WEIR CONTROL & CHOKE VALVES

Excellent Engineering Solutions

WEIR

Weir Severe Service Choke Valve

Excellent solutions providing optimum performance for all severe applications

Weir Power & Industrial UK purpose built factory at Elland.

Weir Control & Choke valves provide critical service safety valves, specialist pumps and service support to flow control and rotating equipment.

Our world-wide reputation is based on engineering excellence applied to a comprehensive range of specialist products and effective customer support.

A proven track record

We have extensive references and a proven track record in the supply of valves across a number of key industries.

Our valves are industry renowned brands, each with an established reputation for quality engineering and reliability.

Valve testing

All pressure containing items are hydrostatically tested, seat leakage tested and functionally tested.

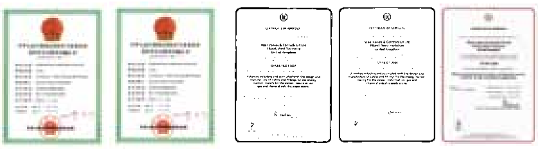
We can also perform gas, packing emission, cryogenic and advanced functional testing, as well as seismic testing for nuclear applications.

Material testing

- Non-destructive examination by radiography, ultrasonics, magnetic particle and liquid penetrant.
- Chemical analysis by computer controlled direct reading emission spectrometer.
- Mechanical testing for tensile properties at ambient and elevated temperatures, bend and hardness testing. Charpy testing at ambient, elevated and sub-zero temperatures.

Aftermarket solutions

Our valve aftermarket solutions are based on our engineering heritage, applying our OEM knowledge and expertise to maintenance strategies, life extension and upgrade projects.



FPAL empowered by Achilles Registered

Achilles

Quality assurance

Weir is qualified to industry standards and working practices including:

- ASME BPVC Section III (N and NPT Stamp)
- ASME BPVC Section VIII (UV Stamp)
- NQA-1 Quality system
- 10CFR50 App. B
- 10CFR50 Part 21
- RCC-E
- RCC-M
- CSA Z299
- OTT 87
- Performance testing and qualification to:
  ASME QME-1
  ASME B16.41
  IEEE 323
  IEEE 344
  IEEE 382
- ISO 9001:2008
- ISO 14001
- ISO 17025
- PED 97/23/CE
- API Q1 TO API LICENCES:
  API 6D (6D-0182)
  API 6A (64-0445)
- TUV-AD MERKBLATT WRD HP 0
- ATEX 94/9/CE
- Lean manufacturing practices

ALLEN® STEAM TURBINES
Single and Multi-stage Steam Turbines

AMERICAN HYDRO
High Performance Hydro Products & Services

ATWOOD & MORRILL™
Engineered Isolation & Check Valves

BATLEY VALVE®
High Performance Butterfly Valves

BDK™
Industrial Valves

BLAKEBOROUGH®
Control & Severe Service Valves

HOPKINSONS®
Parallel Slide Gate & Globe Valves

MAC VALVE®
Ball & Rotary Gate Valves

ROTO-JET®
High Pressure Pitot Tube Pumps

SARASIN-RSBD™
Pressure Safety Devices

SEBIM™
Nuclear Valves

TRICENTRIC®
Triple Offset Butterfly Valves

WEMCO®
Pumps & Systems

WEIR POWER & INDUSTRIAL SERVICES™

Contents

Weir are the oldest control/choke valve supplier in the UK through it's Blakeborough heritage brand. The Weir range of choke valves includes ASME & API designs. Through continuous research and development we are able to offer choke valve trim solutions that can be used in the following applications:

