorporates in its geometry a plate bumper at the centre of mass of the plate. When the valve opens, the bumpers of the plates collide creating an equal and opposite force acting on the plates preventing significant bending moments acting on the hinge pin of the plate thereby prolonging valve life.

It is an accepted fact that there will be occasions when the plates do not arrive fully open at the same instance. Clearance on the bumper allow and ensure the plates hit each other rather than the stop pin. This helps prevent damaging forces being exerted on the stop pin and the subsequent risk of a plate going over the central axis of the valve and leaving one port open in the event of a flow reversal.

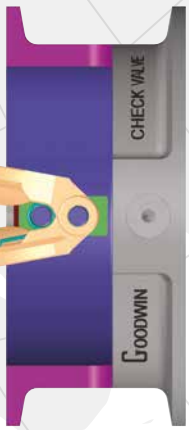
Plate bumpers are standard on all sizes, pressure classes and types of Goodwin Dual Plate Check Valves.



Heel lift prior to plate rotation

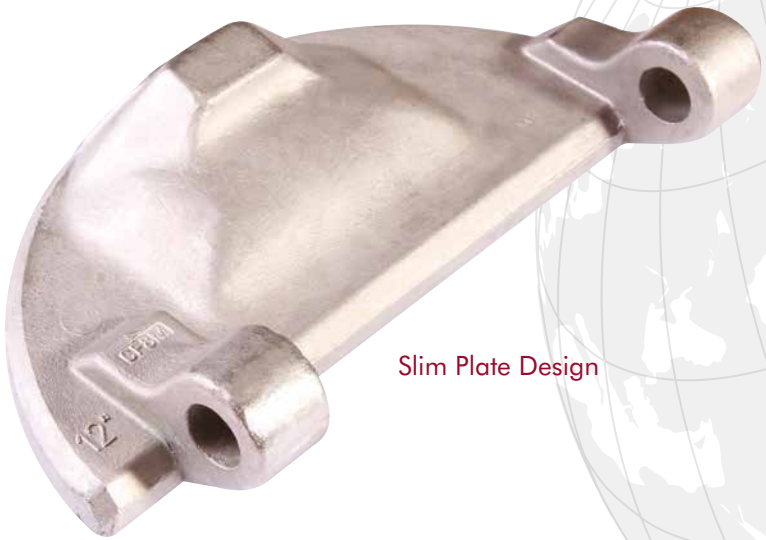


Plates opening - no seat scuffing



Plates fully open - disc shock bumpers meet

NB - for illustration purposes only. When installed in horizontal pipeline, hinge pins should be vertical.



Slim Plate Design

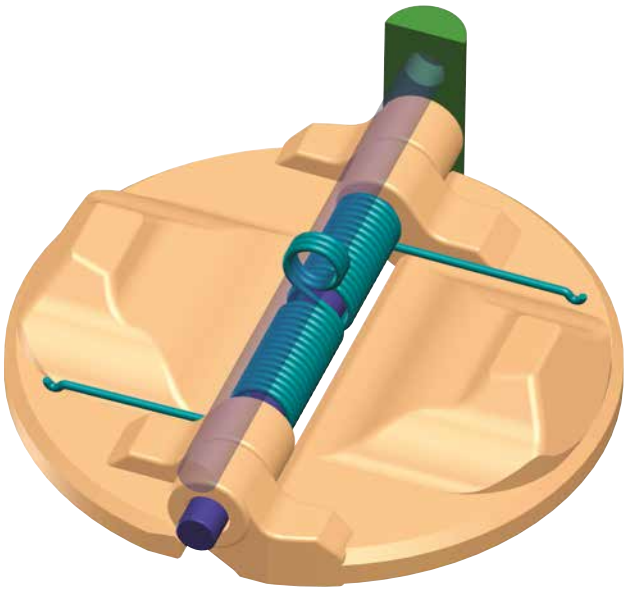
GOODWIN INTERNATIONAL LTD

Dual Plate Check Valves
Independent Plate Closing Action

With coils around the hinge pin, the Goodwin spring acts as two independent springs. The spring action optimises the equal closing rates of each plate especially when friction coefficients are uneven due to one plate resting upon another.

The springs have been designed to ensure stresses are kept to a level so that the spring should have a theoretical infinite life.

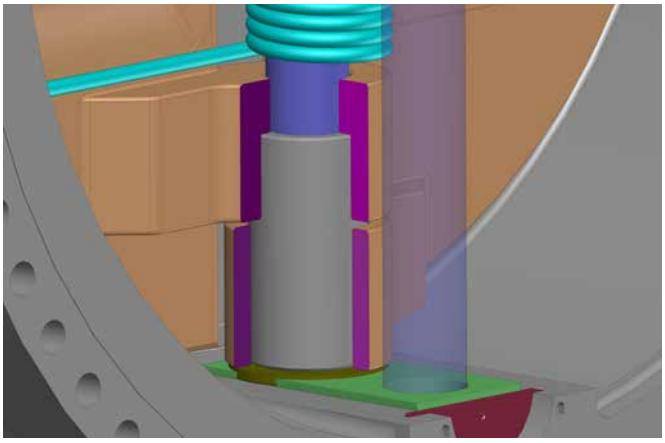
Spring designs utilised in Goodwin valves have undergone accelerated laboratory testing and are proven to be capable of operating over 2,000,000 cycles without failure.



Independent Plate Suspension

In sizes 24" and larger (exception: 24" ANSI 150), Goodwin employs Independent Plate Suspension in its Dual Plate Check Valves. In these larger sizes and higher pressures, the weight of the plates are such that the frictional contact on the lower hinges inhibit the speed of response in both opening and closing of the valve.

To ensure the faster speed of response provided by the Goodwin slim plate in the larger valves, frictional contact between the hinges is eliminated by mounting the plates independent of each other.



Firetest Certified

Goodwin International has had firetests conducted on a number of resilient and metal seated valves by an independent facility, witnessed by Lloyds Register of Shipping, and is approved and certified firesafe for all sizes in pressure classes ASME 150 to ASME 2500. The valves tested met the performance requirements stated in the following standards:

BS EN ISO 10497: Testing of Valves
Fire type-testing requirements

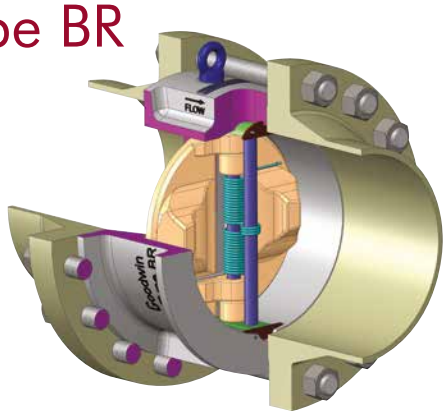
API 6FA 2nd Edition 15th February 1994
Specification for Firetest for Valves

API 6FD 1st Edition 15th February 1995
Specification for Fire Test for Check Valves

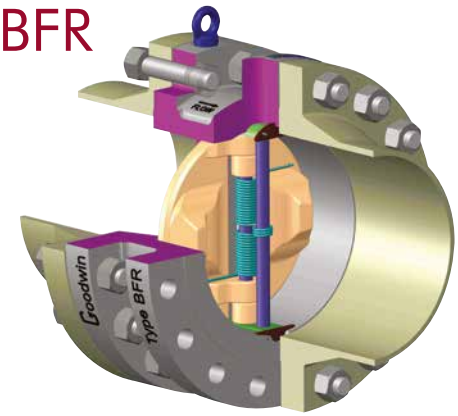
8" 1500# BSR Solid Lug Check Valve undergoing fire test

Dual Plate Check Valve
Installation Between End Connections

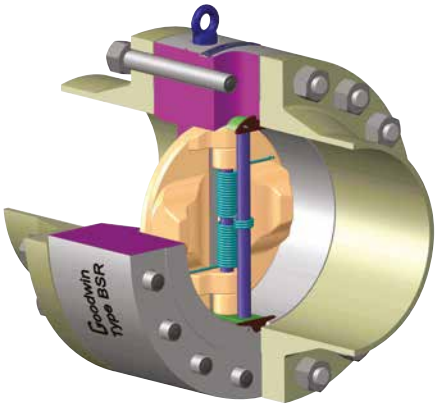
Wafer
Type BR



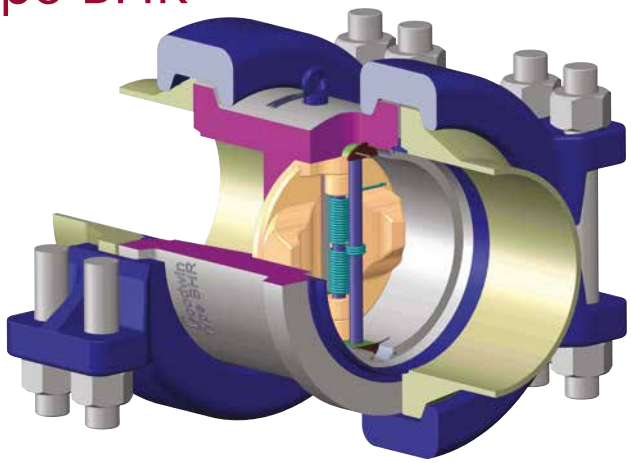
Flanged
Type BFR



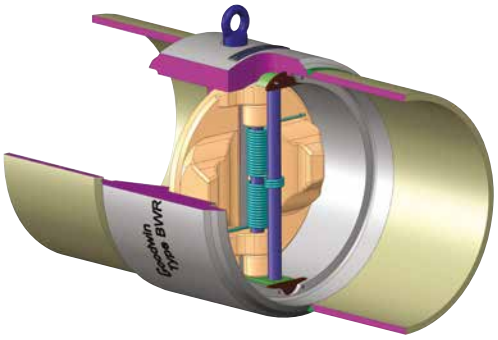
Solid Lug
Type BSR



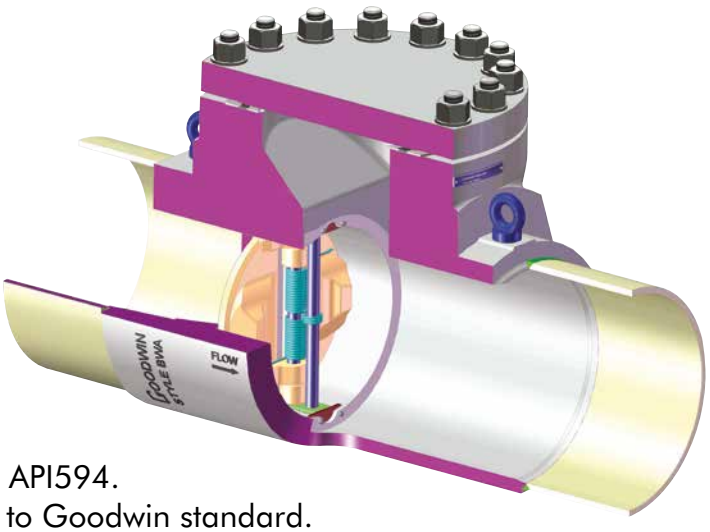
Hub-End
Type BHR



Buttweld End
Type BWR



Buttweld End with Access
Type BWA



BR, BFR and BSR have face-to-face dimensions to API594.
BH, BHR, BWR and BWA face-to-face dimensions to Goodwin standard.

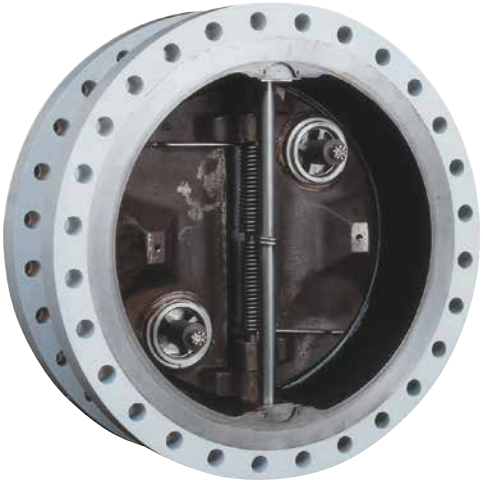
Dual Plate Check Valves
Anti Pressure Surge (For ASME 150 Valves)

A Design for Severe Pump Applications

In pump applications where pressure surge and water hammer problems are anticipated, correct check valve selection is critical. Historically, process and piping engineers when confronted with high system decelerations have opted for either the axial check valve or the damped swing check valve or swing check valve with bypass.

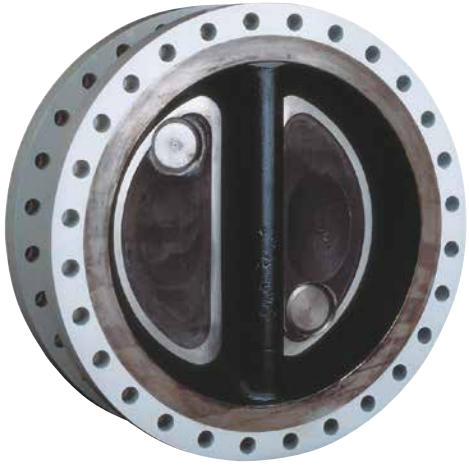
The Axial Check Valve is usually the selection of choice as the two swing check valve options suffer from not only high cost, size and weight but are, generally, a maintenance problem. Similarly the Axial Check Valve is comparatively high cost against the Dual Plate Check Valve. However, Goodwin, with its APS# device, offers the process and piping engineers the lower cost option of using the Dual Plate Check Valve in higher system decelerations than were previously acceptable.

Goodwin can calculate and determine the dynamic performance of its check valves for given system decelerations. Where the demands of the application are beyond the capabilities of the standard Goodwin check valve, Goodwin can employ its APS device. The APS device extends the suitability of the Goodwin Dual Plate Check Valve into those higher system deceleration pump applications where, in the past, only axial or damped swing check valves could be considered.



32" ASME 150 Dual Plate Check Valve with APS, as viewed from valve downstream side.

Patented



32" ASME 150 Dual Plate Check Valve with APS, as viewed from valve upstream side

APS stands for Anti Pressure Surge and is effected in the Goodwin Dual Plate Check Valve by fitting a pressure-sensitive flow-relieving valve in each plate. Essentially, the APS consists of a large piston valve held closed by Belleville washers whose pre-set load will not allow flow through the piston valve from the downstream side of the check valve until the downstream pressure exceeds by 10% the maximum static flow pressure on the downstream side of the valve.

The main function of the APS is not to relieve high pressure but to prevent it from occurring in the first place. It does this by allowing flow which releases excess pressure energy from the downstream side of the valve as the pressure increases on valve closure to the upstream of the valve thereby avoiding the occurrence of full downstream pressure increase. This downstream pressure increase is caused by the instantaneous halt of the column of fluid when the check valve closes and was determined in 1898 by Joukowsky who formulated the equation:

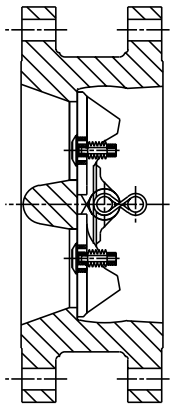
$$\text{Pressure rise} = \text{Speed of sound in the fluid line} \times V_r \text{ max} \times \text{Fluid density}$$

(where V_r max is the maximum reverse velocity of the fluid and is a function of the system deceleration and check valve type).

Tests carried out at the Delft Hydraulics Laboratory in the Netherlands recorded a 40% reduction in the Joukowsky pressure that would have been seen in any check valve not fitted with APS had the same reverse flow velocity occurred.

The Cost Effective Solution

With its compact design, low critical velocity and low pressure loss, the Goodwin Dual Plate Check Valve with APS, provides the piping engineer with a cost effective solution to the more costly alternatives of the axial check and damped swing check valves.



Schematic of a 32" ASME 150 valve with APS

When to use the Goodwin Dual Plate Check Valve with APS

The APS device will minimise pressure surge associated with high deceleration systems to a safe level thereby protecting downstream pipework against over-pressurisation and potential rupture as might be experienced with GRP pipe. It will also eliminate the waterhammer that would occur in a check valve without APS.

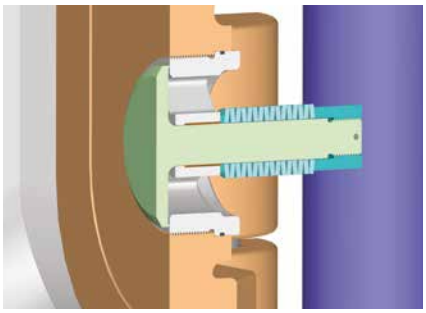
However, the APS device will not minimise the slam forces that occur with rapid closure of the plates. These forces can be calculated by Goodwin for a customer to determine if within acceptable limits. If these limits are exceeded, then Goodwin can offer its Axial Check Valve to eliminate those slam forces.

The APS can be fitted in all Goodwin Check Valves 12" and larger in pressure class ASME 150.

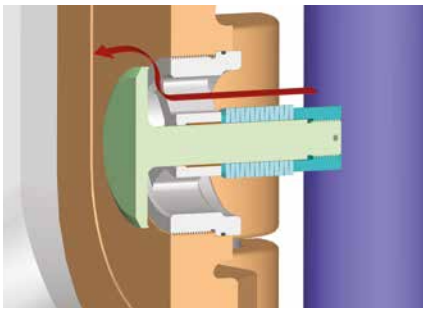
Goodwin requires the following data to establish if its check valve should be fitted with the APS device to meet the demands of its application:

- Valve Size & Pressure Class
- Fluid
- Fluid Density
- Flowrate
- Line Operating Pressure
- Line Design Pressure
- Temperature
- Line Velocity
- System Deceleration
- Downstream pressure in the no flow condition, i.e. when the plates are closed

Patented.

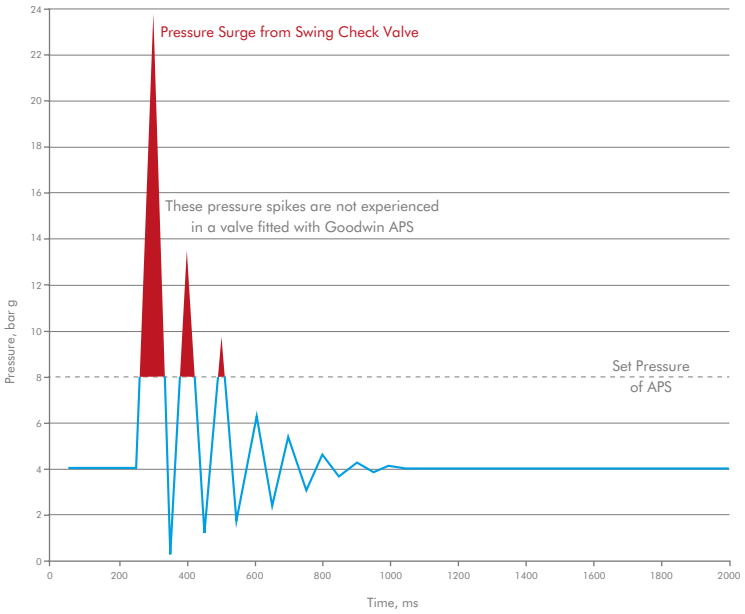


Forward Flow - APS closed



Pressure Surge - APS opens

Surge Pressure Graph Comparison



GOODWIN INTERNATIONAL LTD

Dual Plate Check Valve: Ordering Instructions

EXAMPLE

Type	Valve Size	Flange Standard	ASME/API Pressure Rating		Body Material	Plate Material	Body Seat	Plate Seat	End Connection	Special Feature	Spring Material	Wetted Parts
BR	30	B	015	-	C	S	W	P	R	X	Y	S

* 'R' in the valve type code indicates Retainerless

VALVE TYPE

BR	Wafer
BFR (BFT)	Flanged (BTF: Threaded)
BSR (BTR)	Solid Lug (BTR: Threaded)
BHR (R)	Hub Ended Reduced Bore (R)
BHR (F)	Hub Ended Full Bore (F)
BH (F)	Hub Ended Full Bore (F)
BWR (BWA)	Buttweld End
BL	Wafer - Lined (Retaining Plugs)
BFL	Flanged - Lined (Retaining Plugs)
BSL	Solid Lug - Lined (Retaining Plugs)
BC	Wafer - Clad (Retainerless)
BFC	Flanged - Clad (Retainerless)
BSC	Solid Lug - Clad (Retainerless)
BD	Wafer - Clad (Retaining Plugs)
BFD	Flanged - Clad (Retaining Plugs)
BSD	Solid Lug - Clad (Retaining Plugs)

VALVE SIZE

Inches: For ASME, AWWA & API Standards

FLANGE STANDARD

FIG	STANDARD
-	ASME B16.5
-	ASME B16.47 Series A (MSS SP 44)
B	ASME B16.47 Series B (API 605)
D	AWWA C207 Class D
E	AWWA C207 Class E
F	Hub End - Full Bore Internals
R	Hub End - Reduced Bore Internals
J	JIS 2210
V	Norsok L-005