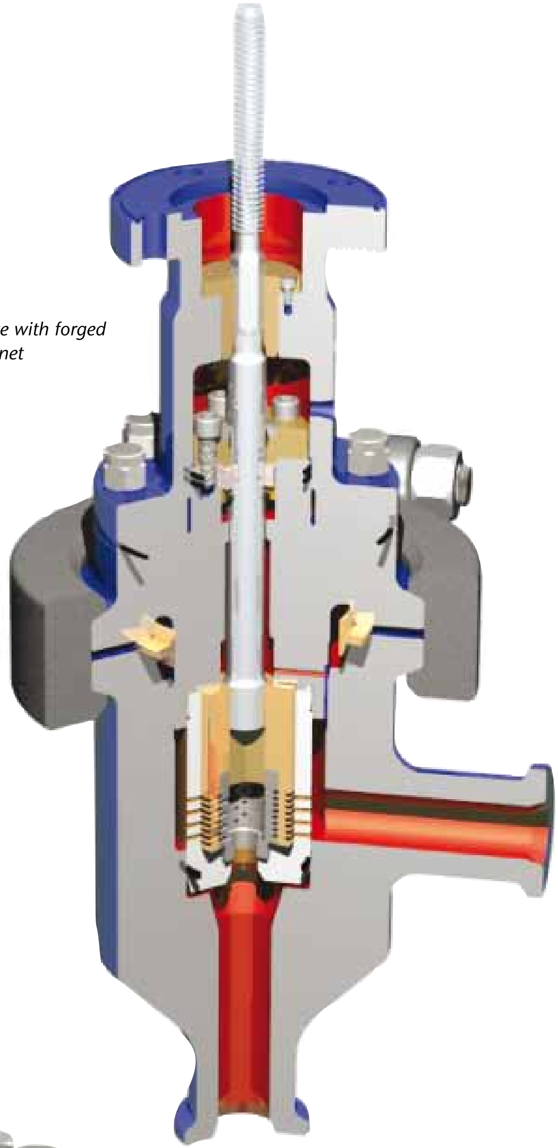
Applications

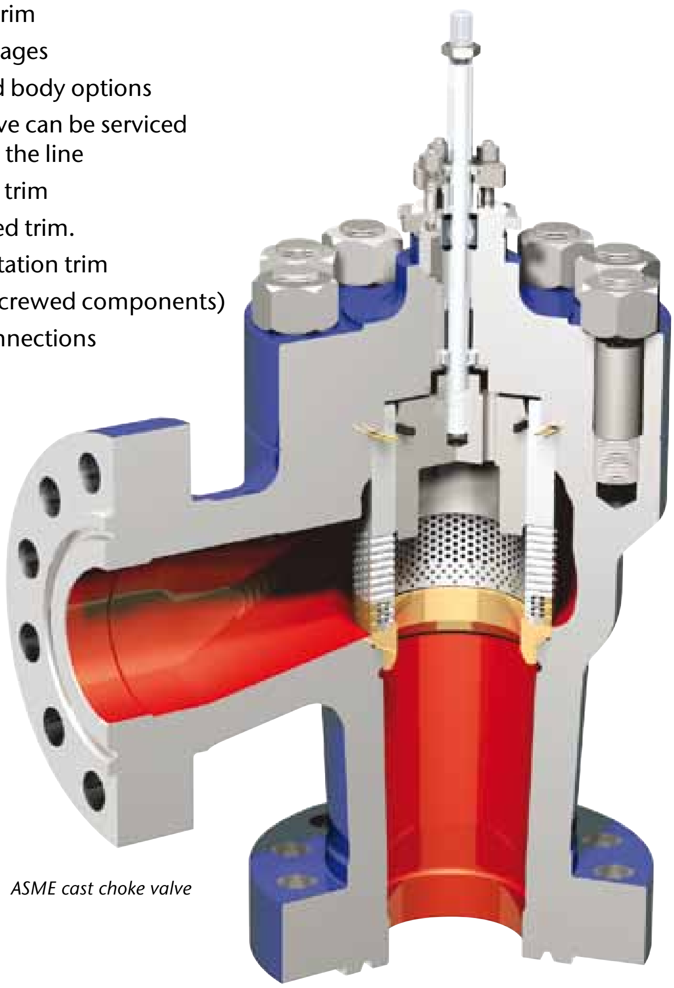
- Production
- Water Injection
- Gas Injection and Gas Lift
- Chemical Injection
- Fracturing clean up
- High pressure drops
- Multi-phase Flows
- Flaring
- Pump discharge
- Overboard dump applications
- Methanol injection

Features

- Flexible trim designs: application specific
- Non-collapsible trim (brickstopper)
- Bolted, clamped or screwed bonnet
- High toughness carbide trims
- X-Stream™ Severe service trim
- Anti clogging design trim
- Streamlined flow passages
- Cast, forged or hipped body options
- Top entry bonnet, valve can be serviced without removal from the line
- Sand erosion resistant trim
- Stable internally guided trim.
- Low noise or anti-cavitation trim
- Easy service trim (no screwed components)
- Wide range of end connections
- Metallic scraper rings

API choke valve with forged body and bonnet





ASME cast choke valve

Pressure ratings:

ASME 150 – ASME 4500LB

API 2000 – 15,000 PSI

Available Body Sizes:

- ASME 1" to 24" (API 1" to 16")

Available End Connections:

- Flanged/RF/RTJ/Hubbed

Available Actuation:

- Linear pneumatic/Hydraulic
- Pneumatic/Hydraulic/Stepping
- Manual
- Electric

Compliance:

- NORSOK compliance
- NACE compliance

The Weir choke valve range is produced to meet the requirements of one of the following design standards, either API 6A/ISO 10423/ASME B16.34 but fundamentally the designs of valves offer the following advantages over externally guided or disc style choke valves.

Body design

Due to the potential for contaminated processes choke valves are usually angle valves with flow over the plug head. Globe valves can be provided if specifically required. The body consists of streamline flow passages to prevent abrasion due to contaminated flows.

Low pressure recovery

Weir have extensive experience in designing valves for high pressure drop applications coupled with the added potential for erosion due to fluid contamination such as sand inclusions in the flow stream. Weir use the 'internally' guided cage trim design of valve for these applications which is a low pressure recovery trim design ensuring the minimum amount of energy is generated at the plug head.

The single stage Multi-Flow trim is suitable for most choke applications either with the addition of a carbide insert or a solid carbide trim . The flow is broken down into a series of multiple jets by a number of radial holes located in the circumference of the cage. The flow is usually from outside to inside the cage (flow over) so that jet impingement/high turbulence levels are controlled within the confines of the valve cage. Impingement of the jets within the cage produces a more stable downstream flow, with the added benefit of noise reduction. This reduces the effect of large scale separation and produces a smaller scale turbulence structure in the valve outlet.

Internal cage guiding

The plug diameter is supported in the cage through the full stroke of the valve, eliminating the potential for noise and vibration through high pressure drops. Seal areas are located within the upper section of the valve plug thereby divorcing the seals from the main flow area. Additionally for highly contaminated duties scrapper rings can be provided to ensure protection of the softer resilient seal.

Noise control by low pressure recovery

The cage guided valve reduces the acoustic efficiency of the flow stream and changes the power spectrum of the generated noise, both of which factors contribute to an overall noise reduction of between 15 and 20dBA, compared with high flow externally guided or disc choke valves. A further noise reduction of 5dBA can be achieved in the choke valve by considering the hole size in the cage. The use of multiple cages (cascade trim) or our X-Stream™ trim, provides further reduction in both hydrodynamic or aerodynamic noise.

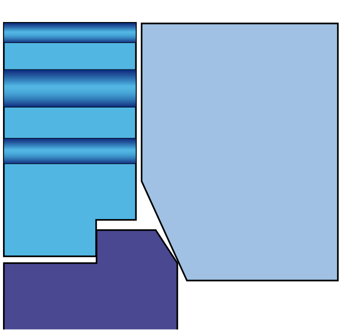
Balanced designs

The valve trim in a choke valve is usually a balanced design (unbalanced designs can be applied for specific applications). This ensures maximum stability of the valve plug in highly turbulent, high pressure drop situations. The balancing effect in the plug ensures an equal pressure both above and below the plug head which ultimately leads to reduced actuation forces to close the valve. Weir ensures that the balance hole diameters are maximised to prevent scaling, which in turn could reduce the shut off capabilities of the valve.

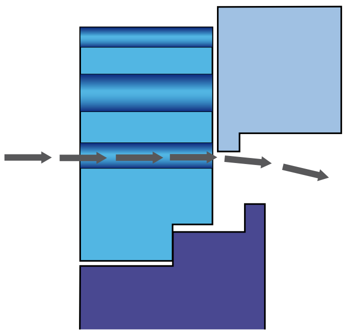
Seat design

Internally guided choke valve plugs are susceptible to impingement of contaminated flows onto the seating surface of a traditionally seated valve plug. Seating on these trims is accomplished by means of a an angle chamfer which is located on the plug outside diameter, as shown below. As the flow passes through the cage holes then the pressure drop and consequent velocity increase take place causing erosion of the seating face.

The Weir choke valve is designed with protected seating faces. The special plug head contour ensures that the seating face of the plug is protected from the cage flow area by means of an extended lip on the outside of the plug nose. Additionally the use of the protected seat design ensures a deadband before flow starts to pass through the cage. This ensures a reduced velocity through the trim and consequently a reduced rate of erosion.



Valve with conventional seat



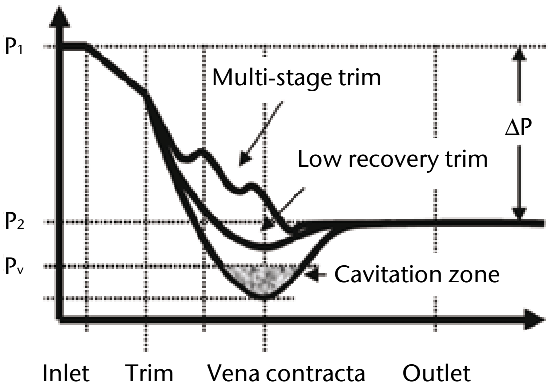
Valve with protected seat

Potential damage through incorrect trim selection

Pressure drop considerations

Choke valves are required to handle some of the most severe operating conditions:- pressure drops of up to 500 bar, with erosive fluid mixtures of hydrocarbon liquids, hydrocarbon gases, sea water and sand.

The problems associated with this application are flow erosion to the valve body, valve trim and the downstream pipework, vibration and noise. The range of products used on this application range from the bean type choke with a fixed area, to needle and seat designs which are high recovery and multistage trims.



Characteristics of pressure drop through a single stage and multi-stage trim

Consider a fluid passing through a simple orifice (bean) choke. Under high pressure drop conditions the fluid pressure drops rapidly below its vapour pressure thereby producing vapour bubbles. As the fluid recovers downstream of the orifice either cavitation or flashing can occur depending on whether the downstream pressure is higher or lower than the fluid vapour pressure. If the pressure is lower than the vapour pressure, flashing occurs, and this can cause erosion damage in the downstream pipework. If the downstream pressure is higher than the vapour pressure then as the pressure recovers vapour bubbles formed during the throttling process are no longer in equilibrium and will collapse (or implode) resulting in very high forces being generated. This energy release can result in significant erosion damage, and extensive noise and vibration problems. On high recovery designs and on severe applications whole sections of metal can be eroded away, affecting the pressure integrity of the valve body and downstream pipework.

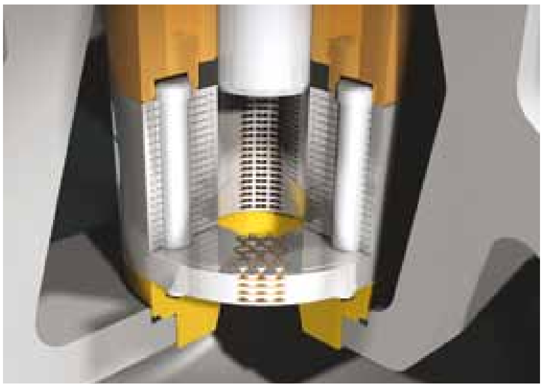
On gas flows high uncontrolled velocities can result in shock waves/turbulence interaction leading to high noise levels and vibration problems.

Severe service trims

Weir Control and Choke Valves have a unique trim specifically designed for severe service applications. The Weir X-Stream™ was developed for applications where standard caged trim designs could not meet the necessary noise attenuation, vibration levels and trim velocity control limits. Using a series of stacked plates/discs, multiple stages of pressure letdown are provided using a series of complex flow paths. The X-Stream™ is exceptionally versatile and even its method of manufacture can be altered to provide a custom design solution (For example, clamped disc stacks for individually replaceable discs).

Features

The X-Stream™ flow path, was developed using the latest in computational fluid dynamics software and fluid dynamics research. Most disc stack trim designs now conform to the internationally recognised trim exit velocity limits,

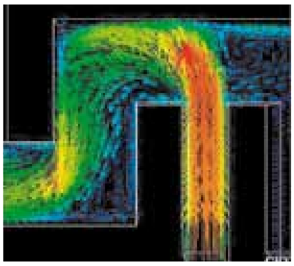


in order to reduce the erosive impact of the fluid. However Weir also believe that velocity must also be controlled and limited at all points of the trim and have thus proposed 'Total Velocity Control'.

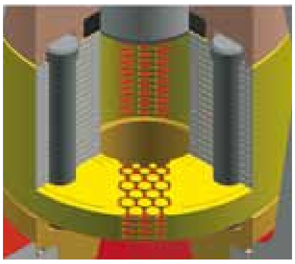
During extensive research, it was discovered that a number of other disc stack designs were too focused on limiting the trim exit velocity and as such were suffering from exceptionally high velocities at the first few stages of pressure letdown, as they tried to expand the flow area too quickly, thus increasing the erosion potential at these areas.