ASME/API PRESSURE RATINGS

FIG	PRESSURE RATINGS
015	150
030	300
060	600
090	900
150	1500
250	2500
200	2000
300	3000
500	5000
100	10000

BODY AND/OR PLATE MATERIAL

FIG	MATERIAL	SPECIFICATION CAST	SPECIFICATION FORGED
C	Carbon Steel	ASTM A216 WCB	ASTM A105
L	Low Temp Carbon Steel	ASTM A352 LCB	-
O	Low Temp Carbon Steel	ASTM A352 LCC	ASTM A350 LF2
D	High Temp Cr Mo Steel	ASTM A217 WC6	ASTM A182 F11-2
K	Low Alloy Steel	ASTM A487 GR 4C	-
E	410 Stainless Steel	ASTM A217 CA15	ASTM A182 F6
P	5% Cr Steel	ASTM A217 C5	ASTM A182 F5a
W	9% Cr Steel	ASTM A217 C12	ASTM A182 F9
G	Low Temp 13% Cr 4% Ni	ASTM A352 CA6NM	ASTM A182 F6NM
S	316 Stainless Steel	ASTM A351 CF8M	ASTM A182 F316
F	316L Stainless Steel	ASTM A351 CF3M	ASTM A182 F316L
Y	347 Stainless Steel (High Temp)	ASTM A351 CF8C	ASTM A182 F321
Q	22% Chrome Duplex	ASTM A890 4A or A995 4A	ASTM A182 F51
B	25% Chrome Super Duplex	ASTM A995 CD4MCuN	-
Z	25% Chrome Super Duplex	ASTM A890 6A or A995 6A	ASTM A182 F55
H	Alloy 825	ASTM A494 CU5MCuC	ASTM B564 N08825
I	Alloy 625	ASTM A494 CW6MC	ASTM B564 N06625
V	Avesta 254 SMO®	ASTM A351 CK3MCuN	ASTM A182 F44
U	Cobalt Alloy 6 / Stellite® 6	Cobalt Alloy 6 / Stellite® 6	-
T	Titanium	ASTM B367 C2	ASTM B381 F2 / B348 GR2
J	Hastalloy C276®	ASTM A494 CW12MW	-
M	Monel	ASTM A494-M35-2	ASTM B564 N04400
A	Nickel Aluminium Bronze	BS EN 1982 CC333G / ASTM B148 C95800	-
1	Chromium Molybdenum Steel	ASTM A217 GR WC9	ASTM A182 F22-3
2	3.5% Nickel Steel	ASTM A352 LC3	ASTM A350 LF3
3	304 Stainless Steel	ASTM A351 CF8	ASTM A182 F304
4	304L Stainless Steel	ASTM A351 CF3	ASTM A182 F304L
5	Alloy 20	ASTM A351 CN7M	ASTM B462 N08020
6	317 Stainless Steel	ASTM A351 CG8M	ASTM A182 317
7	Carbon Molybdenum Steel	ASTM A352 LC1	-
8	Ni Resist® Iron	ASTM A439 D2	-
9	Ductile Iron	ASTM A395	-
X	To Be Specified	TO BE SPECIFIED	-

Cast or Forged option is at manufacturer's discretion

LINED VALVES - Valves can be supplied with various linings, such as Neoprene®, Chloroprene®, Chlorobutyl, EPDM, Chemonit 33 (lined valves have retaining plugs).

CLAD VALVES - Valves can be supplied with various internal claddings such as Inconel 625 & 825.

† Suitability will depend, in part, on operating temperature range of base material

BODY SEAT/PLATE OVERLAY MATERIAL

FIG	MATERIAL	OPERATING TEMP RANGE † °F	°C
P	Same as Body / Plate	As Body / Plate	As Body / Plate
E	410 Stainless Steel	- 20 to 1000	- 29 to 538
S	316 Stainless Steel	- 425 to 1000	-254 to 538
F	316L Stainless Steel	-425 to 850	-254 to 455
G	17-4 PH Stainless Steel	-40 to 800	-40 to 427
I	Alloy 625		
M	Monel 400	-321 to 900	-196 to 482
U	Cobalt Alloy 6 / Stellite 6®	-450 to 1500	-267 to 815
J	Viton GLT®	-22 to 400	-30 to 204
V	Viton A®	-40 to 400	-40 to 204
W	Viton B® Anti Explosive Decompression FR58 90	-4 to 392	-20 to 200
N	Buna-N®	-22 to 250	-30 to 121
T	Neoprene®	-40 to 250	-40 to 121
K	Teflon®	-200 to 450	-129 to 232
D	EPDM	-14 to 230	-10 to 110
L	Elast-O-Lion 985	-40 to 320	-40 to 160
9	Cobalt Alloy 21 / Stellite No 21®	-450 to 1500	-267 to 815
X	To Be Specified	Material Dependent	

END CONNECTION

FIG	CONNECTION
Q	Raised Face 3.2 µm max. Sprial Groove
R	Raised Face 3.2-6.3 µm Spiral Groove
S	Raised Face 6.3-12.5 µm Spiral Groove
F	Flat Face 3.2-6.3 µm Spiral Groove
G	Flat Face 6.3-12.5 µm Spiral Groove
E	Raised Face 3.2 µm max. Concentric Groove
D	Raised Face 3.2-6.3 µm Concentric Groove
C	Raised Face 6.3-12.5 µm Concentric Groove
A	Flat Face 3.2-6.3 µm Concentric Groove
Z	Flat Face 6.3-12.5 µm Concentric Groove
J	Ring Type Joint
H	Clamped End
W	Buttweld End
V	Compact Flange

SPECIAL FEATURES

-	No Special Features
X	To be specified in order and inquiry text
/	NACE
S	Super Torque Spring
L	Low Torque Spring
M	Mini Torque Spring

SPRING MATERIAL

FIG	MATERIAL	RECOMMENDED MAX TEMP °F	°C
S	316 Stainless Steel	570	300
Y	Inconel X750®	1022	550
I	Inconel 625®	392	200
M	Monel K500®	500	260
L	Inconel 718®	1022	550
T	Titanium Ti 6AL4V	662	350
E	Elgiloy	840	450
J	Hastelloy C276	750	400
X	To Be Specified		

WETTED PARTS*

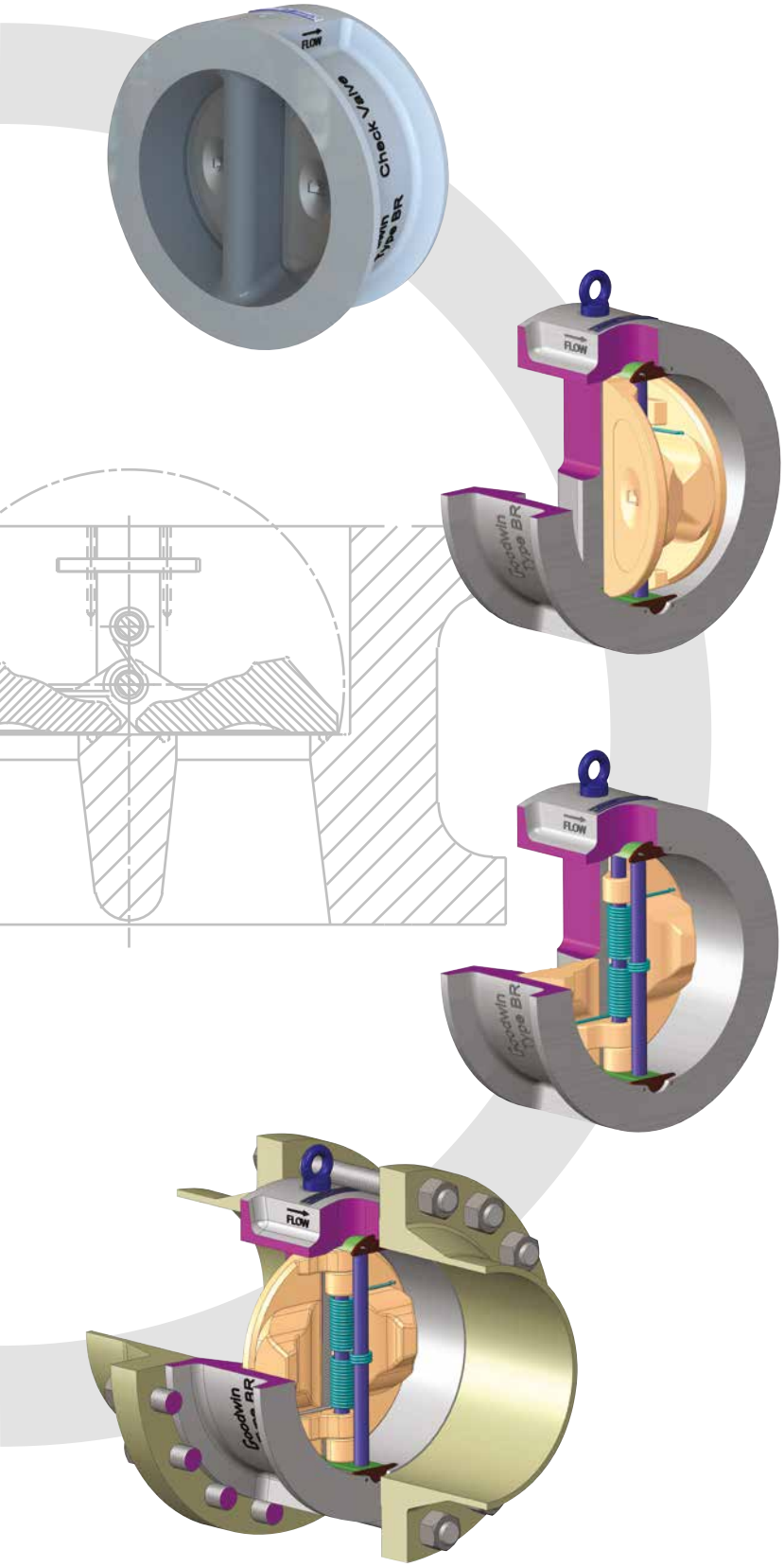
FIG	PINS/OTHER
S	316 SS
F	316L SS / 316 SS
E	410 SS / 316 SS
G	17-4 PH / 316 SS
I	Alloy 625
A	Monel K500® / 625
M	Monel 400® / 625
3	304 SS / 316 SS
4	304L SS / 316 SS
W	347 SS / 625
Y	321 SS / 625
Q	F51 DSS / 625
Z	F55 SDSS / 625
H	Inconel 825® / 625
T	Titanium

*Manufacturers standard materials for Wetted parts. Other combinations available on request.

GOODWIN
INTERNATIONAL LTD

Wafer
Type BR

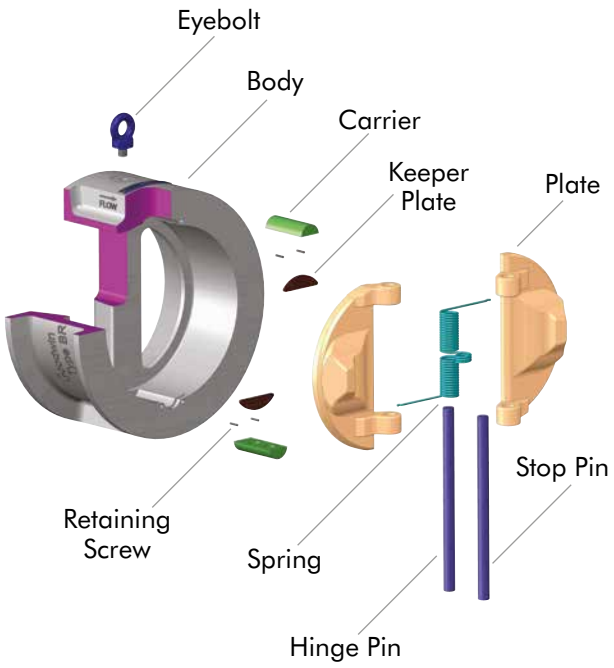
Wafer design. Clamped between flanges with bolting around outside of valve. Permits installation in a piping system in same manner as any conventional wafer valve.



Retainerless
- Retainerless is standard in Goodwin Check Valves

API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to API 594

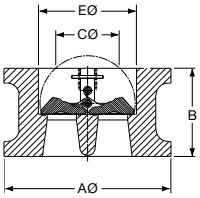
Unique Plate Design
- Pressure sensitive plate.
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Type BR

Installation Dimensions

ASME B16.5



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	105	60	0	57	120.7	19.1	4	5/8	165	3
	300	RF	111	60	0	57	127.0	19.1	8	5/8	170	4
2	600	RF/RJ-23	111	60	0	57	127.0	19.1	8	5/8	195	4
(50mm)	900	RF/RJ-24	143	70	0	57	165.1	25.4	8	7/8	240	7
	1500	RF/RJ-24	143	70	0	57	165.1	25.4	8	7/8	240	7
	2500	RF/RJ-26	146	70	0	57	171.4	28.6	8	1	275	8
	150	RF	137	73	51	87	152.4	19.1	4	5/8	185	6
	300	RF	149	73	51	87	168.3	22.2	8	3/4	205	8
3	600	RF/RJ-31	149	73	51	87	168.3	22.2	8	3/4	230	8
(80mm)	900	RF/RJ-31	168	83	60	87	190.5	25.4	8	7/8	255	13
	1500	RF/RJ-35	175	83	60	87	203.2	31.8	8	1 1/8	285	13
	2500	RF/RJ-32	197	86	60	87	228.6	34.9	8	1 1/4	335	16
	150	RF	175	73	89	113	190.5	19.1	8	5/8	185	9
	300	RF	181	73	89	113	200.0	22.2	8	3/4	210	9
4	600	RF/RJ-37	194	79	89	113	215.9	25.4	8	7/8	255	13
(100mm)	900	RF/RJ-37	206	102	83	113	235.0	31.8	8	1 1/8	300	20
	1500	RF/RJ-39	210	102	83	113	241.3	34.9	8	1 1/4	325	21
	2500	RF/RJ-38	235	105	83	113	273.0	41.3	8	1 1/2	395	25
	150	RF	222	98	140	166	241.3	22.2	8	3/4	220	18
	300	RF	251	98	140	166	269.9	22.2	12	3/4	245	21
6	600	RF/RJ-45	267	137	89	166	292.1	28.6	12	1	340	38
(150mm)	900	RF/RJ-45	289	159	89	166	317.5	31.8	12	1 1/8	380	64
	1500	RF/RJ-46	283	159	89	166	317.5	38.1	12	1 3/8	455	60
	2500	RF/RJ-47	318	159	89	166	368.3	54.0	8	2	540	70
	150	RF	279	127	171	207	298.5	22.2	8	3/4	255	25
	300	RF	308	127	171	207	330.2	25.4	12	7/8	290	40
8	600	RF/RJ-49	321	165	168	207	349.2	31.8	12	1 1/8	385	71
(200mm)	900	RF/RJ-49	359	206	130	207	393.7	38.1	12	1 3/8	455	100
	1500	RF/RJ-50	352	206	130	207	393.7	44.5	12	1 5/8	530	120
	2500	RF/RJ-51	387	206	143	207	438.2	54.0	12	2	630	137
	150	RF	340	146	235	260	362.0	25.4	12	7/8	285	56
	300	RF	362	146	235	260	387.4	28.6	16	1	325	63
10	600	RF/RJ-53	400	213	200	260	431.8	34.9	16	1 1/4	460	118
(250mm)	900	RF/RJ-53	435	241	195	260	469.9	38.1	16	1 3/8	505	196
	1500	RF/RJ-54	435	248	184	260	482.6	50.8	12	1 7/8	620	182
	2500	RF/RJ-55	476	254	191	260	539.8	66.7	12	2 1/2	790	235
	150	RF	410	181	260	300	431.8	25.4	12	7/8	325	107
	300	RF	422	181	260	300	450.8	31.8	16	1 1/8	375	112
12	600	RF/RJ-57	457	229	232	300	489.0	34.9	20	1 1/4	480	192
(300mm)	900	RF/RJ-57	498	292	206	300	533.4	38.1	20	1 3/8	575	293
	1500	RF/RJ-58	521	305	210	300	571.5	54.0	16	2	720	392
	2500	RF/RJ-60	549	305	225	300	619.1	73.0	12	2 3/4	895	451

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

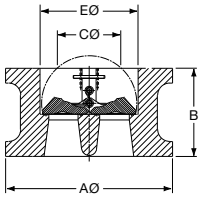
† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

Eyebolt(s) are supplied for valves over 20kg

Type BR

Installation Dimensions

ASME B16.5



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	451	184	286	339	476.3	28.6	12	1	340	102
14	300	RF	486	222	286	339	514.4	31.8	20	1 1/8	420	176
(350mm)	600	RF/RJ-61	492	273	232	339	527.0	38.1	20	1 3/8	535	207
	900	RF/RJ-62	521	356	0	339	558.8	41.3	20	1 1/2	660	396
	1500	RF/RJ-63	578	356	0	339	635.0	60.3	16	2 1/4	810	484
	150	RF	514	191	332	387	539.8	28.6	16	1	350	131
16	300	RF	540	232	330	387	571.5	34.9	20	1 1/4	445	183
(400mm)	600	RF/RJ-65	565	305	330	387	603.2	41.3	20	1 1/2	590	325
	900	RF/RJ-66	575	384	162	387	616.0	44.5	20	1 5/8	705	421
	1500	RF/RJ-67	641	384	162	387	704.8	66.7	16	2 1/2	885	587
	150	RF	549	203	395	438	577.9	31.8	16	1 1/8	375	163
18	300	RF	597	264	391	438	628.6	34.9	24	1 1/4	485	260
(450mm)	600	RF/RJ-69	613	362	330	438	654.0	44.5	20	1 5/8	665	447
	900	RF/RJ-70	638	451	244	438	685.8	50.8	20	1 7/8	815	620
	1500	RF/RJ-71	705	468	184	438	774.7	73.0	16	2 3/4	1010	791
	150	RF	606	219	438	487	635.0	31.8	20	1 1/8	400	205
20	300	RF	654	292	438	487	685.8	34.9	24	1 1/4	520	331
(500mm)	600	RF/RJ-73	683	368	432	487	723.9	44.5	24	1 5/8	685	528
	900	RF/RJ-74	699	451	406	487	749.3	54.0	20	2	835	758
	1500	RF/RJ-75	756	533	210	487	831.8	79.4	16	3	1125	1275
	150	RF	718	222	537	579	749.3	34.9	20	1 1/4	420	282
24	300	RF	775	318	524	579	812.8	41.3	24	1 1/2	570	487
(600mm)	600	RF/RJ-77	791	438	510	579	838.2	50.8	24	1 7/8	800	817
	900	RF/RJ-78	838	495	445	579	901.7	66.7	20	2 1/2	975	1156
	1500	RF/RJ-79	902	559	391	579	990.6	92.1	16	3 1/2	1235	2713

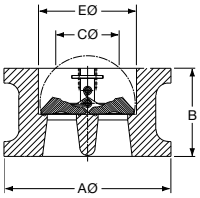
* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

Type BR

Installation Dimensions

ASME B16.47 SERIES A (MSS SP44)



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	775	356	597	629	806.5	34.9	24	1 1/4	605	416
26	300	RF	835	356	597	629	876.3	44.5	28	1 5/8	650	587
(650mm)	600	RF/RJ-93	867	457	578	629	914.4	50.8	28	1 7/8	850	1118
	900	RF/RJ-100	883	533	559	629	952.5	73.0	20	2 3/4	1045	1182
	150	RF	832	381	648	680	863.6	34.9	28	1 1/4	635	599
28	300	RF	899	381	648	680	939.8	44.5	28	1 5/8	685	751
(700mm)	600	RF/RJ-94	914	483	629	680	965.2	54.0	28	2	890	871
	900	RF/RJ-101	946	572	610	680	1022.4	79.4	20	3	1100	1441
	150	RF	883	305	641	735	914.4	34.9	28	1 1/4	565	450
30	300	RF	953	368	641	735	997.0	47.6	28	1 3/4	685	729
(750mm)	600	RF/RJ-95	972	505	584	735	1022.4	54.0	28	2	920	1850
	900	RF/RJ-102	1010	635	584	735	1085.9	79.4	20	3	1180	2132
	150	RF	940	356	641	784	977.9	41.3	28	1 1/2	645	707
32	300	RF	1006	406	641	784	1054.1	50.8	28	1 7/8	750	1635
(800mm)	600	RF/RJ-96	1022	533	610	784	1079.5	60.3	28	2 1/4	970	1743
	900	RF/RJ-103	1073	660	610	784	1155.7	85.7	20	3 1/4	1235	2034
	150	RF	1048	368	648	865	1085.9	41.3	32	1 1/2	675	865
36	300	RF	1118	483	648	865	1168.4	54.0	32	2	845	1269
(900mm)	600	RF/RJ-98	1130	635	527	865	1193.8	66.7	28	2 1/2	1095	2120
	900	RF/RJ-105	1200	718	356	865	1289.1	92.1	20	3 1/2	1335	3259
	150	RF	1162	432	882.7	987	1200.2	41.3	36	1 1/2	740	1223
40	300	RF	1114	546	749.3	909	1155.7	44.5	32	1 5/8	910	1825
(1000mm)	600	RF	1156	660	743.0	909	1212.9	60.3	32	2 1/4	1155	3750
	900	RF	1251	762	736.6	909	1339.9	92.1	24	3 1/2	1395	3972
	150	RF	1219	432	935.1	1062	1257.3	41.3	36	1 1/2	755	1134
42	300	RF	1168	568	836.6	1015	1206.5	44.5	32	1 5/8	940	2630
(1050mm)	600	RF	1219	702	647.7	972	1282.7	66.7	28	2 1/2	1225	3357
	900	RF	1302	787	584.2	972	1390.7	92.1	24	3 1/2	1440	3670
48	150	RF	1384	524	1036.7	1193	1422.4	41.3	44	1 1/2	865	2124
(1200mm)	300	RF	1324	629	965.2	1136	1371.6	50.8	32	1 7/8	1040	4400
	600	RF	1391	787	889	1136	1460.5	73.0	32	2 3/4	1365	4416
54	150	RF	1549	591	1092.2	1281	1593.9	47.6	44	1 3/4	970	2680
(1350mm)	300	RF	1492	718	1092.2	1281	1549.4	60.3	28	2 1/4	1190	3878
60	150	RF	1715	660	1206.5	1422	1759.0	47.6	52	1 3/4	1065	4148
(1500mm)	300	RF	1645	838	1206.5	1422	1701.8	60.3	32	2 1/4	1330	5392