- The X-Stream™ trim, is custom designed for each application and uses fixed areas for the first few stages of pressure letdown, providing Total Velocity Control across the entire disc, keeping velocities within a set limit.
- The X-Stream™ trim uses all 3 of the methods of pressure reduction;
  1. Contraction and Expansion of the Fluid
  2. Change of Direction (The most popular method)
  3. Self Impingement - This splits the flow stream into multiple parts and directs two or more of them into each other.
- Reduced areas of high turbulence, by using a more streamlined approach to change of direction than other disc stack designs. Sharp right angle turns increase the potential for blockage and areas of high velocity, X-Stream™ 'smooth' flow path approach minimises velocity and contains a natural anti-clogging /self cleaning flow path which reduces maintenance time and costs.
- X-Stream™ can be offered with a wide variety of dynamic performance characteristics, from standard Linear, Equal percentage and other custom characteristics.
- Conforming to the latest developments in Aero and Hydrodynamic noise calculations, X-Stream's unique design, minimises noise by avoiding jet coalescence and with added features on Gas applications to further reduce noise by incorporating a 'mesh' of columns at the exit of the trim.
- The overall ability to custom design nearly all aspects of the X-Stream™ disc, make this trim exceedingly versatile. The extensive research carried out in conjunction with some of the leading experts in the field of Fluid Dynamics, means X-Stream™ is the optimal solution for Sever Service.

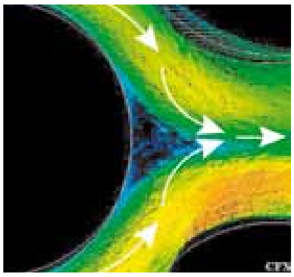
In trims with a tortuous path there are large areas of re-circulating flow (blue area). When debris is present in the flow these areas can cause blockages. Additionally, in trims with a tortuous flow path localised sections of high velocity (red area) can cause premature erosion and loss of control.



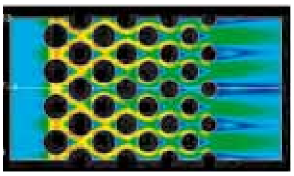
The X-Stream™ trim is designed with smooth flow paths to minimise the areas of re-circulating flow and eliminate localised high velocity.



Jet impingement causes pressure reduction without the negative effects of trim damage.



The X-Stream™ trim is designed to minimise sections of high velocity so the velocity gradient is spread across the trim profile.



Valve considerations per application

Production choke valves

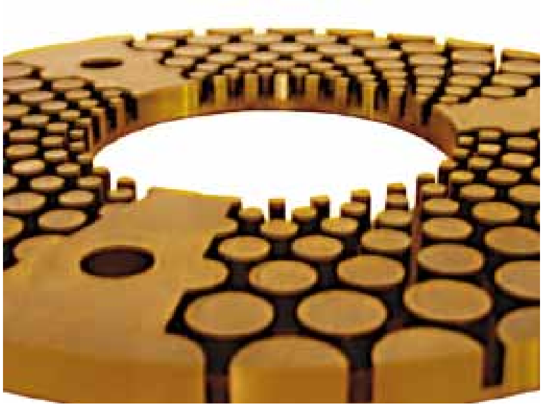
- Choke valve materials are largely selected based on the temperature of the process fluid. Production wells often have a low temperature gas cap and therefore materials of the choke valve should be selected according to the system design temperatures.
- Well fluids can often be a combination of liquids and gas. Fluid droplets in a high velocity gas application can be very erosive and therefore trim materials and pressure drops should be specifically considered.
- Debris such as sand can additionally be associated with production choke valves as a by product of production. Sand as it impinges on the valve/trim will start to erode components. Trim materials and valve velocities should be carefully considered to reduce the rate of erosion.
- Tungsten carbide is usually applied to production choke valves due to its resistance to erosion and abrasion.
- Where contaminated fluids exist then scraper rings must be applied to protect resilient seal rings.
- Generally low pressure drops and high flow rates, which requires a high design Cv. As standard we use heavy section single cage style trims.

Water injection

- Water injections applications are usually associated with cavitating flows due to the low outlet pressures and therefore multi stage trims must be selected to prevent the static pressure dropping below the vapour pressure.
- Low pressure recovery trims such as the multi-flow trim should be applied to eliminate the onset of cavitation.
- Multi stage trims can be employed to handle high pressure drops and cavitation.
- If cavitation is likely then avoid using tungsten carbide as this material is unsuitable for cavitating flows.
- In some applications water injection valves can be used for reverse flow. In this case seals should be specifically considered for sealing in both directions.
- Cage guided valves and multi-stage valves are most suitable for water injection applications as they are most resistant to vibration which can be caused by the natural frequency of the fluid.
- Corrosion can be a problem depending on the water chemistry, so where appropriate corrosion resistant materials should be used.

Gas lift

- Gas lift valves are used to inject gas into the production system to help the production process. Gas lift valves usually require a small Cv trim for accurate control of the gas.
- Usually gas lift valves are small in size and have either a spline or multi-flow trim.
- The process fluid is often corrosive so corrosion resistant body materials are required.
- The type of gas can additionally play an important factor. On clean gases stellited trims can be applied. Wet gases are very erosive due to the high velocity gas causing impingement of the entrained fluid. In wet gas applications then hard wearing trim materials such as tungsten carbide should be applied.



Tungsten Carbide X-Stream™ disc

Issues with externally sleeved choke valves

Some choke valve manufacturers have adopted the externally sleeved choke valve trim design. Rather than running the plug inside the valve cage the plug slides over the external diameter of the cage. In having the plug outside the throttling area, then theoretically the plug seating face is outside the throttling zone and therefore less susceptible to erosion. Experience has highlighted several issues with this design of trim.

The cage in an externally sleeved choke valve is often designed with four large holes to achieve the flow area. This results in a high pressure recovery factor which on liquid applications can cause premature erosion due to high pressure drops at the vena contracta. It can also mean that the trim is more susceptible to cavitation as the static pressure drops and then recovers above the vapour pressure. On gas applications the resulting pressure recovery can induce low frequency noise and vibration.

On internally guided choke valves the plug is guided through the valve stroke ensuring a high degree of stability. Externally guided choke valves have a minimum amount of guiding, especially when the valve is fully open, which ultimately results in severe vibration of the trim.

The main method of handling high pressure drops is to stage the drop over multiple stages of pressure letdown. This can only be achieved in a very crude manner on externally guided choke valves. In addition the design means that the plug is located between the pressure letdown stages, which could result in line debris becoming trapped between the plug and the cage.

Externally guided choke valves can have a seat ring screwed into the valve body. This causes several problems, especially during service and repair, where it becomes difficult to remove the seat ring.

Example of failure of externally sleeved Choke

None Collapsible Trims (Brickstopper)

Choke valve designs often require the use of tungsten carbide trims. These materials are used to reduce the trim erosion due to sand particulates in the process flow. Although tungsten carbide is exceptionally hard it is also brittle and therefore subject to cracking or fracture due to the impact of solids at high velocity. In these situations internally guided choke valves have significant advantages as the carbide components are protected by an outer steel cage.

System concerns with trim collapse are:

- Drawdown on well formations
- Flow and erosion dynamics
- Downstream equipment damage due to fragments,
- Pressure increase imposed on downstream equipment
- Flow rate increases imposed on downstream equipment

Consequences of Debris

Debris travels through the valve.

- No damage occurs to the choke valve.
- No shutdown necessary

Debris fractures valve trim

- Increased valve capacity (Cv) resulting in reduced THP and increased downstream pressure
- Trim fragments travel downstream
- System shutdown for valve service
- Debris lodges in valve inlet
- Decrease in valve capacity (Cv)
- Debris blocks valve inlet resulting in alteration to fluid entry profile resulting in erosion
- System shutdown for valve service

The Weir trim solution ensures maximum protection of the tungsten carbide due to a fully enclosed trim.

Cage (Referred to as the Brickstopper)

The valve cage features a steel outer sleeve which gives maximum protection against large solids in the process flow. Erosion control is achieved via a carbide inner sleeve which is either shrunk or laser welded into the cage.

Plug and Seat

There are two methods of manufacture for the plug head depending upon the particular process requirements.

- The plug is manufactured as a two piece construction, the upper portion from steel and the lower portion from carbide. In this construction the two sections are clamped together by the valve stem. The lower carbide section gives maximum erosion control while the upper steel section allows for guiding in the cage.
- For maximum resistance against collapsibility the carbide can be laser clad onto the plug. This ensures maximum support of the carbide due to the steel base through the length of the plug. Laser cladding of the valve plug additionally ensures a backup steel support which would ensure flow control if the carbide fails.

Customised solutions

Choke valves are complex valves used on the most arduous applications and must be resistant to fluid impingement and high pressure drops. Choke valves are often unique according to the unique process requirements. In one such example Weir were requested to provide a choke valve that could be used for both production and injection. The choke valve therefore had to meet the following criteria:

Injection applications

- Eliminate the potential for cavitating flows through multiple stages of pressure letdown
- Be resistant to erosive conditions

Production applications

Valve to be used for production with high levels of sand content.

Solution

The two key factors in this application were:

- Trim material needed to be suitable for sand and sand contamination
- Sufficient number of design stages were required to prevent or restrict cavitation

The latter is key when offering a trim for sand/solid duties, as typically the trim materials would be tungsten carbide. Tungsten carbide is extremely brittle and susceptible to cracking upon impact (for example impact from cavitation). Cavitation impact can also wear the carbide binder.

During the sizing process it was identified that the valve would require a two stage trim to eliminate cavitation.

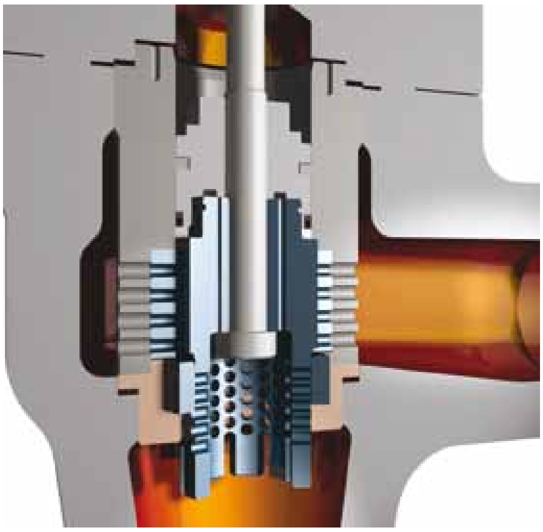
The customer was concerned that a conventional two stage trim would block up due to the large quantity of sand in the process flow. To eliminate blockage Weir proposed a trim with a single stage of pressure letdown located on the cage portion of the trim and one stage of pressure letdown located on the plug nose. This meant that any sand could be flushed through the trim due to the modulation of the valve plug. For large slugs of sand Weir proposed flushing ports in the skirt of the valve plug to allow the plug to be lifted to expose a large ported area.

The plug and seat were manufactured with heavy sections of tungsten carbide and the cage manufactured in solid carbide. Large flow passages were used to reduce the velocity of the fluid through the valve to reduce the impingement effect of the fluid.

The valve was designed for reverse flow conditions where special seals were installed to ensure sealing of the trim with flow in two directions for production and injection

Summary

- Handle high pressure drop liquids choke with entrained sand
- Cavitation & erosion control
- Customer did not want a trim with a tortuous path due to the potential for blockage.
- Conversion nose trim specified to flush the solids through the trim as the plug lifts.
- Additional slots at the bottom of the plug for additional flushing.
- Tungsten carbide trim fitted to reduce sand erosion.



Two-stage trim designed for high sand quatities

Tungstern carbide plug head for erosion control

API Choke valve body materials

There are several factors that need to be considered when selecting the most appropriate valve body material. If the choke is defined as an ASME/ASME valve then the materials can be selected from ASME B16.34.

Materials for API rated chokes are selected from API 6A. API 6A does not specify specific grades of material, but rather sets the physical properties that the material must meet and assign it a material 'rating' either 45k, 60k or 75k.

Flanges must all be made with at least a 60k material or for an API 15000 rated choke valve at least a 75k material.

Valve bodies (without flanges) can be manufactured from any of these materials up to API 15000.

The material classes (60k etc.) will usually be specified by the customer, however the standard used by Weir (up to API 10000) would be a 60k material for body and flanges on a cast valve.