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

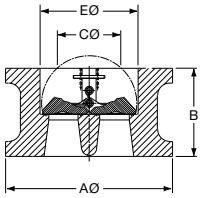
† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

Eyebolt(s) are supplied for valves over 20kg

Type BR

Installation Dimensions

ASME B16.47 SERIES B (API 605)



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
26 (650mm)	150	RF	725	356	597	629	744.5	22.2	36	3/4	525	395
	300	RF	771	356	597	629	803.3	34.9	32	1 1/4	650	698
	600	RF/RJ-93	765	457	578	629	806.5	44.5	28	1 5/8	850	800
	900	RF/RJ-100	838	533	559	629	901.7	66.7	20	2 1/2	1025	1123
28 (700mm)	150	RF	776	381	648	680	795.3	22.2	40	3/4	555	517
	300	RF	826	381	648	680	857.3	34.9	36	1 1/4	675	696
	600	RF/RJ-94	819	483	629	680	863.6	47.6	28	1 3/4	895	827
	900	RF/RJ-101	902	572	610	680	971.6	73.0	20	3	1110	1369
30 (750mm)	150	RF	827	305	641	735	846.1	22.2	44	3/4	480	629
	300	RF	886	368	641	735	920.8	38.1	36	1 3/8	675	904
	600	RF/RJ-95	880	505	584	735	927.1	50.8	28	1 7/8	935	1499
	900	RF/RJ-102	959	635	584	735	1035.1	79.4	20	3	1185	2025
32 (800mm)	150	RF	881	356	641	784	900.2	22.2	48	3/4	530	672
	300	RF	940	406	641	784	977.9	41.3	32	1 1/2	740	1553
	600	RF/RJ-96	933	533	610	784	984.3	54.0	28	2	985	1656
	900	RF/RJ-103	1016	660	610	784	1092.2	79.4	20	3 1/4	1230	1932
36 (900mm)	150	RF	987	368	648	865	1009.7	25.4	44	7/8	565	648
	300	RF	1048	483	648	865	1089.0	44.5	32	1 5/8	840	1206
	600	RF/RJ-98	1048	635	527	865	1104.9	60.3	28	2 1/4	1135	2014
	900	RF/RJ-105	1124	718	356	865	1200.2	79.4	24	3	1310	3096
40 (1000mm)	150	RF	1095	432	883	987	1120.6	28.6	44	1	640	1166
	300	RF	1150	546	749	909	1190.8	44.5	40	1 5/8	910	2007
42 (1050mm)	150	RF	1146	432	935	1062	1171.4	28.6	48	1	645	1077
	300	RF	1200	568	837	1015	1244.6	47.6	36	1 3/4	945	2893
48 (1200mm)	150	RF	1307	524	1037	1193	1335.0	31.8	44	1 1/8	760	2857
	300	RF	1368	629	965	1136	1416.1	50.8	40	1 7/8	1130	4840
54 (1350mm)	150	RF	1464	591	1092	1281	1492.3	31.8	56	1 1/8	840	2546
	300	RF	1530	718	1092	1281	1577.8	50.8	48	1 7/8	1150	4266
60 (1500mm)	150	RF	1630	660	1207	1422	1662.2	34.9	52	1 1/4	925	3941
	300	RF	1707	838	1207	1422	1763.8	60.3	40	2 1/4	1305	5931

LARGE DIAMETER VALVES

Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION Length mm	† Valve Weight kg
66 (1650mm)	150	FF										
72 (1800mm)	150	FF										
78 (1950mm)	150	FF										
84 (2100mm)	150	FF										
90 - 144 (2250mm)	150	FF										

GOODWIN SUPPLY TYPE BR VALVES IN SIZES 66" TO 144" TO CUSTOMER AGREED FLANGE DESIGN

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

GOODWIN
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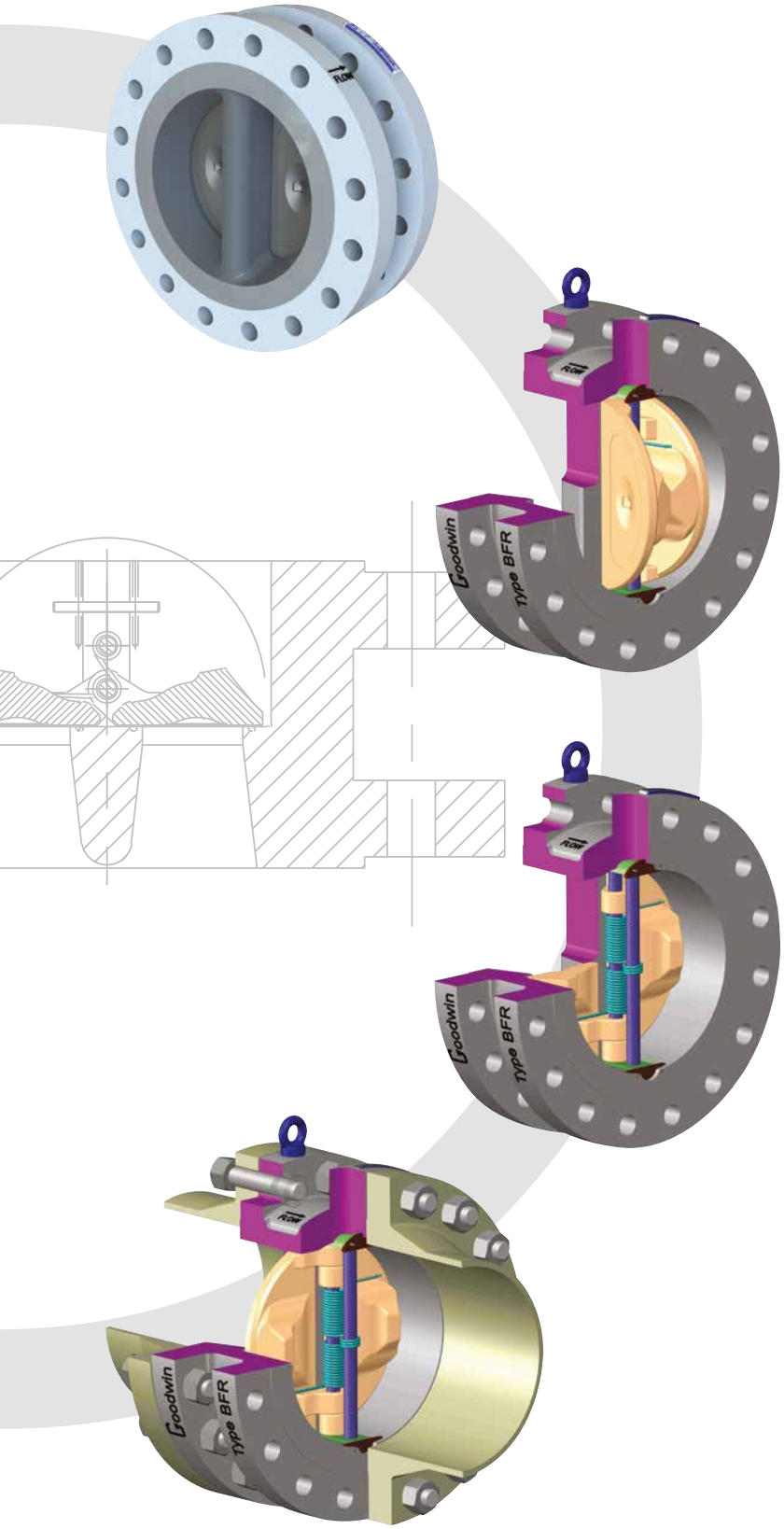
Flanged
Type BFR

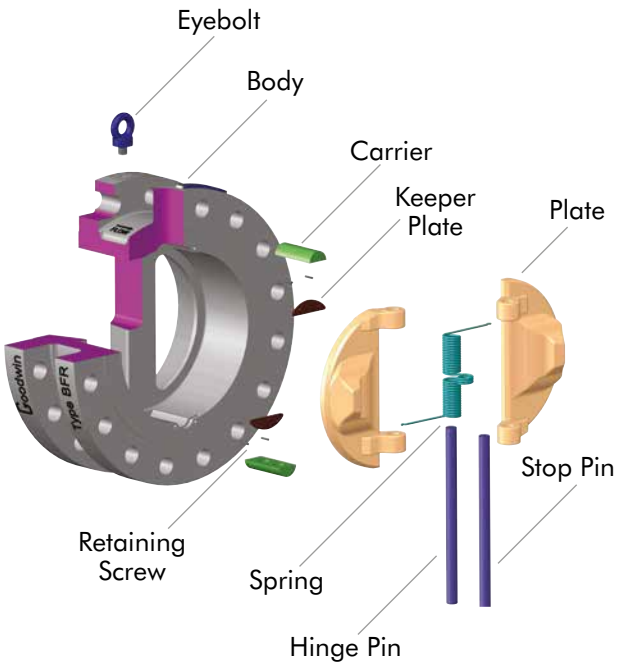
Double flanged design. Permits installation in a piping system in same manner as any conventional double flanged valve, ie studs and nuts per flange.



Retainerless
- Retainerless is standard in Goodwin Check Valves

API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to API 594

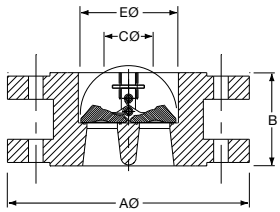
Unique Plate Design
- Pressure sensitive plate
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Type BFR

Installation Dimensions

ASME B16.5



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
8 (200mm)	150	RF	343	127	171	207	298.5	22.2	8	3/4	140	49
10 (250mm)	150	RF	406	146	235	260	362.0	25.4	12	7/8	150	82
	600	RF/RJ-53	508	213	200	260	431.8	34.9	16	1 1/4	245	183
	900	RF/RJ-53	546	241	195	260	469.9	38.1	16	1 3/8	265	203
12 (300mm)	150	RF	483	181	260	300	431.8	25.4	12	7/8	150	115
	300	RF	521	181	260	300	450.8	31.8	16	1 1/8	205	153
	600	RF/RJ-57	559	229	232	300	489.0	34.9	20	1 1/4	255	230
	900	RF/RJ-57	610	292	206	300	533.4	38.1	20	1 3/8	285	354
14 (350mm)	150	RF	533	184	286	339	476.3	28.6	12	1	165	142
	300	RF	584	222	286	339	514.4	31.8	20	1 1/8	210	166
	600	RF/RJ-61	603	273	232	339	527.0	38.1	20	1 3/8	265	313
	900	RF/RJ-62	641	356	0	339	558.8	41.3	20	1 1/2	310	463
16 (400mm)	150	RF	597	191	332	387	539.8	28.6	16	1	170	176
	300	RF	648	232	330	387	571.5	34.9	20	1 1/4	220	301
	600	RF/RJ-65	686	305	330	387	603.2	41.3	20	1 1/2	285	426
	900	RF/RJ-66	705	384	162	387	616.0	44.5	20	1 5/8	325	596
18 (450mm)	150	RF	635	203	395	438	577.9	31.8	16	1 1/8	180	210
	300	RF	711	264	391	438	628.6	34.9	24	1 1/4	230	392
	600	RF/RJ-69	743	362	330	438	654.0	44.5	20	1 5/8	305	565
	900	RF/RJ-70	787	451	244	438	685.8	50.8	20	1 7/8	365	859
20 (500mm)	150	RF	699	219	438	487	635.0	31.8	20	1 1/8	190	284
	300	RF	775	292	438	487	685.8	34.9	24	1 1/4	240	497
	600	RF/RJ-73	813	368	432	487	723.9	44.5	24	1 5/8	325	744
	900	RF/RJ-74	857	451	406	487	749.3	54.0	20	2	385	1045
24 (600mm)	150	RF	813	222	537	579	749.3	35.0	20	1 1/4	205	371
	300	RF	914	318	524	579	812.8	41.3	24	1 1/2	265	777
	600	RF/RJ-77	940	438	510	579	838.2	50.8	24	1 7/8	365	1166
	900	RF/RJ-78	1041	495	445	579	901.7	66.7	20	2 1/2	485	1826

Type BFR (Small Diameter - Extended Body - Non API 594) ASME B16.5

Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
2 (50mm)	150	RF	152	114	0	57	120.7	19.1	4	5/8	105	7
	300	RF	165	114	0	57	127.0	19.1	8	5/8	110	9
3 (80mm)	150	RF	191	121	51	87	152.4	19.1	4	5/8	110	11
	300	RF	210	121	51	87	168.3	22.2	8	3/4	130	15
4 (100mm)	150	RF	229	121	89	113	190.5	19.1	8	5/8	110	16
	300	RF	254	121	89	113	200.0	22.2	8	3/4	135	18
6 (150mm)	150	RF	279	130	140	166	241.3	22.2	8	3/4	120	21
	300	RF	318	130	140	166	269.9	22.2	12	3/4	145	27
8 (200mm)	300	RF	381	152	171	207	330.2	25.4	12	7/8	160	48
10 (250mm)	300	RF	445	178	235	260	387.4	28.6	16	1	175	68

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

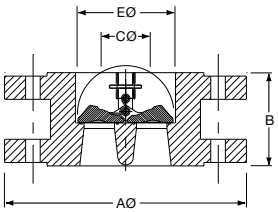
† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

§ Number of studs is per flange, therefore, double the amount for valve installation purposes

Type BFR

Installation Dimensions

ASME B16.47 SERIES A (MSS SP44)



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
26 (650mm)	150	RF	870	356	597	629	806.5	34.9	24	1 1/4	245	463
	300	RF	972	356	597	629	876.3	44.5	28	1 5/8	290	1238
	600	RF/RJ-93	1016	457	578	629	914.4	50.8	28	1 7/8	390	977
	900	RF/RJ-100	1086	533	559	629	952.5	73.0	20	2 3/4	510	1991
28 (700mm)	150	RF	927	381	648	680	863.6	35.0	28	1 1/4	255	1025
	300	RF	1035	381	648	680	939.8	44.5	28	1 5/8	305	1120
	600	RF/RJ-93	1073	483	629	680	965.2	54.0	28	2	405	1467
	900	RF/RJ-100	1168	572	610	680	1022.4	79.4	20	3	525	2426
30 (750mm)	150	RF	984	305	641	735	914.4	35.0	28	1 1/4	260	747
	300	RF	1092	368	641	735	997.0	47.6	28	1 3/4	325	1206
	600	RF/RJ-95	1130	505	584	735	1022.4	54.0	28	2	410	1908
	900	RF/RJ-102	1232	635	584	735	1085.9	79.4	20	3	540	3829
32 (800mm)	150	RF	1060	356	641	784	977.9	41.3	28	1 1/2	290	1032
	300	RF	1149	406	641	784	1054.1	50.8	28	1 7/8	345	1615
	600	RF/RJ-96	1194	533	610	784	1079.5	60.3	28	2 1/4	430	1977
	900	RF/RJ-103	1314	660	610	784	1155.7	85.7	20	3 1/4	570	3425
36 (900mm)	150	RF	1168	368	648	865	1085.9	41.3	32	1 1/2	305	1318
	300	RF	1270	483	648	865	1168.4	54.0	32	2	360	1957
	600	RF/RJ-98	1314	635	527	865	1193.8	60.3	28	2 1/2	455	2885
	900	RF/RJ-105	1461	718	356	865	1289.1	92.1	20	3 1/2	615	4354
40 (1000mm)	150	RF	1289	432	883	987	1200.2	41.3	36	1 1/2	305	1560
	300	RF	1238	546	749	909	1155.7	44.5	32	1 5/8	360	3073
	600	RF	1321	660	743	909	1212.9	60.3	32	2 1/4	490	3152
	900	RF	1511	762	737	909	1339.9	92.1	24	3 1/2	630	6688
42 (1050mm)	150	RF	1346	432	935	1062	1257.3	41.3	36	1 1/2	320	2149
	300	RF	1289	568	837	1015	1206.5	44.5	32	1 5/8	370	2876
	600	RF	1403	702	648	972	1282.7	66.7	28	2 1/2	520	3965
	900	RF	1562	787	584	972	1390.7	92.1	24	3 1/2	650	**
48 (1200mm)	150	RF	1511	524	1037	1193	1422.4	41.3	44	1 1/2	340	2904
	300	RF	1467	629	965	1136	1371.6	50.8	32	1 7/8	410	3722
	600	RF	1594	787	889	1136	1460.5	73.0	32	2 3/4	575	5450
54 (1350mm)	150	RF	1683	591	1092	1281	1593.9	47.6	44	1 3/4	380	2790
	300	RF	1657	718	1092	1281	1549.4	60.3	28	2 1/4	470	**
60 (1500mm)	150	RF	1854	660	1207	1422	1759.0	47.6	52	1 3/4	400	6065
	300	RF	1810	838	1207	1422	1701.8	60.3	32	2 1/4	490	**

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

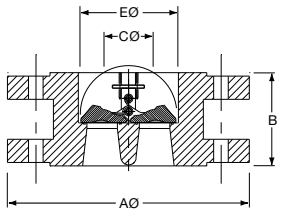
§ Number of studs is per flange, therefore, double the amount for valve installation purposes.

** Apply to Goodwin for details.

Type BFR

Installation Dimensions

ASME B16.47 SERIES B (API 605)



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	786	356	597	629	744.5	22.2	36	3/4	165	906
26	300	RF	867	356	597	629	803.3	34.9	32	1 1/4	290	1114
(650mm)	600	RF/RJ-93	889	457	578	629	806.5	44.5	28	1 5/8	380	1276
	900	RF/RJ-100	1022	533	559	629	901.7	66.7	20	2 1/2	480	1792
	150	RF	837	381	648	680	795.3	22.2	40	3/4	175	923
28	300	RF	921	381	648	680	857.3	34.9	36	1 1/4	290	1008
(700mm)	600	RF/RJ-94	953	483	629	680	863.6	47.6	28	1 3/4	395	1320
	900	RF/RJ-101	1105	572	610	680	971.6	73.0	20	2 3/4	515	2183
	150	RF	887	305	641	735	846.1	22.2	44	3/4	175	714
30	300	RF	991	368	641	735	920.8	38.1	36	1 3/8	305	1155
(750mm)	600	RF/RJ-95	1022	505	584	735	927.1	50.8	28	1 7/8	420	1418
	900	RF/RJ-102	1181	635	584	735	1035.1	79.4	20	3	545	3446
	150	RF	941	356	641	784	900.2	22.2	48	3/4	175	855
32	300	RF	1054	406	641	784	977.9	41.3	32	1 1/2	330	**
(800mm)	600	RF/RJ-96	1086	533	610	784	984.3	54.0	28	2	440	2642
	900	RF/RJ-103	1238	660	610	784	1092.2	79.4	20	3	555	2642
	150	RF	1057	368	648	865	1009.7	25.4	44	7/8	195	1033
36	300	RF	1172	483	648	865	1089.2	44.5	32	1 5/8	340	1794
(900mm)	600	RF/RJ-98	1213	635	527	865	1104.9	60.3	28	2 1/4	480	2589
	900	RF/RJ-105	1346	718	356	865	1200.2	79.4	24	3	585	**
40	150	RF	1175	432	883	987	1120.6	28.6	44	1	210	1364
(1000mm)	300	RF	1273	546	749	909	1190.6	44.5	40	1 5/8	365	3380
42	150	RF	1226	432	935	948	1171.4	28.6	48	1	215	1953
(1050mm)	300	RF	1334	568	837	1015	1244.6	47.6	36	1 3/4	375	4872
48	150	RF	1392	524	1037	1193	1335.0	31.8	44	1 1/8	235	2475
(1200mm)	300	RF	1511	629	965	1136	1416.1	50.8	40	1 7/8	400	5511
54	150	RF	1549	591	1092	1281	1492.3	31.8	56	1 1/8	245	2790
(1350mm)	300	RF	1673	718	1092	1281	1577.8	50.8	48	1 7/8	415	**
60	150	RF	1726	660	1207	1422	1662.2	34.9	52	1 1/4	260	**
(1500mm)	300	RF	1878	838	1207	1422	1763.8	60.3	40	2 1/4	465	**

LARGE DIAMETER VALVES

Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No.	STUD SELECTION DIA. inches	STUD SELECTION Length mm	† Valve Weight kg
66 - 144 (1650mm - 3600mm)	150	FF	GOODWIN SUPPLY TYPE BFR VALVES IN SIZES 66" TO 144" TO EITHER AWWA C207 FLANGE STANDARD OR CUSTOMER AGREED FLANGE DESIGN									

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

§ Number of studs is per flange, therefore, double the amount for valve installation purposes.