Table 1 - API Choke valve body materials

Generic material	Material designation	Material type	Material Max. temp. (Deg C)	Material Min. temp (Deg C)	NACE	Material		API 6A Material designation
						60k	75k	
Carbon steel	ASTM A487 Grade 4 C	Cast	482	-46	✓	✓	✕	AA, BB, DD & EE
Duplex	ASTM A995 Grade 4A	Cast	370	-29	✓	✓	✕	CC & FF
Super Duplex	ASTM A995 Grade 6A	Cast	370	-29	✓	✓	✕	CC & FF
AISI 4130	AISI 4130	Forged	427	-46	✓	✓	✓	AA, BB, DD & EE HH with Inconel cladding
AISI 4140	AISI 4140	Forged	538	-101	✓	✓	✕	AA, BB, DD & EE
Duplex	UNS S31803	Forged	370	-29	✓	✓	✕	CC & FF
Super Duplex	UNS S32760	Forged	370	-29	✓	✓	✓	CC & FF
Inconel 625	UNS N06625	Forged	593	-196	✓	✓	✓	CC & FF
LF6	ASTM A350 LF6 Class 2	Forged	500	-46	✓	✓	✕	AA, BB, DD & EE
660	ASTM A638 Grade 660	Forged	600	-196	✓	✓	✓	CC & FF
AISI 4140	AISI 410 (Condition T)	Forged	482	-29	✕	✓	✕	CC & FF

Note: Forged choke valves can either be directly produced from forged material or by HIPping.

Table is shown for guidance. Consult API 6A for detailied information.

Requirements for PSL testing

Where PSL testing is required then the following table highlights the quality requirements of the 4 levels. It should be noted that this table is for reference only and the exact requirements for PSL testing are shown in the API standards.

Table 2 - Requirements for PSL testing

	PSL 1	PSL 2	PSL 3/3G	PSL 4
Cast body/Bonnet & Cuff pieces				
Material	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**
Chemical	Required	Required	Required	Required
Mechanical	Not required	Not required	Required	Required
Impact	Dependent on temperature		Required	Required
Hardness testing	Not required	Not required	Required	Required
NDE	Not required	100% MT or PT after machine. 100% MT or PT on castings	100% RT or UT 100% MT or PT of surfaces	100% RT or UT 100% MT or PT of surfaces
Welding	Controlled by qualified procedures	Controlled by qualified procedures	Controlled by qualified procedures	Welding not permitted
Welding NDE	100% volumetric and surface	100% volumetric and surface	100% volumetric and surface	N/A
Forged body/Bonnet & Cuff pieces				
Material	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**
Chemical	Required	Required	Required	Required
Mechanical	Required	Required	Required	Required
Impact	Required	Required	Required	Required
Hardness testing	Not required	Not required	Required	Required
NDE	Not required	100% MT or PT 100% MT or PT (AM)	100% RT or UT 100% MT or PT of surfaces	100% RT or UT 100% MT or PT of surfaces
Welding repair	Not permitted	Not permitted	Not permitted	Not permitted
Stem and Pressure retaining Bolting				
Chemical	Required	Required	Required	Required
Mechanical	Required	Required	Required	Required
Impact	Required	Required	Required	Required
Hardness testing	Required	Required	Required	Required
NDE	Not required	Not required	100% PT 100% RT or UT	100% PT 100% RT or UT
Welding	Controlled by qualified procedures	Controlled by qualified procedures	Controlled by qualified procedures	Controlled by qualified procedures

Table 2 - Requirements for PSL testing (continued)

	PSL 1	PSL 2	PSL 3	PSL 4
Trim				
Material	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**	**API 6A designated material**
Chemical	Not required	Not required	Required	Required
Mechanical	Not required	Not required	Required	Required
Impact	Not required	N/A	Required	Required
Hardness testing	Required	Required	Required	Required
NDE	Not required	Not required	100% PT after machining	100% PT after machining
Welding	Controlled by qualified procedures	Controlled by qualified procedures	Controlled by qualified procedures	Controlled by qualified procedures
Testing				
Hydro test	Pressures as per API 6A	Pressures as per API 6A	Pressures as per API 6A	Pressures as per API 6A
Gauges	Calibrated to API 6A	Pressures as per API 6A	Pressures as per API 6A	Pressures as per API 6A
Test results	Recorded by production	Recorded by production	Recorded by someone independent from production	Recorded by someone independent from production
Tests			Raise to static pressure and hold. Reduce to zero. Raise to static pressure and isolate from pressure source	Raise to static pressure and hold. Reduce to zero. Raise to static pressure and isolate from pressure source
Medium	Water or gas	Water or gas	Water or gas	Water or gas
Test time	3 mins & 15 mins	3 mins & 15 mins	3 mins & 15 mins	3 mins & 15 mins
Gas shell test	Not required	Not required	Only required for PSL 3 G. Required at rated working pressure. Gas test to be in an approved location	Required at rated working pressure. Gas test to be in an approved location
Gas seat test	Not required	Not required	Only required for PSL 3 G. Required - test is two stage primary and working secondary at 5 - 10% of rated working pressure.	Required - test is two stage primary and working secondary at 5 - 10% of rated working pressure. Gas test to be in approved location.

Note: Table is shown for guidance. Consult API 6A for detailied information.

Choke valve selection guidelines

When specifying choke valves it is critical that the correct size, trim design and materials are selected to ensure a satisfactory life and operation of the valve.

Our philosophy is to control the energy dissipation within the valve and not to pass the problem on to the downstream pipework.

In the selection process the following considerations/ calculations are made and recommended limits on velocity and pressure drop for trim material followed.

Inlet velocity & outlet velocity

These velocities are limited as per the tables. The reason for limiting to these values are to minimise valve body erosion and to minimise the potential for instability and vibration.

Sound pressure level

Noise predictions are carried out in order to ensure noise limits are not exceeded and the energy conversion is dissipated over the correct number of stages of let-down.

Pressure drop limitations

The above limits are used for liquid service applications to minimise erosion rates. As a general rule on clean gas/vapour service the stage pressure drops can be doubled.

Table 3 - Liquid velocity limits

Body size		Max. recommended liquid phase velocity			
		Low alloy		High alloy	
Ins.	mm	ft/s	m/s	ft/s	m/s
1 - 8	25 - 200	52.5	16	58	18

Table 4 - Gas/vapour velocity limits

Body size		Max. recommended velocity			
		Low alloy		High alloy	
Ins.	mm	ft/s	m/s	ft/s	m/s
1 - 8	25 - 200	490	150	0.85 x sonic	0.85 x sonic

Table 5 - Pressure drop limitation (liquids)

Material	Stage pressure drop	
	Psi	Bar
316 st. st.	218	15
17-4 st. st. NACE	435	30
17-4 st. st.	725	50
316 st. st. + Stellite	725	50
Tungsten Carbide	2175	150
Advanced ceramics	2175	150

Note

These limits will be affected by fluid phase and the presence of contamination. The figures assume that cavitation has been eliminated.

Table 6 - API Temperature class

Temp. Class	C° min.	C° max.	F° min.	F° max.
K	-60	82	-75	180
L	-40	82	-50	180
P	-29	82	-20	180
R	Room temperature		Room temperature	
S	-18	66	0	150
T	-18	82	0	180
U	-18	121	0	250
V	2	121	35	250

Note: The temperature rating will be determined by the end user/customer. The material of the body etc. must then be selected from table 7.

Table is shown for guidance. Consult API 6A for detailed information.

Table 7 - Standard material applications

Part	API 2000	API 3000	API 5000	API 10000	API 15000
	Material designation				
Body/Bonnet	45k	45k	45k	45k	45k
	60k	60k	60k	60k	60k
	75k	75k	75k	75k	75k
	Non standard				
Integral end connection					
Flanged	60k, 75k	60k, 75k	60k, 75k	60k, 75k	75k
Threaded	60k, 75k	60k, 75k	60k, 75k	N/A	N/A
Loose connection					
Welded neck	45k	45k	45k	60k, 75k	75k
Other	As specified by the manufacturer				

Table 8 - Materials of construction

Service	Body	Trim
Standard	Carbon St. WCB/AISI 4130/ASME A487	316 & stellite Gr. 6
Sour	Carbon St. WCB/AISI 4130/ASME A487	316 & stellite Gr. 6 (NACE)
Corrosive sour	Carbon St. WCB or AISI 4130 + inconel in seal area ASTM A182 F316	316 & stellite Gr. 6 (NACE)
High duty production	Carbon St. WCB/AISI 4130/ASME A487	17-4 PH & tungsten carbide
High duty production with contaminates	Carbon St. WCB/AISI 4130/ASME A487	17-4 PH & tungsten carbide with protected seat design
High duty production with contaminates, sour	Carbon St. WCB or AISI 4130 + inconel, Duplex St.St. Super Duplex St.St	Duplex st.st./super duplex St.St. & tungsten carbide with protected seat design
Water injection	Carbon St. WCB/AISI 4130/ASME A487	316 & stellite Gr. 6
Water injection - high duty	Carbon St. WCB or AISI 4130 + inconel in seal area St. St. CF8M or Duplex St. St.	316 & stellite Gr. 6 (NACE) & tungsten carbide/advanced ceramics

Note: Tables are shown for guidance. Consult API 6A for detailied information.

Table 9 - ASME outline dimensions

Nominal End Connections (ins)	End Connections Rating					
	ASME 900		ASME 1500		ASME 2500	
	F	M	F	M	F	M
2	7 1⁄16	7	7 1⁄8	7	8 7⁄8	7
3	8 3⁄16	7 7⁄8	8 9⁄16	7 7⁄16	10 3⁄4	11
4	9 5⁄16	9 1⁄16	9 11⁄16	9 7⁄15	13 13⁄16	13 1⁄4
6	12 1⁄4	15	13 15⁄16	14 1⁄4	18 3⁄4	15 5⁄8
8	14 9⁄16	15 1⁄4	14 9⁄16	16	CF	CF

Table 10 - API outline dimensions

Nominal End Connections (ins)	End Connections Rating					
	API 3000		API 5000		API 10000	
	F	M	F	M	F	M
2 1⁄16	9 1⁄8	8	9 3⁄8	8	10 7⁄8	10 1⁄8
3 1⁄8	10 1⁄8	9 7⁄8	10 5⁄8	9 7⁄8	11 3⁄8	12 1⁄4
4 1⁄16	12 1⁄16	13	12 7⁄16	13	13 7⁄8	13 7⁄8
5 1⁄8	14 1⁄8	14 7⁄8	14 3⁄8	14 7⁄8	18 1⁄8	15 1⁄8
7 1⁄16	17 1⁄16	17 1⁄4	17 1⁄4	17 1⁄4	CF	CF

Note: The above dimensions are based on standard valve designs. Choke valves are often manufactured to customer requirements and/or have specific body designs. For valves outside the above range, please consult the factory.