** Apply to Goodwin for details.

GOODWIN
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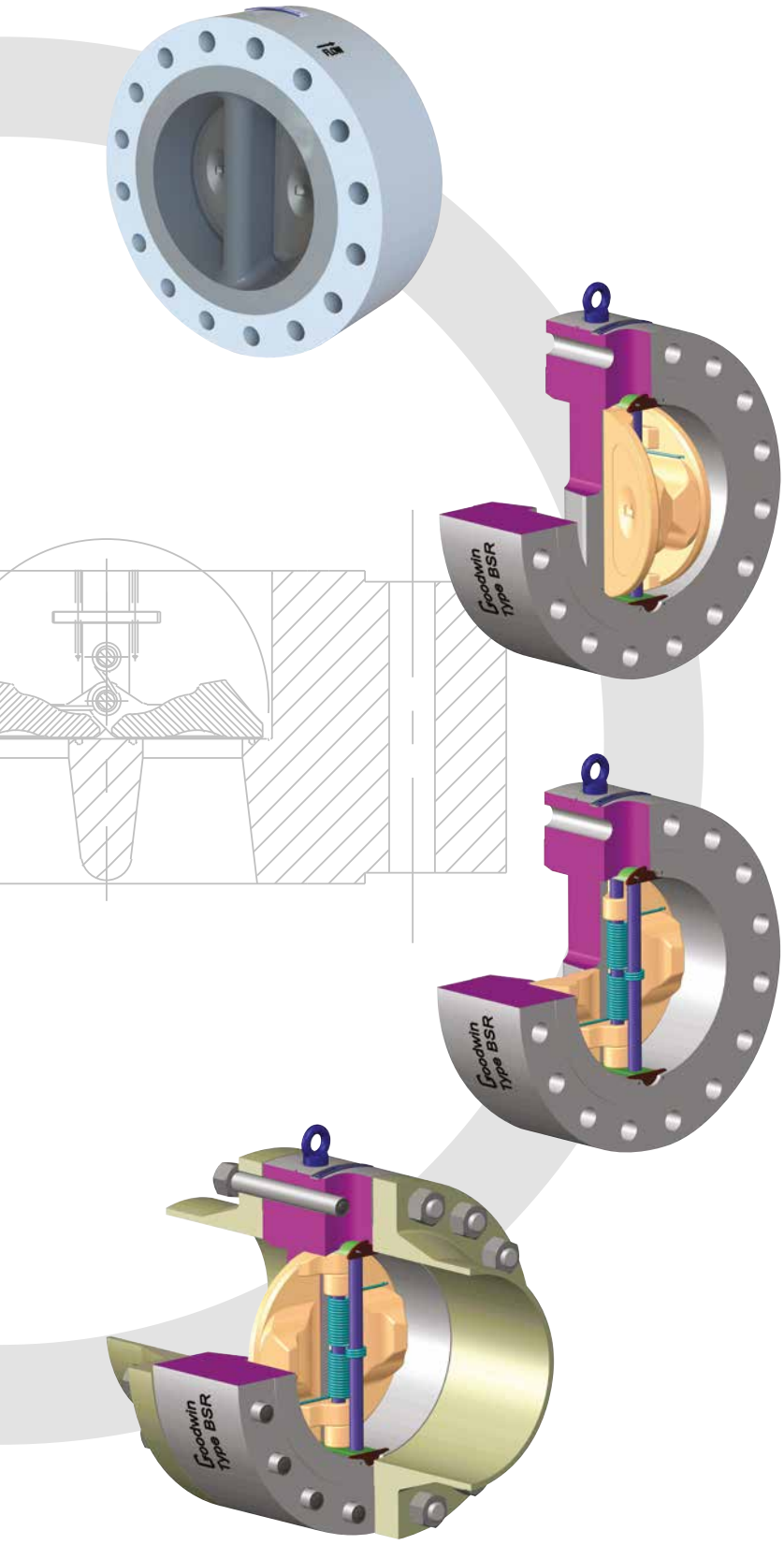
Solid Lug
Type BSR

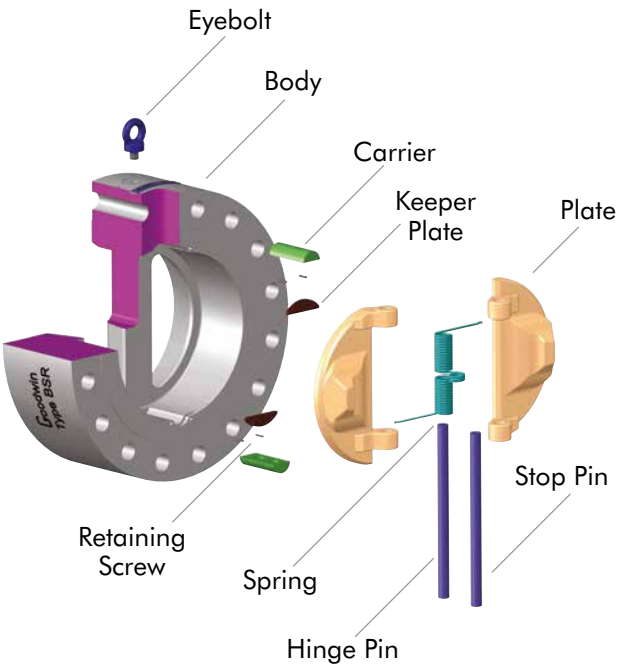


Solid Lug Wafer design. Clamped between flanges with bolting passing through the body of the valve.

Retainerless
- Retainerless is standard in Goodwin Check Valves

API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to API 594

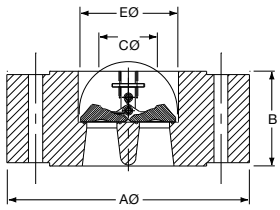
Unique Plate Design
- Pressure sensitive plate
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Type BSR

Installation Dimensions

ASME B16.5



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	152	60	0	57	120.7	19.1	4	5/8	165	5
	300	RF	165	60	0	57	127.0	19.1	8	5/8	170	7
2	600	RF/RJ-23	165	60	0	57	127.0	19.1	8	5/8	195	7
(50mm)	900	RF/RJ-24	216	70	0	57	165.1	25.4	8	7/8	240	14
	1500	RF/RJ-24	216	70	0	57	165.1	25.4	8	7/8	240	14
	2500	RF/RJ-26	235	70	0	57	171.4	28.6	8	1	275	18
	150	RF	191	73	51	87	152.4	19.1	4	5/8	185	8
	300	RF	210	73	51	87	168.3	22.2	8	3/4	205	15
3	600	RF	210	73	51	87	168.3	22.2	8	3/4	230	14
(80mm)	900	RF/RJ-31	241	83	60	87	190.5	25.4	8	7/8	255	22
	1500	RF/RJ-35	267	83	60	87	203.2	31.8	8	1 1/8	285	26
	2500	RF/RJ-32	305	86	60	87	228.6	34.9	8	1 1/4	335	38
	150	RF	229	73	89	113	190.5	19.1	8	5/8	185	13
	300	RF	254	73	89	113	200.0	22.2	8	3/4	210	20
4	600	RF/RJ-37	273	79	89	113	215.9	25.4	8	7/8	255	27
(100mm)	900	RF/RJ-37	292	102	83	113	235.0	31.8	8	1 1/8	300	39
	1500	RF/RJ-39	311	102	83	113	241.3	34.9	8	1 1/4	325	51
	2500	RF/RJ-38	356	105	83	113	273.0	41.3	8	1 1/2	395	69
	150	RF	279	98	140	166	241.3	22.2	8	3/4	220	33
	300	RF	318	98	140	166	269.9	22.2	12	3/4	245	46
6	600	RF/RJ-45	356	137	89	166	292.1	28.6	12	1	340	77
(150mm)	900	RF/RJ-45	381	159	89	166	317.5	31.8	12	1 1/8	380	104
	1500	RF/RJ-46	394	159	89	166	317.5	38.1	12	1 3/8	455	119
	2500	RF/RJ-47	483	159	89	166	368.3	54.0	8	2	540	165
	150	RF	343	127	171	207	298.5	22.2	8	3/4	255	64
	300	RF	381	127	171	207	330.2	25.4	12	7/8	290	82
8	600	RF/RJ-49	419	165	168	207	349.2	31.8	12	1 1/8	385	129
(200mm)	900	RF/RJ-49	470	206	130	207	393.7	38.1	12	1 3/8	455	208
	1500	RF/RJ-50	483	206	130	207	393.7	44.5	12	1 5/8	530	214
	2500	RF/RJ-51	552	206	143	207	438.2	54.0	12	2	630	277
	150	RF	406	146	235	260	362.0	25.4	12	7/8	285	96
	300	RF	445	146	235	260	387.4	28.6	16	1	325	122
10	600	RF/RJ-53	508	213	200	260	431.8	34.9	16	1 1/4	460	234
(250mm)	900	RF/RJ-53	546	241	195	260	469.9	38.1	16	1 3/8	505	324
	1500	RF/RJ-54	584	248	184	260	482.6	50.8	12	1 7/8	620	378
	2500	RF/RJ-55	673	254	191	260	539.8	66.7	12	2 1/2	790	500
	150	RF	483	181	260	300	431.8	25.4	12	7/8	325	181
	300	RF	521	181	260	300	450.8	31.8	16	1 1/8	375	214
12	600	RF/RJ-57	559	229	232	300	489.0	34.9	20	1 1/4	480	300
(300mm)	900	RF/RJ-57	610	292	206	300	533.4	38.1	20	1 3/8	575	502
	1500	RF/RJ-58	673	305	210	300	571.5	54.0	16	2	720	792
	2500	RF/RJ-60	762	305	225	300	619.1	73.0	12	2 3/4	895	790
	150	RF	533	184	286	339	476.3	28.6	12	1	340	199
14	300	RF	584	222	286	339	514.4	31.8	20	1 1/8	420	313
(350mm)	600	RF/RJ-61	603	273	232	339	527.0	38.1	20	1 3/8	535	313
	900	RF/RJ-62	641	356	0	339	558.8	41.3	20	1 1/2	660	775
	1500	RF/RJ-63	749	356	0	339	635.0	60.3	16	2 1/4	810	905
	150	RF	597	191	332	387	539.8	28.6	16	1	350	282
16	300	RF	648	232	330	387	571.5	34.9	20	1 1/4	445	489
(400mm)	600	RF/RJ-65	686	305	330	387	603.2	41.3	20	1 1/2	590	660
	900	RF/RJ-66	705	384	162	387	616.0	44.5	20	1 5/8	705	795
	1500	RF/RJ-67	826	384	162	387	704.8	66.7	16	2 1/2	885	1170

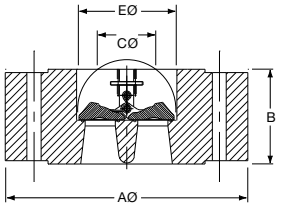
* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

Type BSR

Installation Dimensions

ASME B16.5



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
18 (450mm)	150	RF	635	203	395	438	577.9	31.8	16	1 1/8	375	290
	300	RF	711	264	391	438	628.6	34.9	24	1 1/4	485	558
	600	RF/RJ-69	743	362	330	438	654.0	44.5	20	1 5/8	665	1078
	900	RF/RJ-70	787	451	244	438	685.8	50.8	20	1 7/8	815	1165
	1500	RF/RJ-71	914	468	184	438	774.7	73.0	16	2 3/4	1010	1665
20 (500mm)	150	RF	699	219	438	487	635.0	31.8	20	1 1/8	400	348
	300	RF	775	292	438	487	685.8	34.9	24	1 1/4	520	700
	600	RF/RJ-73	813	368	432	487	723.9	44.5	24	1 5/8	685	933
	900	RF/RJ-74	857	451	406	487	749.3	54.0	20	2	835	1960
	1500	RF/RJ-75	984	533	210	487	831.8	79.4	16	3	1125	2249
24 (600mm)	150	RF	813	222	537	579	749.3	34.9	20	1 1/4	420	396
	300	RF	914	318	524	579	812.8	41.3	24	1 1/2	570	1076
	600	RF/RJ-77	940	438	510	579	838.2	50.8	24	1 7/8	800	1554
	900	RF/RJ-78	1041	495	445	579	901.7	66.7	20	2 1/2	975	2351
	1500	RF/RJ-79	1168	559	391	579	990.6	92.1	16	3 1/2	1235	3230

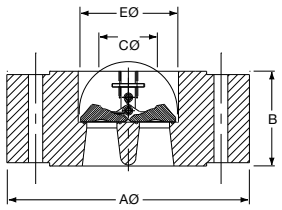
* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

Type BSR

Installation Dimensions

ASME B16.47 SERIES A (MSS SP44)



Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
	150	RF	870	356	597	629	806.5	34.9	24	1 1/4	605	1254
26	300	RF	972	356	597	629	876.3	44.5	28	1 5/8	650	1542
(650mm)	600	RF/RJ-93	1016	457	578	629	914.4	50.8	28	1 7/8	850	1766
	900	RF/RJ-100	1086	533	559	629	952.5	73.0	20	2 3/4	1045	2479
	150	RF	927	381	648	680	863.6	34.9	28	1 1/4	635	1276
28	300	RF	1035	381 6	48 6	80	939.8	44.5 2	8	1 5/8	685	1395
(700mm)	600	RF/RJ-94	1073	483	629	680	965.2	54.0	28	2	890	1827
	900	RF/RJ-101	1168 5	72	610	680	1022.4	79.4	20	3	1100	3021
	150	RF	984	305	641	735	914.4	34.9	28	1 1/4	565	1010
30	300	RF	1092	368	641	735	997.0	47.6	28	1 3/4	685	1996
(750mm)	600	RF/RJ-95	1130	505	584	735	1022.4	54.0	28	2	920	3045
	900	RF/RJ-102	1232	635	584	735	1085.9	79.4	20	3	1180	3835
	150	RF	1060	356	641	784	977.9	41.3	28	1 1/2	645	2925
32	300	RF	1149	406	641	784	1054.1	50.8	28	1 7/8	750	3428
(800mm)	600	RF/RJ-96	1194	533	610	784	1079.5	60.3	28	2 1/4	970	3815
	900	RF/RJ-103	1314	660	610	784	1155.7	85.7	20	3 1/4	1235	4265
	150	RF	1168	368	648	865	1085.9	41.3	32	1 1/2	675	1430
36	300	RF	1270	483	648	865	1168.4	54.0	32	2	845	2661
(900mm)	600	RF/RJ-98	1314	635	527	865	1193.8	66.7	28	2 1/2	1095	5896
	900	RF/RJ-105	1461	718	356	865	1289.1	92.1	20	3 1/2	1335	**
	150	RF	1289	432	883	987	1200.2	41.3	36	1 1/2	740	1386
40	300	RF	1238	546	749	909	1155.7	44.5	32	1 5/8	910	3827
(1000mm)	600	RF	1321	660	743	909	1212.9	60.3	32	2 1/4	1155	7862
	900	RF	1511	762	737	909	1339.9	92.1	24	3 1/2	1395	8328
	150	RF	1346	432	935	1062	1257.3	41.3	36	1 1/2	755	2377
42	300	RF	1289	568	837	1015	1206.5	44.5	32	1 5/8	940	2961
(1050mm)	600	RF	1403	702	648	972	1282.7	66.7	28	2 1/2	1225	6572
	900	RF	1562	787	584	972	1390.7	92.1	24	3 1/2	1440	**
	150	RF	1511	524	1037	1193	1422.4	41.3	44	1 1/2	865	4174
48	300	RF	1467	629	965	1136	1371.6	50.8	32	1 7/8	1040	6239
(1200mm)	600	RF	1594	787	889	1136	1460.5	73.0	32	2 3/4	1365	**
54	150	RF	1683	591	1092	1281	1593.9	47.8	44	1 3/4	970	**
(1350mm)	300	RF	1657	718	1092	1281	1549.4	60.3	28	2 1/4	1190	**
60	150	RF	1854	660	1207	1422	1759.0	47.6	52	1 3/4	1065	**
(1500mm)	300	RF	1810	838	1207	1422	1701.8	60.3	32	2 1/4	1330	**

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.

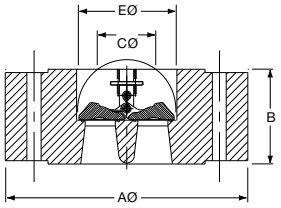
† Weights are for valve only and exclude mating flanges and bolting. Weight will vary according to corrosion allowance specification.

** Apply to Goodwin for details

Type BSR

Installation Dimensions

API 6A / ISO 10423



API 5000: Type BSR (RETAINERLESS)

Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
2 1/16	5000	R-24	215.9	70	0	53.1	165.1	25.5	8	7/8	225	8
2 9/16	5000	R-27	244.5	70	0	65.8	190.5	28.5	8	1	235	
3 1/8	5000	R-35	266.7	83	60	81.8	203.2	31.75	8	1 1/8	270	14
4 1/16	5000	R-39	311.2	102	83	108.7	241.3	35	8	1 1/4	305	28
5 1/8	5000	R-44	374.7	102	83	131.1	292.1	41.25	8	1 1/2	360	
7 1/16	5000	R-46	393.7	159	89	181.9	317.5	38	12	1 3/8	435	53
9	5000	R-50	482.6	206	130	229.4	393.7	44.5	12	1 5/8	510	117
11	5000	R-54	584.2	248	184	280.2	482.6	51	12	1 7/8	600	204

API 10000 & API 15000: Type BS (RETAINERED, i.e.with Retaining plugs)

Size inches	Pressure Rating ASME	End Facing	A mm	B mm	C mm	E mm	HOLE P.C.D. mm	HOLE DIA. mm	STUD SELECTION No. §	STUD SELECTION DIA. inches	STUD SELECTION *Length mm	† Valve Weight kg
2 1/16	10000 15000	BX-152 BX-152	200.0 222.3	70 95	0 0	53.1 53.1	158.8 174.6	22.2 25.4	8 8	3/4 7/8	205 250	
2 9/16	10000 15000	BX-153 BX-153	231.8 254.0	70 95	0 0	65.8 65.8	184.2 200.0	25.4 28.4	8 8	7/8 1	225 270	
3 1/16	10000 15000	BX-154 BX-154	269.9 287.3	86 111	60 60	78.5 78.5	215.9 230.2	28.6 31.8	8 8	1 1 1/8	260 305	
4 1/16	10000 15000	BX-155 BX-155	316.0 360.4	105 130	83 83	103.9 103.9	258.7 290.6	31.8 38.1	8 8	1 1/8 1 3/8	310 365	
5 1/8	10000 15000	BX-169 BX-169	357.1 419.1	105 130	83 83	131.1 131.1	300.0 342.9	31.8 41.1	12 12	1 1/8 1 1/2	330 425	
7 1/16	10000 15000	BX-156 BX-156	479.6 505.0	159 184	89 89	180.1 180.1	403.2 428.6	41.1 41.1	12 16	1 1/2 1 1/2	445 510	
9	10000 15000	BX-157 BX-157	552.5 647.7	206 231	143 143	229.4 229.4	476.3 552.5	41.1 50.8	16 16	1 1/2 1 7/8	540 635	
11	10000 15000	BX-158 BX-158	654.1 812.8	254 273	191 191	280.2 280.2	565.2 711.2	47.6 53.8	16 20	1 3/4 2	635 765	

* Where Ring Joint Facing shown in End Facing, Stud lengths based on Ring Joint flange connection.
Testing procedures in accordance with API 6A / ISO 10423. Allowable leakage rate in accordance with API 598.

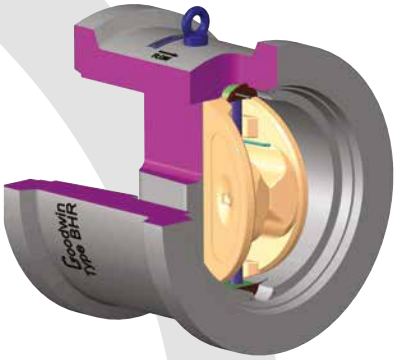
Types BR and BSR to API 6D / ISO 14313

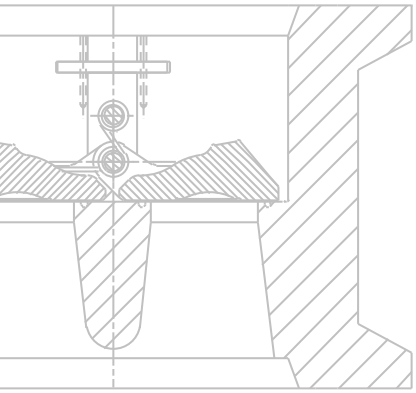
The installation dimensions are the same as for ASME valves (refer Type BR and Type BSR)
Sizes 2" - 12" 2500# 14"-1500#

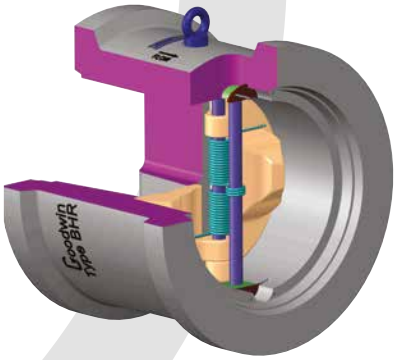
Testing procedures in accordance with API 6D / ISO 10423. Allowable leakage rate in accordance with API 598.

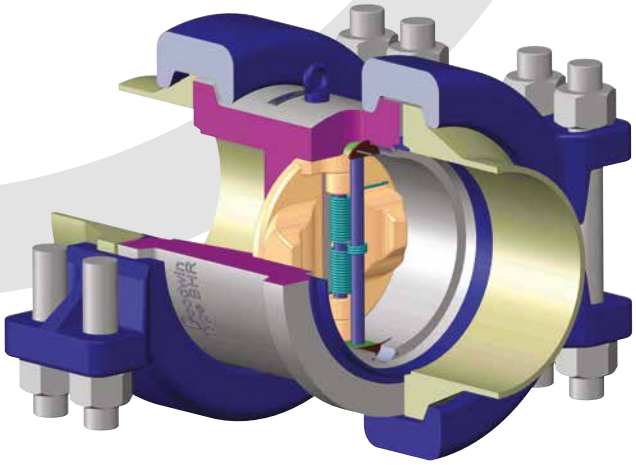
GOODWIN
INTERNATIONAL LTD

Hub End
Type BHR







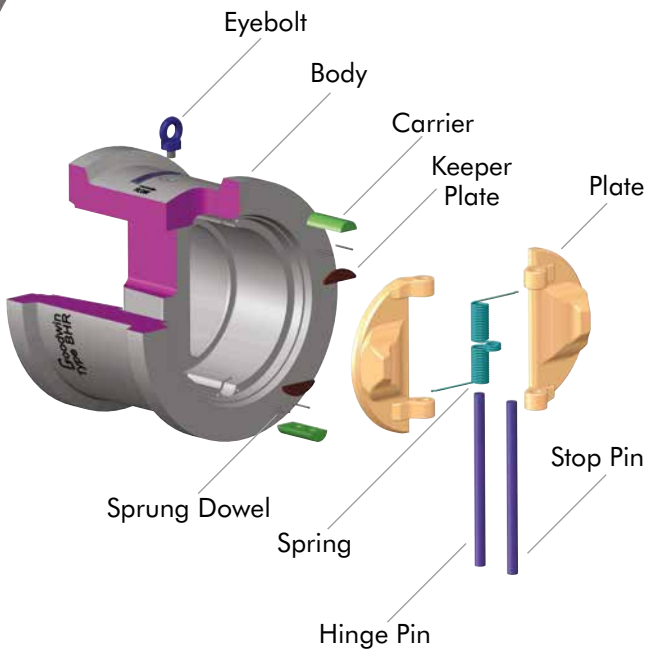


Hub End design.
Clamped into a piping system using mechanical clamp connectors, eg. Grayloc®, Galperti®, Vector Techlok®.

Retainerless
- Retainerless is standard in Goodwin Check Valves

API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to Goodwin standard
- 3 design options available
  - BHR(F) (Full bore retainerless)
  - BH(F) (Full bore retaining plugs)
  - BHR(R) (Reduced bore retainerless)

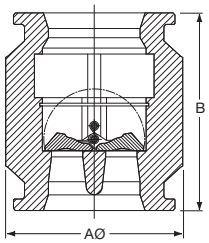
Unique Plate Design
- Pressure sensitive plate
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Hub End (Full Bore)

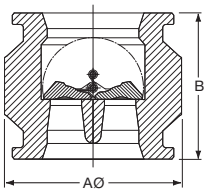
Installation Dimensions

Type BHR(F)



Size mm	Pressure Rating ASME	Seal Ring Size	A mm	B mm	† Valve Weight kg
4 (100mm)	900	34-40	229	279	47
	1500		229	279	47
	2500		259	308	71
6 (150mm)	900	46-62	327	358	130
	1500		327	358	130
	2500		349	445	205
8 (200mm)	900	62-82	409	418	245
	1500		409	418	245
	2500		435	451	300
10 (250mm)	900	84-97	464	485	375
	1500		464	485	375
	2500		533	533	520
12 (300mm)	900	97-110	590	602	678
	1500		590	602	678
	2500		638	638	908
14 (350mm)	900	112-130	590	602	932
	1500		590	602	932
	2500		638	689	945

Type BH(F)



Size mm	Pressure Rating ASME	Seal Ring Size	A mm	B mm	† Valve Weight kg
2 (50mm)	900	13-20	117	136	14
	1500		117	136	14
	2500		117	136	14
3 (80mm)	900	23-27	162	158	29
	1500		162	158	29
	2500		162	158	29
4 (100mm)	900	31-40	191	220	46
	1500		191	220	46
	2500		191	220	46
6 (150mm)	900	40-62	274	279	135
	1500		274	279	135
	2500		274	279	135
8 (200mm)	900	56-82	368	311	243
	1500		368	311	243
	2500		368	311	243
10 (250mm)	900	72-97	409	381	320
	1500		409	381	320
	2500		409	381	320
12 (300mm)	900	92-112	482	431	440
	1500		482	431	440
	2500		482	431	440
14 (350mm)	900	110-120	511	482	646
	1500		511	482	646
16 (400mm)	900	112-120	651	628	770
	1500		651	628	770
16 (400mm)	900	130-137	552	533	770
	1500		552	533	770
18 (450mm)	900	160	660	584	1245
	1500		660	584	1245

† Weights are for valve only and exclude mating clamps and bolting. Weight will vary according to corrosion allowance specification.

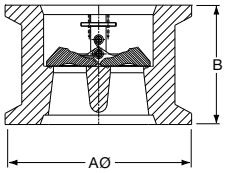
1. Type BH(F) is supplied with external threaded retainers
2. Reduced Bore Retainerless, Type BHR(R), i.e. no external threaded components.
3. Clamps, seal rings and companion hubs are not included with the valve
4. Particular make of Hub Ends, Seal Ring Size and Clamp Style must be specified by customer. Relevant technical information should be obtained from the chosen clamp supplier, e.g. Grayloc®, Techlok®, Galperti®.
5. Dimension B: These are typical only. Due to the large variety of Hub End sizes and Clamp Styles available the face-to- face dimensions for a given size and rating may vary to maintain ASME and API design specifications. Please contact Goodwin for details prior to using above data as design criteria.
6. Valve sizes not listed above are available on application, together with customer specified end sizes and types. All valves are rated in accordance with ASME B 16.34, API 594 and API 598 design and application specifications.
7. Internals designed to suit customer's specified hub-ended bore details.

HEAVY DUTY HUB DIMENSIONS ARE AVAILABLE ON APPLICATION TO GOODWIN INTERNATIONAL

Type BHR(R)

Hub End (Reduced Bore)

Installation Dimensions



Size mm	Pressure Rating ASME	Seal Ring Size	A mm	B mm	† Valve Weight kg
3 (80mm)	900	23-27	127	114	15
	1500		127	114	15
	2500		127	114	15
4 (100mm)	900	31-40	152	127	17
	1500		152	127	17
	2500		152	127	17
6 (150mm)	900	46-62	235	159	54
	1500		235	159	54
	2500		235	159	54
8 (200mm)	900	52	292	159	95
	1500		292	159	95
	2500		292	159	95
8 (200mm)	900	64-82	292	206	95
	1500		292	206	95
	2500		292	206	95
10 (250mm)	900	67-97	346	248	120
	1500		346	248	120
	2500		346	248	120
12 (300mm)	900	91-112	406	317	321
	1500		406	317	321
	2500		406	317	321
14 (350mm)	900	97-120	470	356	490
	1500		470	356	490
	2500		470	356	490

Size mm	Pressure Rating ASME	Seal Ring Size	A mm	B mm	† Valve Weight kg
16 (400mm)	900	114-120	533	406	642
	1500		533	406	642
16 (400mm)	900	130-140	533	381	642
	1500		533	381	642
18 (450mm)	900	134-144	559	394	335
	1500		559	394	339
18 (450mm)	900	S162	533	314	301
	1500		533	314	304
20 (500mm)	900	160	660	463	994
	1500		660	463	994
20 (500mm)	900	180	660	381	994
	1500		660	381	994
24 (600mm)	900	180	749	578	1750
	1500		749	578	1750
24 (600mm)	900	200-220	749	533	1300
	1500		749	533	1300
30 (750mm)	900	251	992	584	2950
	1500		992	584	2950

† Weights are for valve only and exclude mating clamps and bolting. Weight will vary according to corrosion allowance specification.

1. Clamps, seal rings and companion hubs are not included with the valve

2. Particular make of Hub Ends, Seal Ring Size and Clamp Style must be specified by customer. Relevant technical information should be obtained from the chosen clamp supplier, e.g. Grayloc®, Techlok®, Galperti®.

3. Dimension B: These are typical only. Due to the large variety of Hub End sizes and Clamp Styles available the face-to- face dimensions for a given size and rating may vary to maintain ASME and API design specifications. Please contact Goodwin for details prior to using above data as design criteria.

4. Valve sizes not listed above are available on application, together with customer specified end sizes and types. All valves are rated in accordance with ASME B 16.34, API 594 and API 598 design and application specifications.

5. Internals designed to suit customer's specified hub-ended bore details.

6. BHR(R) valves have reduced bore internals. C_V values available on request.

HEAVY DUTY HUB DIMENSIONS ARE AVAILABLE ON APPLICATION TO GOODWIN INTERNATIONAL

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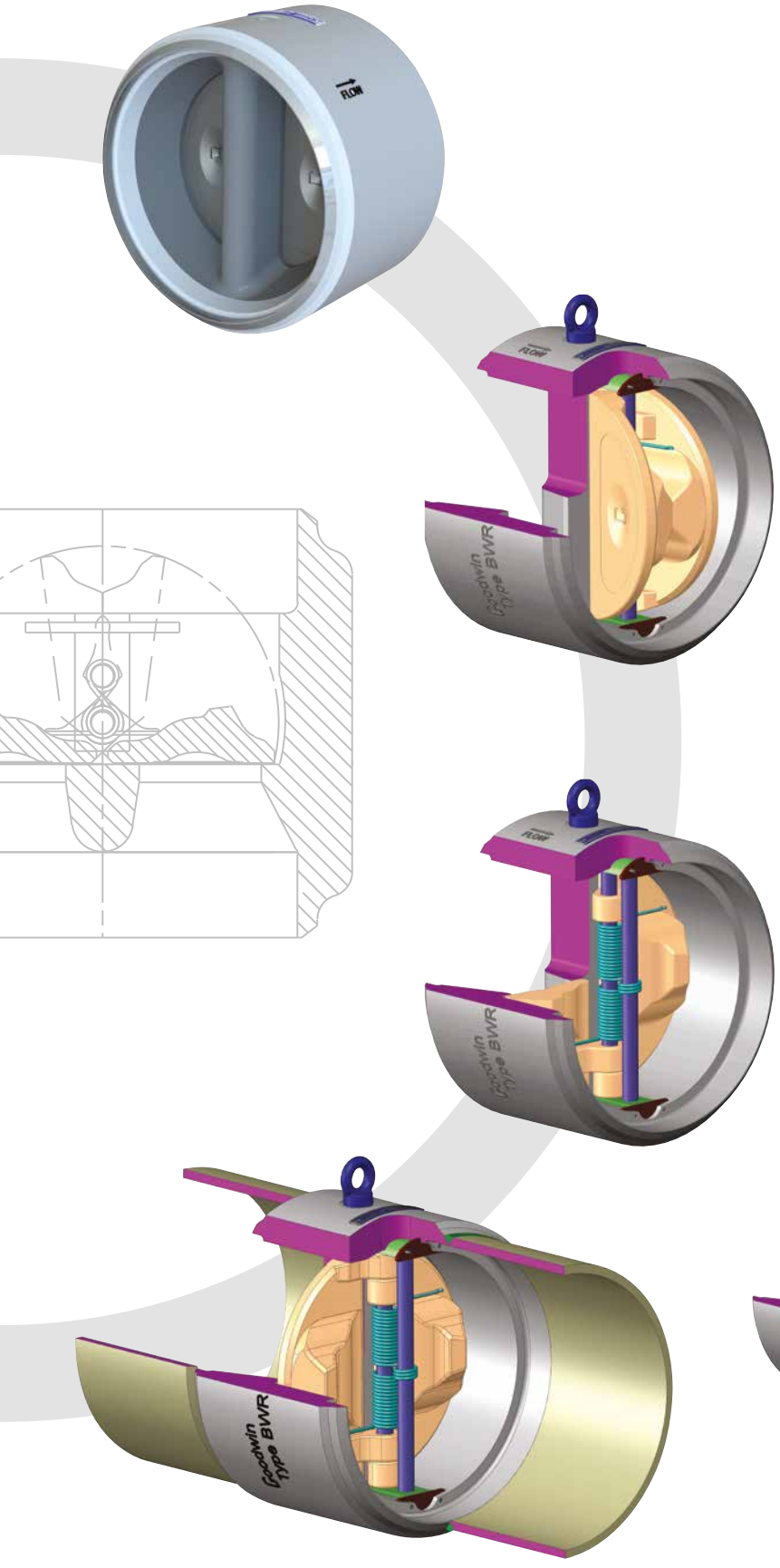
Buttweld End
Type BWR

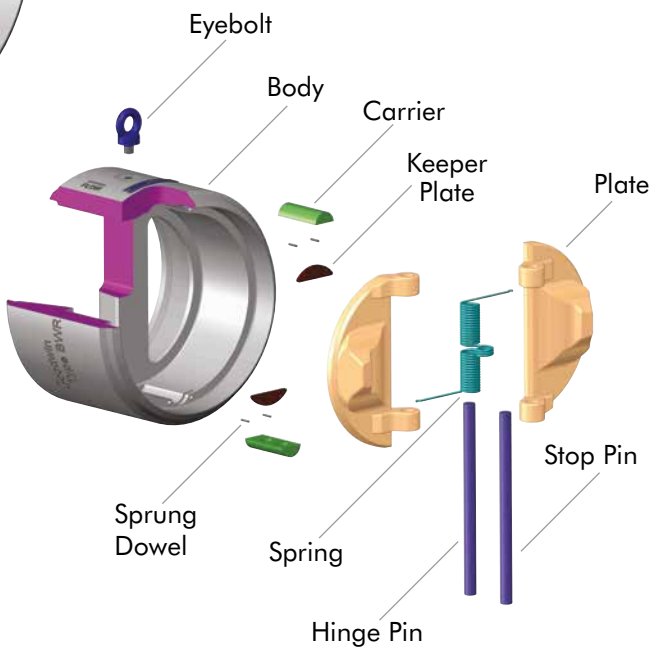


Buttweld End design. For direct welding into a piping system. Can be provided with transition and/or pup pieces

Retainerless
- Retainerless is standard in Goodwin Check Valves

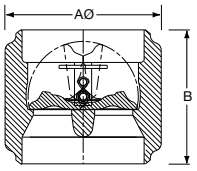
API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to Goodwin Standard

Unique Plate Design
- Pressure sensitive plate
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Type BWR

Installation Dimensions



Size mm	Pressure Rating ASME	A mm	B mm	Δ Valve Weight kg
3 (80mm)	150	98.0	136.0	6.5
	300	98.0	136.0	6.5
4 (100mm)	150	129.5	120.7	6.9
	300	129.5	120.7	7.4
	600	135.6	120.7	8.5
	900	146.7	165.1	14
	1500	155.1	165.1	16
	2500	169.8	165.1	19
6 (150mm)	150	168.3	136.5	13
	300	168.3	136.5	13
	600	171.9	136.5	15
	900	228.8	206.4	28
	1500	228.8	206.4	37
	2500	228.8	206.4	44
8 (200mm)	150	226.5	152.4	22
	300	226.5	152.4	25
	600	239.5	215.9	43
	900	252.2	292.1	69
	1500	284.2	292.1	92
	2500	312.6	292.1	113
10 (250mm)	150	270.6	187.3	43
	300	270.6	187.3	43
	600	289.4	262.0	78
	900	305.7	262.0	90
	1500	346.5	346.1	159
	2500	367.3	346.1	179
12 (300mm)	150	329.5	215.9	63
	300	329.5	215.9	69
	600	351.8	292.1	117
	900	372.6	317.5	159
	1500	419.2	349.3	234
	2500	367.3	412.8	344
14 (350mm)	150	380.0	260.4	102
	300	380.0	260.4	113
	600	381.8	355.6	199
	900	381.8	355.6	231
	1500	429.6	355.6	264
16 (400mm)	150	425.3	304.8	146
	300	425.3	304.8	164
	600	441.0	400.1	263
	900	469.5	400.1	315
	1500	493.8	438.2	434

Size mm	Pressure Rating ASME	A mm	B mm	Δ Valve Weight kg
18 (450mm)	150	475.4	330.2	190
	300	475.4	330.2	215
	600	487.5	409.6	306
	900	519.5	447.7	423
	1500	555.4	457.2	568
20 (500mm)	150	526.7	400.1	273
	300	526.7	400.1	213
	600	539.9	495.3	461
	900	578.0	546.1	637
	1500	621.7	546.1	855
24 (600mm)	150	609.6	342.9	361
	300	609.6	419.1	458
	600	635.4	546.1	722
	900	680.1	603.2	1020
	1500	738.5	660.4	1401
28 (700mm)	150	711.2	374.7	435
	300	727.1	419.1	572
	600	774.3	489.0	910
	900	822.1	584.2	1307
30 (750mm)	150	762.0	387.4	596
	300	768.4	431.8	715
	600	819.2	508.0	1098
	900	868.9	609.6	1568
32 (800mm)	150	812.8	368.3	572
	300	833.0	431.8	792
	600	887.3	533.4	1342
	900	940.2	635.0	1892
36 (900mm)	150	914.4	419.1	921
	300	914.4	482.6	1118
	600	944.8	552.5	1618
	900	1003.2	660.4	2292
40 (1000mm)	150	1016.0	469.9	1255
	300	1016.0	571.5	1607
	600	1057.8	660.4	2396
	900	1121.8	736.6	3256
42 (1050mm)	150	1066.8	508.0	1637
	300	1066.8	596.9	2013
	600	1109.6	673.1	2739
	900	1175.6	749.0	3767
48 (1200mm)	150	1219.2	520.7	1922
	300	1219.2	622.3	3180
	600	1219.2	698.5	3719
	900	1226.6	775.0	4174

Δ Weights are for valve only and exclude pup or transition pieces. Weight will vary according to corrosion allowance specification.

PIPE SCHEDULE

Customer must state pipe schedule at time of enquiry as this may necessitate transition pieces. The nominal bore of the valve will be determined by the pipe schedule selected by the customer and be in accordance with ASME B16.25

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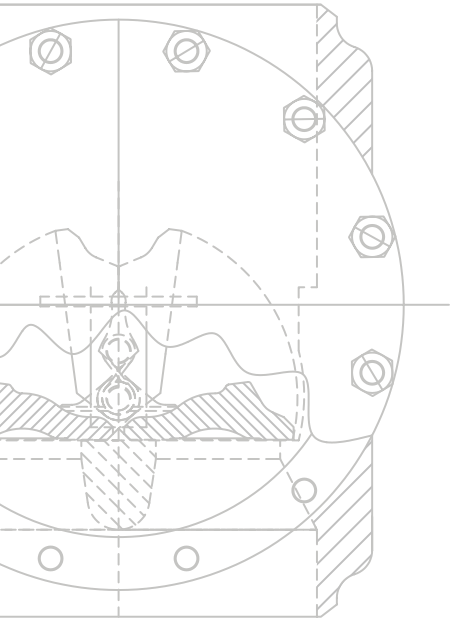
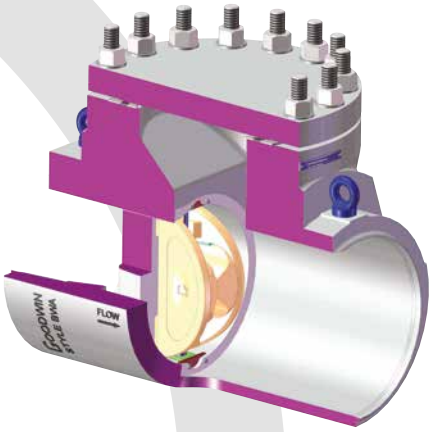
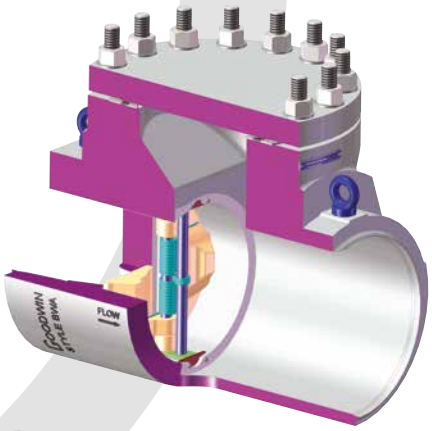
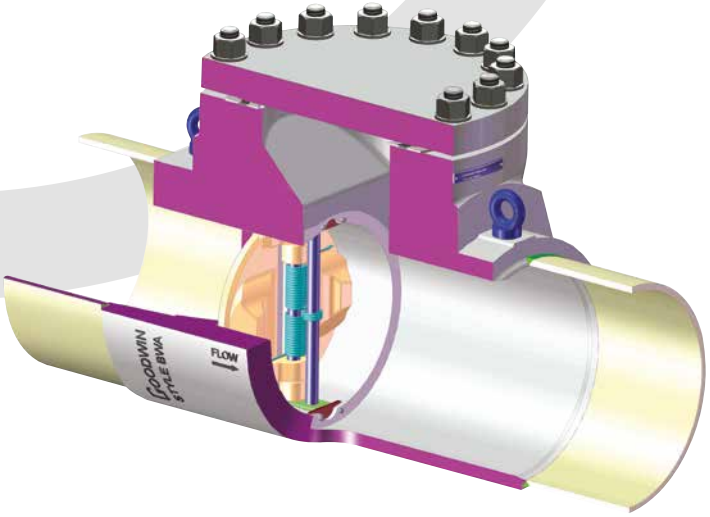
Buttweld End with Access
Type BWA

Buttweld End design with top bonnet access for inspection purposes. For direct welding into a piping system. Can be provided with transition and/or pup pieces.





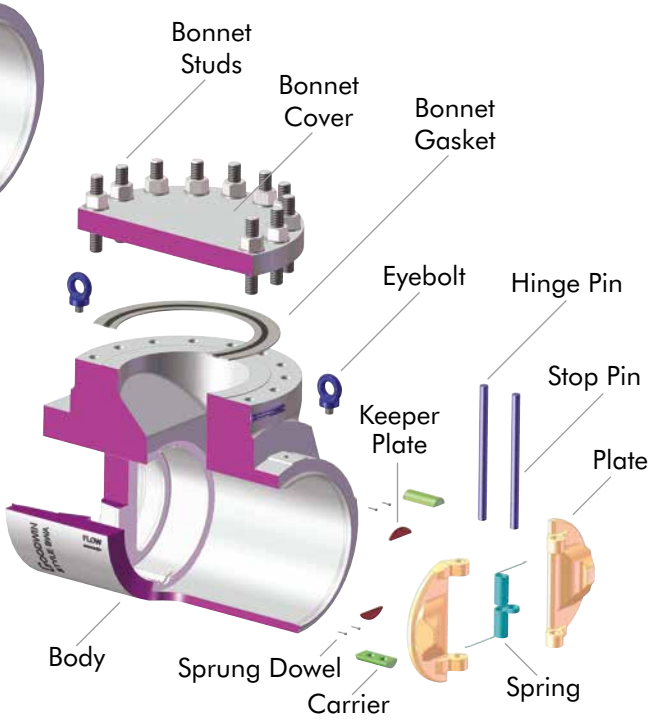




Retainerless
- Retainerless is standard in Goodwin Check Valves
- No screwed body plugs
  Note: Bolted bonnet for inspection

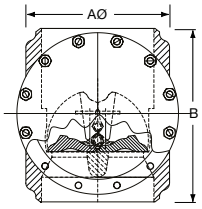
API 594
- Designed in accordance with API 594 / API 6D
- Face-to-face dimensions to Goodwin standard

Unique Plate Design
- Pressure sensitive plate
- Improved flow efficiencies
- Total Life Cycle Costs reduced
- Superior metal-to-metal sealing
- High degree of shut-off



Type BWA

Installation Dimensions



Size mm	Pressure Rating ASME	A mm	B mm	Δ Valve Weight kg
4 (100mm)	150	129.5	305	23
	300	129.5	305	25
	600	135.6	356	28
	900	146.7	356	41
	1500	155.1	406	53
	2500	169.8	457	69
6 (150mm)	150	168.3	406	51
	300	168.3	406	51
	600	171.9	508	62
	900	228.8	508	91
	1500	228.8	559	130
	2500	228.8	610	166
8 (200mm)	150	226.5	457	79
	300	226.5	457	89
	600	239.5	610	153
	900	252.2	660	208
	1500	284.2	711	298
	2500	312.6	762	387
10 (250mm)	150	270.6	533	138
	300	270.6	533	138
	600	289.4	737	274
	900	305.7	787	347
	1500	346.5	864	525
	2500	367.3	914	619
12 (300mm)	150	329.5	610	195
	300	329.5	610	214
	600	351.8	813	421
	900	372.6	914	591
	1500	419.2	991	860
	2500	367.3	1041	1144
14 (350mm)	150	380.0	686	301
	300	380.0	686	334
	600	381.8	889	656
	900	381.8	991	834
	1500	429.6	1067	1016
16 (400mm)	150	425.3	737	401
	300	425.3	737	451
	600	441.0	991	861
	900	469.5	1092	1118
	1500	493.8	1194	1540

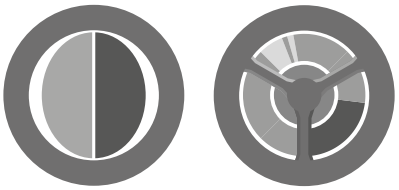
Size mm	Pressure Rating ASME	A mm	B mm	Δ Valve Weight kg
18 (450mm)	150	475.4	813	521
	300	475.4	813	591
	600	487.5	1092	1046
	900	519.5	1194	1474
	1500	555.4	1295	2081
20 (500mm)	150	526.7	864	684
	300	526.7	864	782
	600	539.9	1168	1423
	900	578.0	1321	1981
	1500	621.7	1372	2834
24 (600mm)	150	609.6	1067	1140
	300	609.6	1067	1228
	600	635.4	1295	2132
	900	680.1	1346	3065
	1500	738.5	1422	4089
28 (700mm)	150	711.2	1118	1382
	300	727.1	1118	1657
	600	774.3	1397	3152
	900	822.1	1448	4281
30 (750mm)	150	762.0	1168	1908
	300	768.4	1168	2093
	600	819.2	1448	3806
	900	868.9	1499	5103
32 (800mm)	150	812.8	1219	1997
	300	833.0	1219	2423
	600	887.3	1473	4604
	900	940.2	1524	6037
36 (900mm)	150	914.4	1372	3054
	300	914.4	1372	3301
	600	944.8	1499	5555
	900	1003.2	1549	7174
40 (1000mm)	150	1016.0	1422	4012
	300	1016.0	1422	4379
	600	1057.8	1524	7297
	900	1121.8	1575	9449
42 (1050mm)	150	1066.8	1422	5042
	300	1066.8	1422	5440
	600	1109.6	1524	8327
	900	1175.6	1600	10630
48 (1200mm)	150	1219.2	1524	6240
	300	1219.2	1524	8923
	600	1219.2	1626	11120
	900	1226.6	1700	12257

Δ Weights are for valve only and exclude pup or transition pieces. Weight will vary according to corrosion allowance specification.

PIPE SCHEDULE

Customer must state pipe schedule at time of enquiry as this may necessitate transition pieces. The nominal bore of the valve will be determined by the pipe schedule selected by the customer and be in accordance with ASME B16.25

Engineering Data



C_V Pressure Drop Formulae

For Liquids

$$Q = 0.865\, C_V \sqrt{\frac{\Delta P}{G_f}}$$

For Gases

$$Q = 417 C_v P_1 Y \sqrt{\frac{X}{G_g T_1 Z}}$$

Based on ISA-S75.01-1985 for
Fully developed turbulent flow.

Q = Liquid flow rate, m^3/h
Gas flow rate, sm^3/h (@ 1.013 bar and 15.6°C)
C_v = Valve flow coefficient, US gpm
ΔP = Pressure drop, bar
P_1 = Inlet pressure, bar abs.
G_f = Specific gravity of liquid @ 1.013 bar, 15.6°C
G_g = Specific gravity of gas @ 1.013 bar, 15.6°C
T_1 = Inlet temperature, K
Y = Valve Expansion Factor
X = $\Delta P/P_1$
Z = Gas Compressibility Factor
(Ideal Gas = 1)

DUAL PLATE CHECK VALVE FLOW COEFFICIENT (C_V)

ASME 150/300*	
Valve Size	C_V
2″	48
3″	150
4″	394
6″	900
8″	1589
10″	3300
12″	3926
14″	5418
16″	8256
18″	10452
20″	14251
24″	26511
26″	30000
28″	33600
30″	38400
32″	48000
36″	55200
40″	84000
42″	96000
48″	107600

*See graphs for C_V values for ASME 600#, 900#, 1500# & 2500#.

AXIAL CHECK VALVE FLOW COEFFICIENT (C_V)

ZB VALVES ALL PRESSURE CLASSES

Valve Size	ZB
1"	24
1¼"	41
1½"	65
2"	103
2½"	181
3"	282
4"	452
5"	725
6"	1071
8"	1966
10"	3163

NK/NB VALVES ASME 150/300

Valve Size	NK	NB
12"	2808	4425
14"	3884	6127
16"	5158	8146
18"	6609	10436
20"	8262	13046
22"	10048	15887
24"	12051	19029
26"	14369	22629
28"	16893	26601
30"	19501	30748

The above tabulated C_V values are for the most commonly used axial valves. For the full range of C_V valves please see the graphs on the following pages or contact Goodwin.

Valve Cracking Pressures

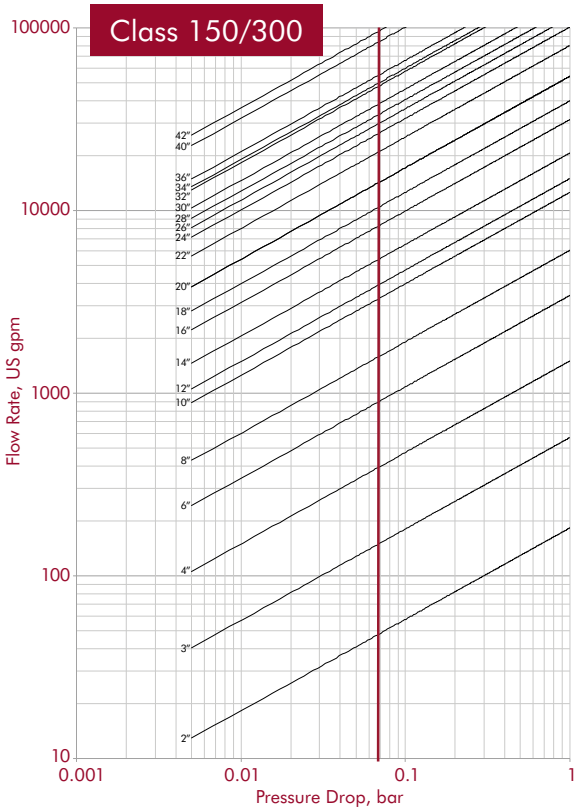
On the initial opening of a check valve, such as at system start-up, the upstream pressure applied by the flow to the front of the plates/disc is required to overcome the force of the spring and any upstream back pressure acting on the back of the plates/disc. The pressure differential at which this happens is known as the "cracking pressure". When the pressure differential exceeds the cracking pressure, the valve plates/disc are "cracked open" from the valve seat and the media can flow.

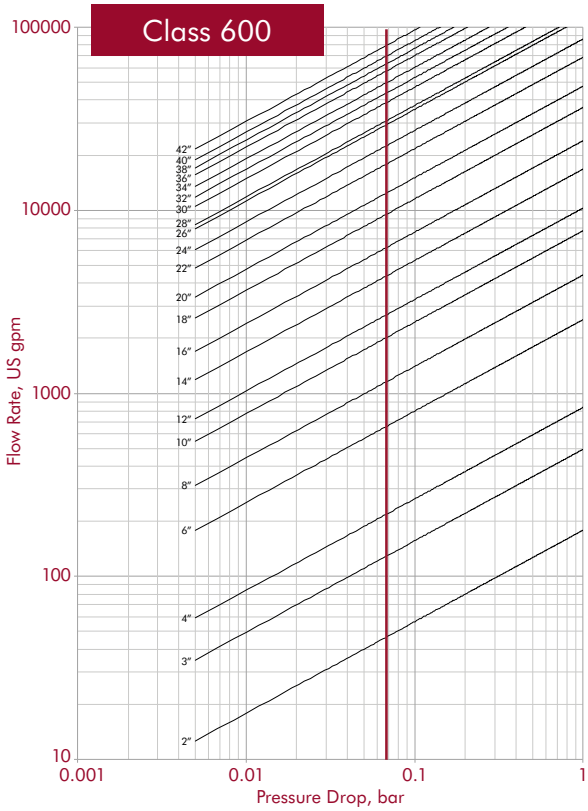
As soon as the plates /disc are cracked open the media cannot sustain a pressure differential and at this point the plates are not kept open by pressure, but by the fluid velocity (see Critical velocity).

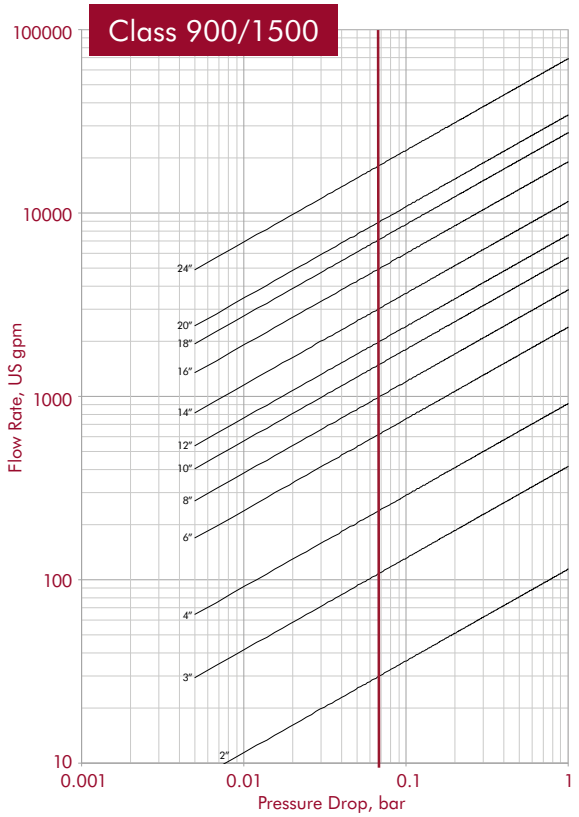
Specific values for cracking pressures at atmospheric conditions can be obtained from Goodwin upon request.

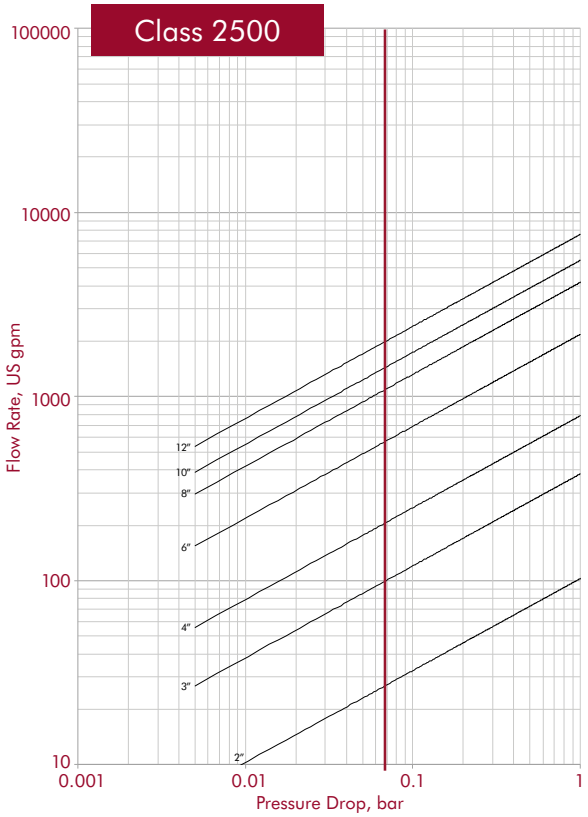
Dual Plate Check Valves

Pressure Loss / Flow Coefficient (C_V)









Pressure drop versus flow, as depicted in the above graphs, have been established following tests carried out at Delft Hydraulics Laboratories.

The flow curves do not show the full Goodwin range. Upon request Goodwin can manufacture valves in sizes up to 144" diameter and in pressure classes up to API 20000.

Critical Velocity

All check valves should be used in the fully open position. This means that the force provided by the flowing fluid must be greater than the force from the spring(s). This velocity is known as the "Critical Velocity", i.e. that fluid velocity required to keep the plates or disc of a valve fully open.

If the fully open position is not reached any pressure drop calculations would be invalid as the C_V of a valve is determined on the basis of the valve being fully open. With the valve plates or disc only partially open, i.e. the flow velocity being less than the critical velocity of the valve, then a higher pressure drop will exist than would otherwise be calculated.

Goodwin offers a range of spring options requiring different critical velocities to ensure a fully open valve can be selected to suit customer flow data that will be both chatter-free and provide excellent dynamics. All Critical Velocities in the tables are for water. When the fluid is gaseous an energy balance can be applied to convert the media velocity to a water equivalent velocity.

For valves that are installed in a vertical flow up or inclined up position, it must be borne in mind that the fluid velocity must be sufficient to overcome the weight vector of the plates/disc in addition to the Critical Velocity of the spring.

For flow velocities different to those on the right, please consult Goodwin. Other spring strengths are available.

Dual Plate Check Valve Springs

Spring	Critical Velocity
Mini-Torque	1.5 m/s
Low Torque	2.0 m/s
High Torque (Standard)	3.0 m/s
Super Torque	4.4 m/s

Axial Check Valve Springs

Spring	Critical Velocity
#1	1.5 m/s
#2	2.0 m/s
#3	2.5 m/s
#4	3.0 m/s

$$v_{Water,equivalent} = v_{Medium}\sqrt{\frac{\rho_{Medium}}{\rho_{Water}}}$$

Chatter / Flutter

Chatter or flutter will occur when the forward flow is insufficient to fully open the valve plates/disc, i.e. flow through the valve is less than the critical velocity of the valve. Chatter/Flutter will ultimately lead to premature failure of a valve's internal components. A correctly sized check valve should be fully open when operating in forward flow.

To ensure a valve is fully open, the flow through the valve must exceed the 'critical velocity'. The spring must be chosen such that it is weaker than the flow through the valve, otherwise the valve will be only partially open.

Pressure Surge

A check valve closing against a rapidly moving reverse-flowing liquid induces a pressure rise in the downstream region of the line at the moment of closure.

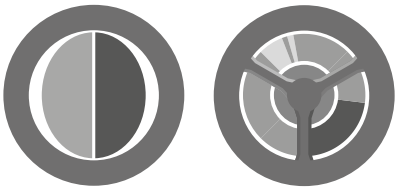
This pressure rise can become large and result in a surge of high pressure moving back down the line as a shock wave.

The magnitude of this pressure was characterised by Joukowsky as:

$$\Delta P_{SURGE} = \frac{\rho \cdot c \cdot v_r}{1\times10^5}$$

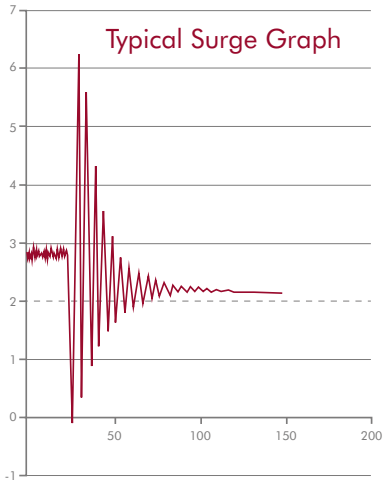
Where ΔP is the maximum surge pressure (bar), r is the media density (kg/m³), c is the celerity (velocity of sound in the line, m/s), v_r is the maximum reverse velocity of the fluid (m/s).

The Phenomenon of Surge



Closing a valve against a moving body of fluid results in pressure pulses. These pulses become stronger as the magnitude of the velocity change increases. A common example of this is when a check valve closes following a pump trip. The pressure pulse can be high and is known as surge or water-hammer.

Whereas surge is the phenomenon of the advancing pressure wave, the term 'slam' relates more specifically to the valve itself, which can be the root cause of the surge. Valve slam occurs after a pump stops when the forward flow decelerates, reverses and accelerates back towards the pump. The check valve must close quickly before the reverse velocity is too high, in order to minimise the surge pressure and protect the line.



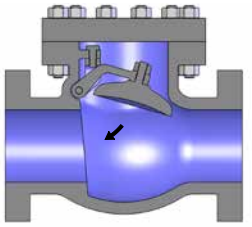
Surge Mitigation

Extensive research has been conducted (Prof. A.R.D. Thorley) into the dynamic response of all types of check valves. It has been found that slam can be reduced by improving the dynamic response of the valve. This is achieved by ensuring that:

- The disc has low inertia and friction
- The travel of the disc is short
- The closure of the disc is assisted with springs

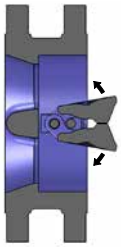
By meeting these requirements, Goodwin provide a range of non-slam check valves to suit up to the most severe of customer requirements.

Swing Check



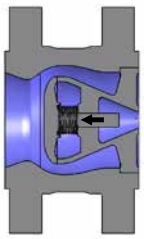
Low Inertia	No
Minimal Travel	No
Mechanical Assistance	No

Dual Plate Check



Low Inertia	Yes
Minimal Travel	No
Mechanical Assistance	Yes

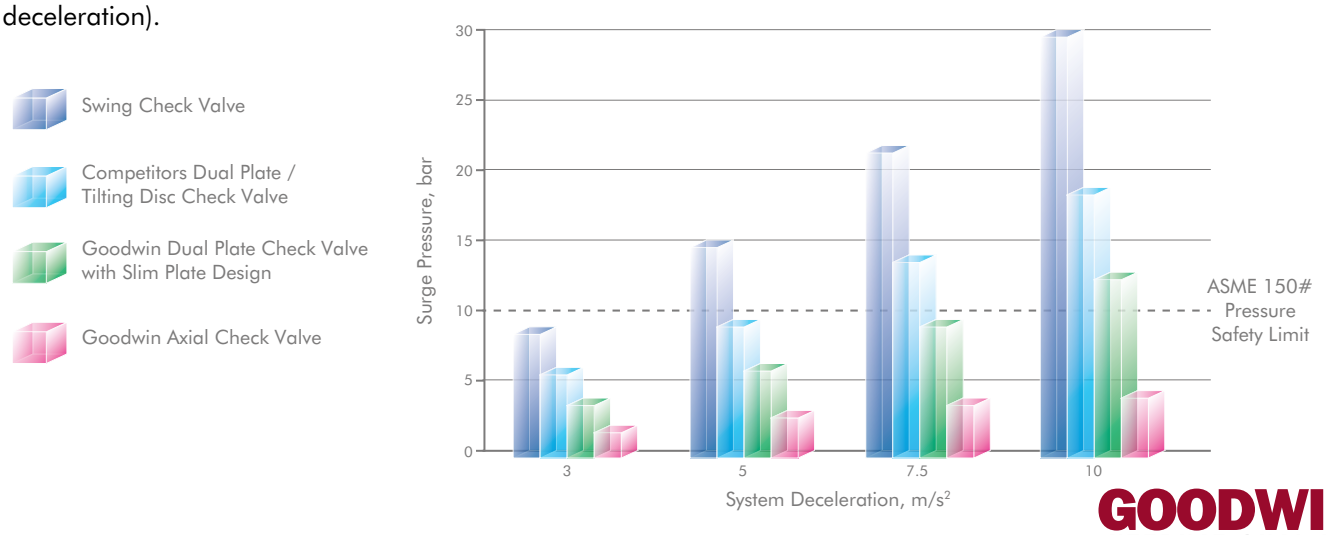
Axial Check



Low Inertia	Yes
Minimal Travel	Yes
Mechanical Assistance	Yes

Valve Selection

The magnitude of the surge pressure can be approximated using the Joukowsky equation (See 'Pressure Surge'). A valve can then be selected based upon the severity of the system into which it is installed (how high the system deceleration).



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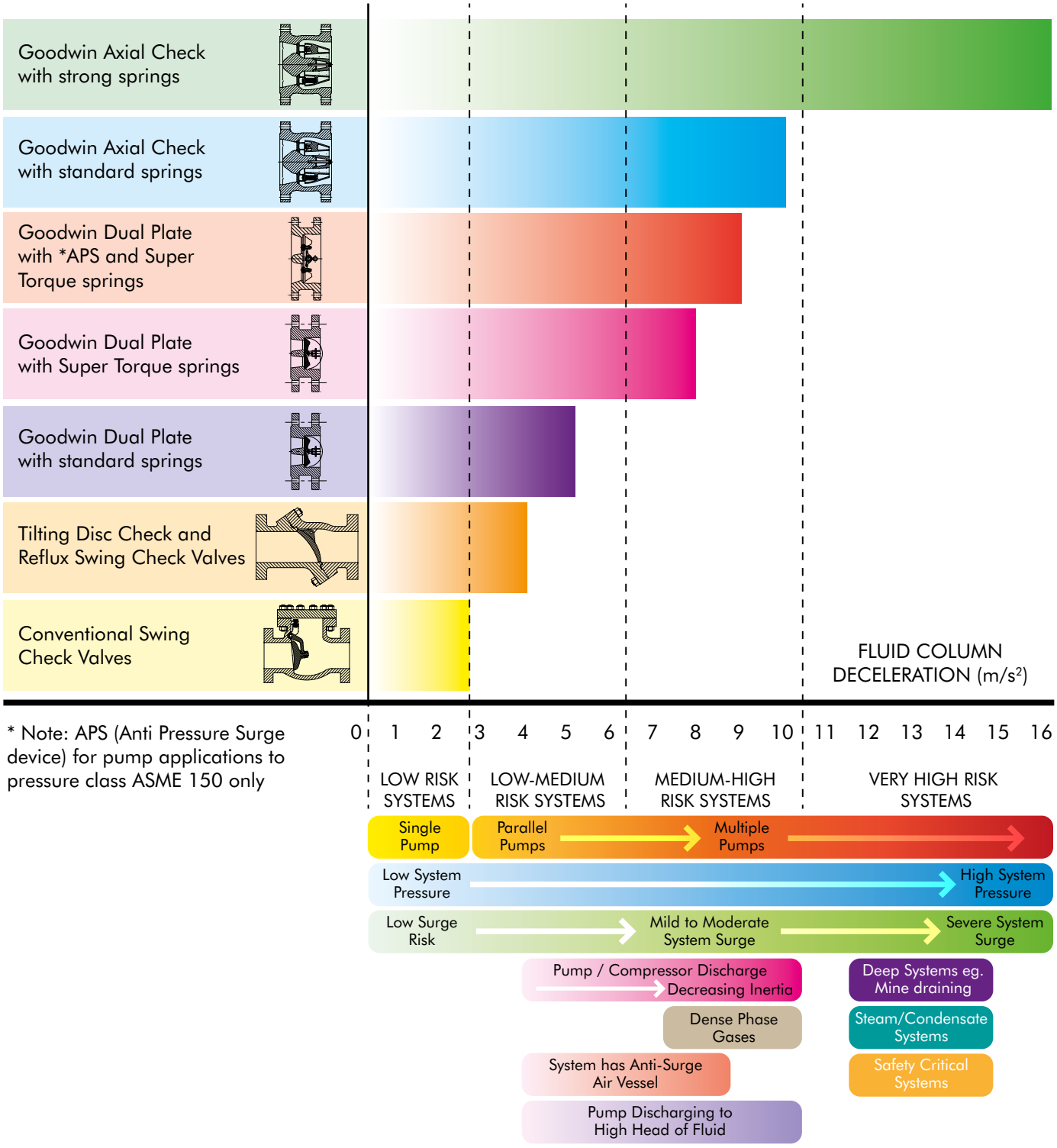
Check Valve Selection based upon System Deceleration Characteristic

Check Valve Types



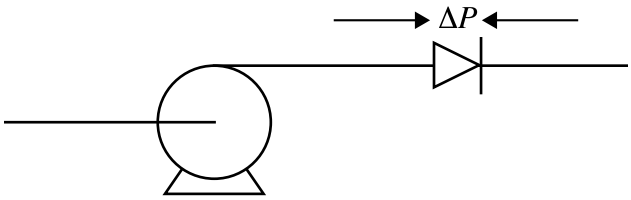
* Note: APS (Anti Pressure Surge device) for pump applications to pressure class ASME 150 only

The above check valve selections and information are for guidance only. Please consult Goodwin for Check Valve applications.

Total Life Cycle Costs

As fluid passes through a check valve there will be a drop in pressure. To maintain the flow-rate, the pump will need to compensate for this pressure loss by working harder.

Today, energy cost is a prime concern for all plant manufacturers – the below analysis shows why a low pressure drop check valve should be considered for long-term economic benefit.



		SWING CHECK	COMPETITOR DUAL PLATE	GOODWIN DUAL PLATE	GOODWIN AXIAL
Check Valve Size	mm	DN400	DN400	DN400	DN400
ΔP Coefficient	ξ	1.21	1.05	0.81	0.83
Pipe Velocity, v	m/s	3.00	3.00	3.00	3.00
Flow Rate, Q	m^3/s	0.342	0.342	0.342	0.342
Pressure Loss, ΔP	Pa	5551	4817	3716	3807
Pump Power, P	kW	2.5313	2.1966	1.6945	1.7360
Energy Cost /Year	$	2,430	2,109	1,627	1,667
Life Cycle Cost	$	48,600	42,180	32,540	33,340

Area of Sch. 40 DN400 Pipe $=0.1140m^2$

Pipe velocity = Critical velocity (3.0m/s)

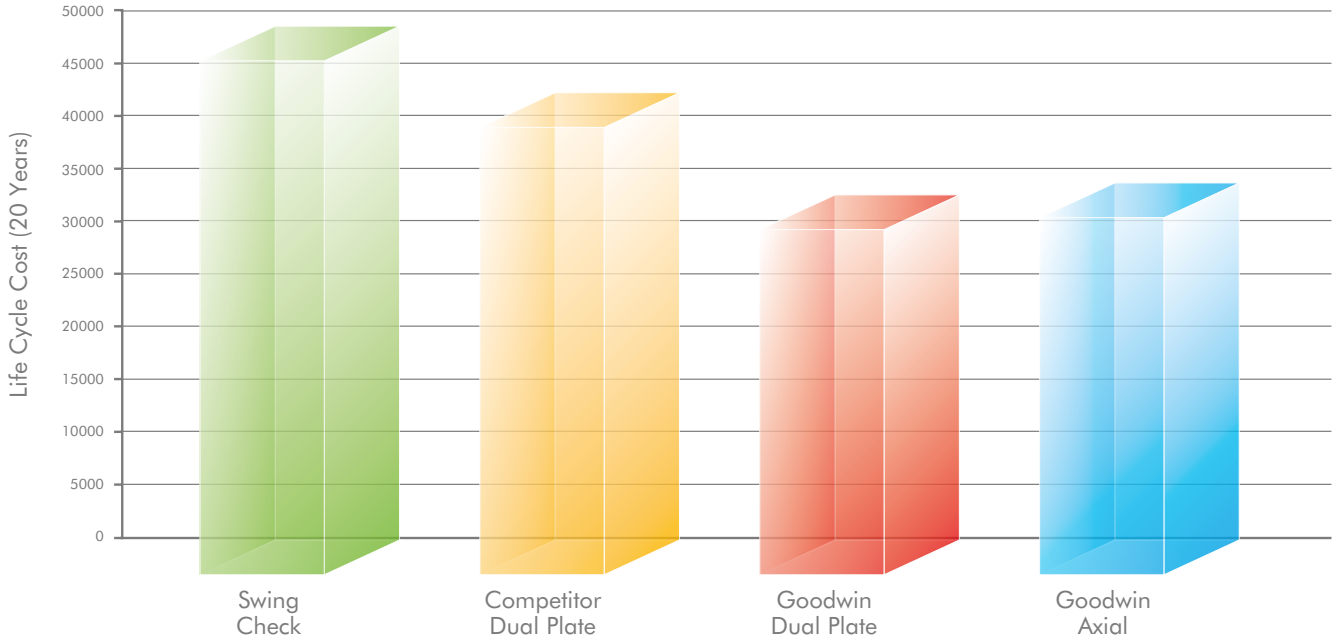
$Q = Av = 0.1140 \times 3.0 = 0.342m^3/s$

$$\Delta P = {10000 \xi v^2}/{2g}$$

$$P = {Q}/{1000} \cdot {\Delta P}/{\eta}$$ (η = efficiency = 0.75)

Cost = P x Cost/yr x hrs/yr*
= Annual Cost x 20 years

Energy Cost = 0.12 $/kWh
8000 hrs/year



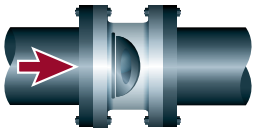
Some swing check valves appear to offer higher Cv values and, therefore, lower pressure losses. However, such pressure losses are only achieved when the valve is 100% open which invariably requires a high fluid velocity – a consequence of which is high system pressure loss. Reducing the flowrate to address this problem causes the valve to partially close resulting in severe valve pressure drop, whereas the Goodwin Dual Plate and Axial Check Valves would still be 100% open and performing well.

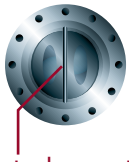
With swing check valves other issues arise in high velocity systems - such as slam and water hammer.

Dual Plate Check Valves
Best Practice Valve Installation

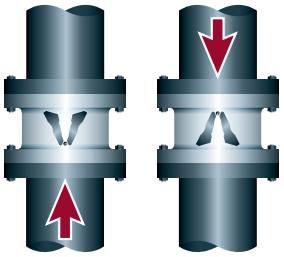
Piping components such as pumps, compressors, valves, reducers, bends, elbows create turbulence in a flow stream. To maximise the life of a Dual Plate Check Valve, it should be installed in accordance with industrial best practice i.e. a sufficient distance from turbulence sources to ensure the valve is in fully developed flow. Examples of recommended best practice installation for Dual Plate Check Valves are:

Horizontal Flow



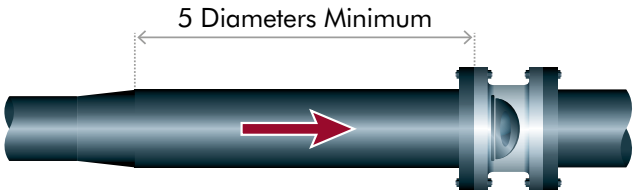


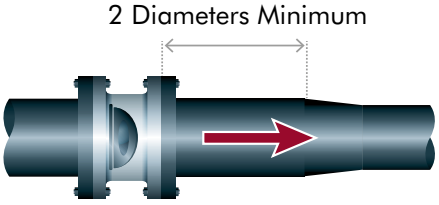
Vertical Flow

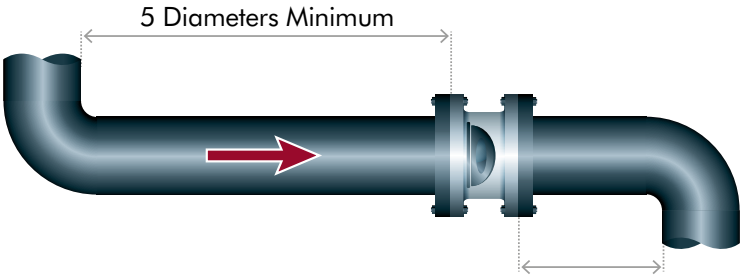


Valves (with standard springs) suitable for vertical flow up in sizes to and including 12", and flow down for sizes to and including 8".

For vertical flow in larger valve sizes, please contact Goodwin International with process conditions.





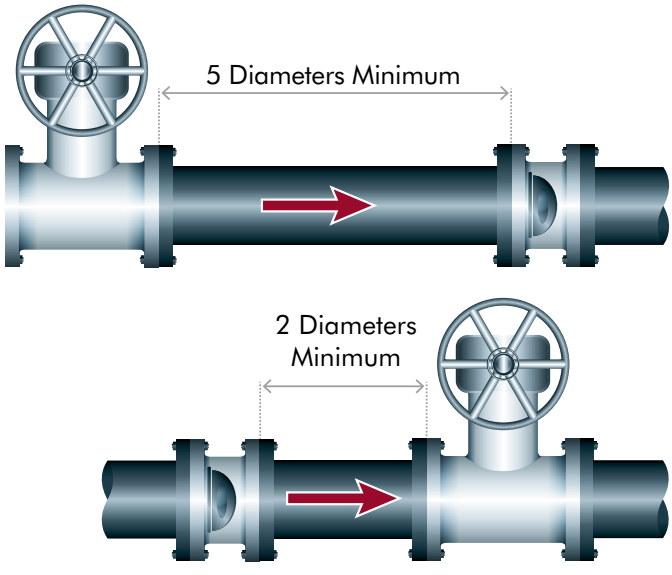


Check Valve should be installed a minimum of 5 diameters downstream of a reducer/ expander or bend to ensure flow at valve is fully developed and turbulence is minimised.

Check Valve should be installed a minimum of 2 diameters upstream of a reducer or bend to avoid choked flow, which would cause the valve to only partially open.

When installed near a throttling valve, the check valve should be installed a minimum of 5 diameters downstream, or 2 diameters upstream, of the throttling valve.

Check Valves can be close coupled upstream or downstream of non-throttling isolation valve (e.g. Full Port Ball Valves). On ball valves, disc clearance must be considered to ensure full operation of the ball valve.



Note: Goodwin Check Valves are not piggable

Indicates direction of flow

Material Specifications

	ASTM GRADE	MATERIAL DESCRIPTION	MIN UTS (Nmm²)	(ksi)	MIN YIELD (Nmm²)	(ksi)	MINIMAL IMPACT (J)	PREn Δ	NOMINAL COMPOSITION C	Cr	Ni	Mo	Cu	N	v	W	Nb
GENERAL PURPOSE	A216 WCB	Carbon Steel	485	70	250	36	-	-	0.23	-	-	-	-	-	-	-	-
	A105	Forged Carbon Steel	485	70	250	36	-	-	0.23	-	-	-	-	-	-	-	-
	B148 C95800	Aluminium Bronze	600	87	250	36	-	-	-	-	4.5	-	79min	-	-	-	-
	A487 4C	Low Alloy Steel	620	90	415	60	-	-	0.20	0.5	0.5	0.25	-	-	-	-	-
LOW TEMP	A352 LCB	Low Temp Carbon Steel	450	65	240	35	27@ -46°C (-50°F)	-	0.23	-	-	-	-	-	-	-	-
	A352 LCC	Low Temp Carbon Steel	485	70	275	40	27@ -46°C (-50°F)	-	0.23	-	-	-	-	-	-	-	-
	A350 LF2	Low Temp Carbon Steel	485	70	250	36	27@ -46°C (-50°F)	-	0.23	-	-	-	-	-	-	-	-
	A352 LC3	Low Temp Alloy Steel	485	70	275	40	27@ -101°C (-150°F)	-	0.10	-	3.5	-	-	-	-	-	-
	A351 CF8M	Cryogenic Stainless Steel	485	70	205	30	80@ -196°C (-320°F)	27	0.08*	19	10	2.50	-	-	-	-	-
	A351 CF3M	Cryogenic Stainless Steel	485	70	205	30	80@ -196°C (-320°F)	27	0.03*	19	10	2.50	-	-	-	-	-
HIGH TEMP	A217 WC6	Chrome Molybdenum Steel	485	70	275	40	-	-	0.10	1.25	-	0.50	-	-	-	-	-
	A217 C5	Chrome Molybdenum Steel	620	90	415	60	-	-	0.10	5.0	-	0.50	-	-	-	-	-
	A217 C12	Chrome Molybdenum Steel	620	90	415	60	-	-	0.10	9.0	-	1.00	-	-	-	-	-
	A217 C12A	Chrome Molybdenum Steel	585	85	415	60		-	0.10	9.0	-	1.0	-	0.05	0.20	-	0.8
	A351 CF8M	Stainless Steel	485	70	205	30	-	27	0.08*	19	10	2.50	-	-	-	-	-
	A351 CF8C	Stainless Steel	485	70	205	30	-	20	0.08*	19	10	0.5*	-	-	-	-	8 x C
HARD WEARING	A217 CA15	Chrome Stainless Steel	620	90	450	65	-	-	0.10	13	-	-	-	-	-	-	-
	A487 CA6NM	Low Temp Chrome Stainless Steel	760	110	515	80	-	-	0.03	13	4.5	0.75	-	-	-	-	-
CORROSION RESISTANT MATERIAL	A351 CF8M	Stainless Steel	495	70	205	30	-	27	0.08*	19	10	2.5	-	-	-	-	-
	A890 4A & A995 4A	Duplex 22% Cr	620	90	415	60	45 @ -40°C (-40°F)	34	0.03*	22	5.5	3	-	0.15	-	-	-
	A890 5A & A995 5A	Super Duplex 25% Cr	690	100	515	75	45 @ -50°C (-58°F)	-	0.03*	25	7.5	4.5	-	0.25	-	-	-
	A890 6A & A995 6A	Super Duplex 25% Cr	690	100	450	65	-	41	0.03*	25	7.5	3.5	0.75	0.25	-	0.75	-
	A351 CK3MCuN	Super Austenitic	550	80	260	38	-	44	0.025*	20	18	6.5	0.75	0.2	-	-	-
	A494-M35-2	Monel	450	65	205	30	-	-	0.35*	-	BAL	-	30	-	-	-	0.5*
	A494 CU5MCuN	High Nickel 825	520	75	240	35	-	-	0.03	21	41	3	2	-	-	-	0.9
	A494 CW-6MC	High Nickel 625	485	70	275	40	-	-	0.03	21	62	9	-	-	-	-	3.5
	A494 CW-12MW	Hastelloy® C276	495	72	275	40	-	-	0.03	16	57	17	-	-	0.35	4	-
	A494 N-7M	Hastelloy® B2	525	76	275	40	-	-	0.03	1*	67	32	-	-	-	-	-
	A494 CX2MW	Hastelloy® C22	550	80	280	45	-	-	0.02*	22	56	13	-	-	0.3	3	-
	B367C2/B348Gr.2	Titanium	345	50	275	40	-	-	0.10*	-	-	-	-	-	-	-	-

* Max

Δ PREn = Pitting Resistance Equivalent number

ASME B16.34 Pressure/Temperature Ratings

Maximum Non-Shock Working Pressure (Standard Class) Bar

	150				300				600			
Temperature °C	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6
-29 to 38	19.6	19.8	19.6	19.8	51.1	51.7	51.1	51.7	102.1	103.4	102.1	103.4
50	19.2	19.5	19.2	19.5	50.1	51.7	50.1	51.7	100.2	103.4	100.2	103.4
100	17.7	17.7	17.7	17.7	46.6	51.5	46.6	51.5	93.2	103.0	93.2	103.0
150	15.8	15.8	15.8	15.8	45.1	50.2	45.1	49.7	90.2	100.3	90.2	99.5
200	13.8	13.8	13.8	13.8	43.8	48.6	43.8	48.0	87.6	97.2	87.6	95.9
250	12.1	12.1	12.1	12.1	41.9	46.3	41.9	46.3	83.9	92.7	83.9	92.7
300	10.2	10.2	10.2	10.2	39.8	42.9	39.8	42.9	79.6	85.7	79.6	85.7
350	8.4	8.4	8.4	8.4	37.6	40.0	37.6	40.3	75.1	80.0	75.1	80.4
400	6.5	6.5	6.5	6.5	34.7	34.7	34.7	36.5	69.4	69.4	69.4	73.3
450	4.6	4.6	4.6	4.6	23.0	23.0	23.0	33.7	46.0	46.0	46.0	67.7
500	2.8	2.8	2.8	2.8	11.8	11.6	11.8	25.7	23.5	23.2	23.5	51.5
538	1.4	1.4	1.4	1.4	5.9	5.9	5.9	14.9	11.8	11.8	11.8	29.8

	900				1500				2500			
Temperature °C	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6	A216 WCB / A105	A352 LCC	A350 LF2	A217 WC6
-29 to 38	153.2	155.1	153.2	155.1	255.3	258.6	255.3	258.6	425.5	430.9	425.5	430.9
50	150.4	155.1	150.4	155.1	250.6	258.6	250.6	258.6	417.7	430.9	417.7	430.9
100	139.8	154.6	139.8	154.4	233.0	257.6	233.0	257.4	388.3	429.4	388.3	429.0
150	135.2	150.5	135.2	149.2	225.4	250.8	225.4	248.7	320.8	418.1	375.6	414.5
200	131.4	145.8	131.4	143.9	219.0	243.2	219.0	239.8	365.0	405.4	365.0	399.6
250	125.8	139.0	125.8	139.0	209.7	231.8	209.7	231.8	349.5	386.2	349.5	386.2
300	119.5	128.6	119.5	128.6	199.1	214.4	199.1	214.4	331.8	357.1	331.8	357.1
350	112.7	120.1	112.7	120.7	187.8	200.1	187.8	201.1	313.0	333.5	313.0	335.3
400	104.2	104.2	104.2	109.8	173.6	173.6	173.6	183.1	289.3	289.3	289.3	304.9
450	69.0	69.0	69.0	101.4	115.0	115.0	115.0	169.0	191.7	191.7	191.7	281.8
500	35.3	35.3	35.3	77.2	58.0	57.9	58.8	128.6	97.9	96.5	97.9	214.4
538	17.7	17.7	17.7	44.7	29.5	29.5	29.5	74.5	49.2	49.2	49.2	124.1

	150				300				600			
Temperature °C	A351 CF8M / CF3M	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*	A351 CF8M / CF3M CF3M	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*	A351 CF8M / CF3M A351	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*
-29 to 38	19.0	19.0	20.0	20.0	49.6	49.6	51.7	51.7	99.3	99.3	103.4	103.4
50	18.4	18.7	19.5	19.5	48.1	48.8	51.7	51.7	96.2	97.5	103.4	103.4
100	16.2	17.4	17.7	17.7	42.2	45.3	50.7	51.5	84.4	90.6	101.3	103.0
150	14.8	15.8	15.8	15.8	38.5	42.5	45.9	50.3	77.0	84.9	91.9	100.3
200	13.7	13.8	13.8	13.8	35.7	39.9	42.7	48.3	71.3	79.9	85.3	96.7
250	12.1	12.1	12.1	12.1	33.4	37.8	40.5	46.3	66.8	75.6	80.9	92.7
300	10.2	10.2	10.2	10.2	31.6	36.1	38.9	42.9	63.2	72.2	77.7	85.7
350	8.4	8.4	-	8.4	30.3	34.8	-	40.3	60.7	69.5	-	80.4
400	6.5	6.5	-	6.5	29.4	33.9	-	36.5	58.9	67.8	-	73.3
450	4.6	4.6	-	4.6	28.8	33.5	-	33.7	57.7	66.9	-	67.7
500	2.8	2.8	-	2.8	28.2	28.2	-	28.2	56.5	56.5	-	56.5
538	1.4	1.4	-	1.4	25.2	25.2	-	25.2	50.0	50.0	-	50.0

	900				1500				2500			
Temperature °C	A351 CF8M / CF3M	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*	A351 CF8M / CF3M	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*	A351 CF8M / CF3M	A351 CF8C	A995 4A A995 6A	A494 CW6MC 625 ALLOY*
-29 to 38	148.9	148.9	155.1	155.1	248.2	248.2	258.6	258.6	413.7	413.7	430.9	430.9
50	144.3	146.3	155.1	155.1	240.6	243.8	258.6	258.6	400.9	406.4	430.9	430.9
100	126.6	135.9	152.0	154.6	211.0	226.5	253.3	257.6	351.6	377.4	422.2	429.4
150	115.5	127.4	137.8	150.6	192.5	212.4	229.6	250.8	320.8	353.9	382.7	418.2
200	107.0	119.8	128.0	145.0	178.3	199.7	213.3	241.7	297.2	332.8	355.4	402.8
250	100.1	113.4	121.4	139.0	166.9	189.1	202.3	231.8	278.1	315.1	337.2	386.2
300	94.9	108.3	116.6	128.6	158.1	180.4	194.3	214.4	263.5	300.7	323.8	357.1
350	91.0	104.3	-	120.7	151.6	173.8	-	201.1	252.7	289.6	-	335.3
400	88.3	101.7	-	109.8	147.2	169.5	-	183.1	245.3	282.6	-	304.9
450	86.5	100.4	-	101.4	144.2	167.3	-	169.0	240.4	278.8	-	281.8
500	84.7	84.7	-	84.7	140.9	140.9	-	140.9	235.0	235.0	-	235.0
538	75.2	75.2	-	75.2	125.5	125.5	-	125.5	208.9	208.9	-	208.9

* Extrapolations from materials with similar CR/NI/MO content

Large Diameter Check Valves

Goodwin specialises in the manufacture of large diameter valves being capable of manufacturing both its Dual Plate Check Valve and the Axial Check Valve in sizes to 144" and 88" respectively in all materials and in all relevant pressure classes.

Applicable Flange Standards

26" - 60": ASME B16.47 Series A
ASME B16.47 Series B

66" - 144": AWWA C207 Class B, D, E & F
(Flat Face flanges)
Taylor Forge (Raised Face flanges)
or
Customer agreed flange design

52" 300# Axial Check Valve Type NKF

Large diameter check valves are utilised throughout the hydrocarbon, energy and process industries in a wide variety of applications. Goodwin Check Valves are in service in applications ranging from potable water and seawater to hydrocarbon gas and LNG in materials such as Carbon Steel, Aluminium Bronze, Duplex Stainless Steel and CF8M Stainless Steel.

Typical Goodwin Large Diameter Check Valve Applications

- Pipelines: Extensive use in the compressor stations and pumping stations of many of the world's cross-country and country-to-country pipelines. Many for the transportation of energy and traversing 1000s of kilometres, by their nature these pipelines are critical - Goodwin Check Valves are selected for their reliability and high performance.
- Ethylene Centrifugal Compressor Trains: Employed on the discharge of each compressor stage, Goodwin Check Valves prevent any potential for backflow to protect compressors against reverse rotation and over pressurisation and the consequent mechanical damage.
- LNG: Especially used within the liquefaction plants, large diameter Goodwin Check Valves are in service at -161°C

84" 150# Dual Plate Check Valve

- Seawater intake line and seawater discharge pumps: Used on the discharge of the pumps, Goodwin Check Valves protect the pumps against reverse rotation and the consequential mechanical damage.

Cryogenic Valves

Goodwin International has its own in-house cryogenic test facility where it is capable of pressure testing at temperatures from ambient temperature down to -196°C.

Cryogenic testing is conducted by immersing the valve in Liquid Nitrogen to cool to the desired temperature which is monitored and recorded at a number of locations on the valve, both internally and externally. Once temperature has stabilised, the pressure test commences using pure Helium (for low temperature testing: Nitrogen or 99% Nitrogen / 1% Helium) as the test medium. Pressure can be increased in increments and seat leakage measured at each increment. Test pressure depends on the rating of the valve and the maximum is limited by the working pressure as designated by ASME B16.34.

Seat leakage is measured with calibrated flow meters. Valve Inspection and Test Standard API 598 defines the maximum permissible leakrate with air or inert gas at ambient temperature conditions as 700cc/minute/inch bore diameter. However, for cryogenic service Goodwin manufactures, as standard, both its valves* with a maximum leakrate of 450cc/minute/NPS (ISO5208 Rate E) with Helium at -196° C. Goodwin has selected this maximum leakrate in response to the requirements of today's LNG plant designers.

Following the seat leak test, valve body integrity is tested whereby the entire body cavity is pressurised and a shell leak detection test carried out using a Mass Spectrometer.

Goodwin has supplied to the majority of the world's most prestigious LNG (Liquefied Natural Gas) projects, particulary to the export liquefaction plants but also to the LNG tanker carriers and the reception/regasification terminals. The vast majority of valves are of 316 Stainless Steel construction for use in Liquefied Natural Gas service at a temperature of -161°C. Additionally, a large number of valves are of LTCS body construction for low temperature service applications.

*On a number of LNG projects, in response to customers' design requirements, Goodwin has supplied its valves to far lower permissible leakrates than the 450 cc/minute/NPS. With the Goodwin Dual Plate Check Valve, Goodwin's ability to meet these more stringent customer shut-off requirements is achievable due to its unique and patented pressure sensitive plate design.

Cryogenic & High Pressure Gas Testing Facility

Goodwin has over 25 years of in-house cryogenic testing experience. Having its own cryogenic and high pressure gas test facility enables Goodwin to test valves in-house as large as 72" at temperatures down to -196°C and pressures to 15000psig/1035barg.

Typical Test Procedures

BS 6364
Shell SPE 77/200

Acceptance Standards

Seat Leakage: ISO 5208 Rate E - 450 cc/min/NPS
[Note: API598 - 700 cc/min/NPS]

Outside Leakage (body): Zero

18" 300# Axial Check Valve Type NKF on Cryogenic Test

70" 150# Dual Plate Check Valve on Cryogenic Test

Certification & Approvals


bsi.

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2008

This is to certify that: Goodwin International Limited, Newstead Industrial Trading Estate, Trentham, Stoke-on-Trent, ST4 8HU, United Kingdom

Holds Certificate Number: FM 00343

and operates a Quality Management System which complies with the requirements of ISO 9001:2008 for the following scope:

Project and sub tier management including design, purchasing, manufacture (machining, fabricating, welding, finishing, painting, measurement), assembly and testing of precision engineered components and electromechanical systems for critical applications. Industries supplied include Civil/Military, Oil, Gas, Petrochemical, Nuclear, Aerospace and other allied industries. Design and manufacture of valves and submersible slurry pumps to the petrochemical and mining industries.

For and on behalf of BSI: Frank Lee, EMEA Compliance & Risk Director

Original Registration Date: 17/08/1984 | Effective Date: 27/05/2015
Latest Revision Date: 31/03/2016 | Expiry Date: 26/05/2018

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Certificate of Registration

OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM

This is to certify that: Goodwin International Limited, Newstead Industrial Trading Estate, Trentham, Stoke-on-Trent, ST4 8HU, United Kingdom

Holds Certificate Number: OHS 600980

and operates an Occupational Health and Safety Management System which complies with the requirements of BS OHSAS 18001:2007 for the following scope:

Please see scope page.

For and on behalf of BSI: Frank Lee, EMEA Compliance & Risk Director

Original Registration Date: 17/06/2014 | Effective Date: 17/06/2014
Latest Revision Date: 29/04/2016 | Expiry Date: 16/06/2017

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Certificate of Registration

ENVIRONMENTAL MANAGEMENT SYSTEM - ISO 14001:2004

This is to certify that: Goodwin International Limited, Newstead Industrial Trading Estate, Trentham, Stoke-on-Trent, ST4 8HU, United Kingdom

Holds Certificate Number: EMS 600979

and operates an Environmental Management System which complies with the requirements of ISO 14001:2004 for the following scope:

Project and sub tier management including design, purchasing, manufacture (machining, fabricating, welding, finishing, painting, measurement), assembly and testing of precision engineered components and electromechanical systems for critical applications. Industries supplied include: Civil / Military, Oil, Gas, Petrochemical, Nuclear, Aerospace and other allied industries. Design and manufacture of valves and submersible slurry pumps to the petrochemical and mining industries.

For and on behalf of BSI: Frank Lee, EMEA Compliance & Risk Director

Original Registration Date: 18/06/2014 | Effective Date: 18/06/2014
Latest Revision Date: 29/04/2016 | Expiry Date: 16/06/2017

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Certificate of Registration

INTEGRATED MANAGEMENT REGISTRATION - PAS 99:2012

This is to certify that: Goodwin International Limited, Newstead Industrial Trading Estate, Trentham, Stoke-on-Trent, ST4 8HU, United Kingdom

Holds Certificate Number: IMR 613512

and operates an Integrated Management System which complies with the requirements of PAS 99:2012 for the following scope:

Project and sub tier management including design, purchasing, manufacture (machining, fabricating, welding, finishing, painting, measurement), assembly and testing of precision engineered components and electromechanical systems for critical applications. Industries supplied include Civil/Military, Oil, Gas, Petrochemical, Nuclear, Aerospace and other allied industries. Design and manufacture of valves and submersible slurry pumps to the petrochemical and mining industries.

This client is compliant with ISO 14001:2004 and BS OHSAS 18001:2007.

For and on behalf of BSI: Frank Lee, EMEA Compliance & Risk Director

Original Registration Date: 19/09/2014 | Effective Date: 19/09/2014
Latest Revision Date: 03/05/2016 | Expiry Date: 16/06/2017

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Conformity based on Full Quality Assurance

This is to certify that: Goodwin International Ltd, Newstead Industrial Trading Estate, Trentham, Stoke-on-Trent, ST4 8HU, United Kingdom

Holds Certificate Number: CE 55079

In respect of: **Pressure Accessories**

On the basis of our examination under the requirements of Council Directive 2014/68/EU Module H of the Pressure Equipment Directive.

For and on behalf of BSI, a Notified Body for the above Directive (Notified Body Number 0086): Gary Fenton, Global Product Certification Director

First Issued: 01/03/2002 | Latest Issue: 20/02/2017

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JQS

Joint Qualification System for suppliers to the Oil Industry in Norway and Denmark

Certificate of Qualification

Awarded to

GOODWIN INTERNATIONAL LIMITED

Company Registration number: 468115

Achilles Id: 12283

Achilles Information Centre hereby confirms that GOODWIN INTERNATIONAL LIMITED is Qualified in the Achilles Joint Qualification System for suppliers to the Oil Industry in Norway and Denmark. The Qualification concerns the product and service codes listed in the appendix.

16.12.2016 Issued date | 01.01.2018 Expiry date

FPAL empowered by **Achilles**

Registered

Supplier No. 42851

UVDB empowered by **Achilles**

Registered

Supplier No. 206106


Achilles | UVDB

Certificate of Registration

This is to certify that

GOODWIN INTERNATIONAL LIMITED

Supplier Number: 206106

are now fully registered as a supplier on UVDB for the following products/services

3.16.4 Non-Return/Reflux/Check Valves | *3.16.30 Control valves*

3.16.12 Pressure Control Valves

Melanie Cox, Procurement Manager, Bournemouth Water

Registration Expiry Date: 23 May 2017


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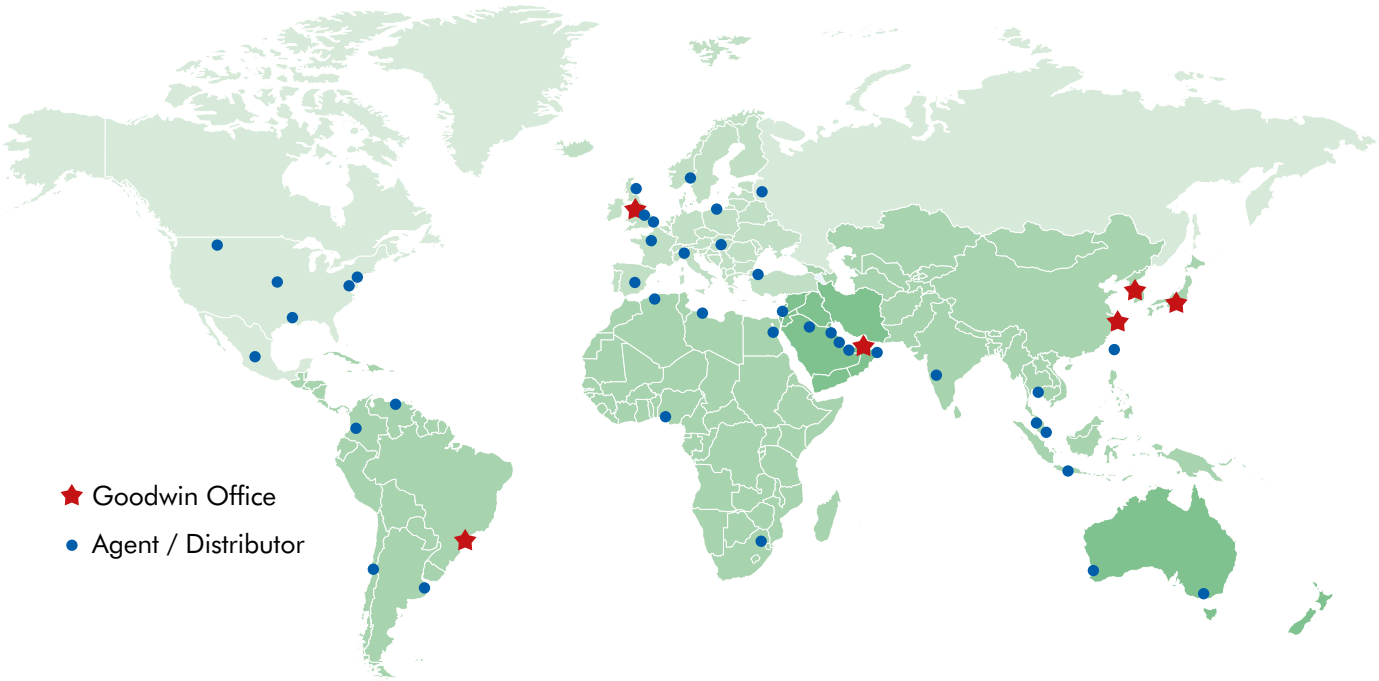

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