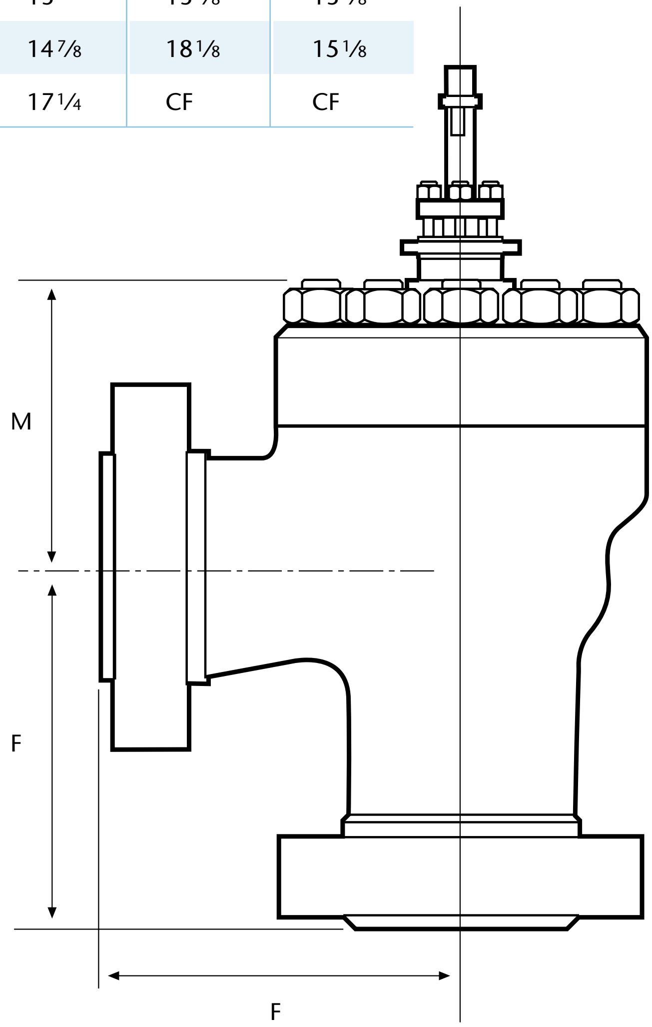


Table 11 - Examples of choke valves supplied by Weir

Project Name & Location of Client	Valve Size	Rating	Qty	Line fluid	Pressure drop	Body/Trim material
Caythorpe Kelt V.K. Ltd	3”	ASME 1500	1	Gas/Condensate/Sand	234 bar	A105, 17-4 / ceramic
Transmark / Maersk	3”	ASME 2500	1	Raw Gas (sour)	245 bar	Tungsten Carbide
Tyne & Trent, ARCO	1”	ASME 1500	3	Produced Water	118 bar	UNS S31803/Ceramic
	1”	ASME 1500	2	H.C. Condensate	111.4 bar	UNS S31803/Ceramic
	1 1/2”	ASME 1500	5	Water	101.2 bar	UNS S31803/Ceramic
ETAP, BP Aberdeen (*)	3”	ASME 2500	1	Produced Water	354 bar	Gr F 60/Ceramic
	3”	ASME 2500	1	Deaerated Seawater	399 bar	Gr F 60/Ceramic
	2”	API 10000	1	Well Stream Fluids	503 bar	GrF51/Ceramic
	4”	API 10000	1	Well Stream Fluids	531 bar	Inconel/Ceramic
	3”	ASME 1500	1	Produced Water	35 bar	Duplex
	8”	ASME 1500	2	Hydrocarbon/Liquid/Sand	53 bar	Duplex/Tungsten Carbide
	3”	ASME 2500	3	Produced Water	350 bar	F60/Ceramic
Marathon Brae Panaqua	1”	API 10000	1	Methanol	680 bar	316 L + Ceramic
ONGC - India	3”	ASME 900	32	Produced Water	103 bar	WCB/Tungsten Carbide
KOC - Kuwait	6”	API 5000	16	Produced Water	60 bar	316 L/Stellite
CRMP 1 - India Mazagon Dock	2”	API 5000	2	Injection Water (sub sea)	40 bar	AISI 4130 Tungsten Carbide
Gupco - Egypt	6”	ASME 900	2		155 bar	WCB/Stellite
Lakshimi - Hyundai	4”	ASME 900	8	Natural Gas	8 bar	CF3M/17-4 PH + T.C. Coat.
Kala Naft - Iran	6”	ASME 900	29	Oil/Gas	78 bar	WCB/17-4 PH + T. C Coat.
Lasmo Oil - Pakistan	4”	ASME 900	2	Natural Gas/Liquid	39 bar	CF8M/410 + T. C. Coating
Lasmo Oil - Pakistan	6”	ASME 900	6	Natural Gas/Liquid	21 bar	CF8M/410 + T. Coating
BP Columbia	7.1/16”	API 10000	4	Produced Water	297 bar	Duplex/17-4PH + Tung.Carbide
Shell Na Kika - LTS	2”	API 10000	2	Natural Gas	358 bar	660 St. St./316 + T. C. Coating
Cairn Energy India	4”	ASME 900	2	Natural Gas	40 bar	WCB/Tungsten Carbide
Mehras	4”	ASME 2500	2	Hydrocarbon	258 bar	CF3M/Tungsten Carbide
SVS	3”	ASME2500	2	Well Fluids	153 bar	Duplex/Tungsten Carbide
KBR	4”	ASME1500	4	Well Fluids	57 bar	Inconel 625/Tungsten Carbide
Maersk	4”	ASME2500	10	Well Fluids	85 bar	LCC/Tungsten Carbide
Maersk	6”	ASME2500	1	Well Fluids	85 bar	LCC/Tungsten Carbide
Gusto BV (Saxi)	3”	API10000	1	Hydrocarbon Gas	315 bar	AISI 4130/Tungsten Carbide
Gusto BV (Saxi)	4”	API10000	1	Hydrocarbon Gas	315 bar	AISI 4130/Tungsten Carbide

Weir's valve and aftermarket solutions are based on our OEM engineering and design heritage. Because of our OEM expertise, we have complete working knowledge of valve design and operation - as well as a full system understanding. This enables us to provide the optimum level of service based on the current condition of your valve, with the know-how to work on our own and other OEM equipment.

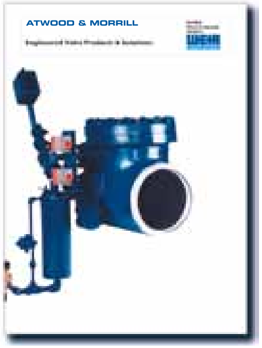
Our valve aftermarket services include:

- Outage and shutdown management
- Control valve service solutions
- Actuation service solutions
- Online safety valve testing and analysis
- Diagnostic testing
- Spare parts support
- Customised training

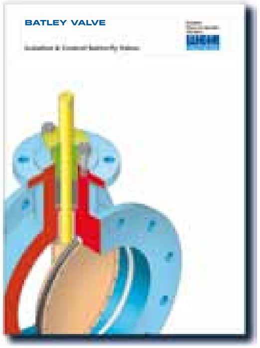
The core of any effective valve service program is the skill and experience of the technicians and supervisors who come to your site

Benefits

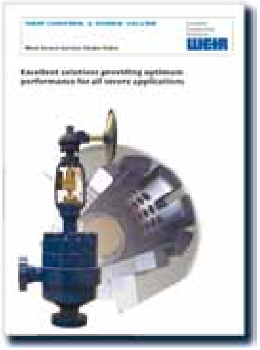
- Extensive references and proven track record
- Detailed and full system understanding
- Reliability-centred maintenance
- Reverse engineering capability



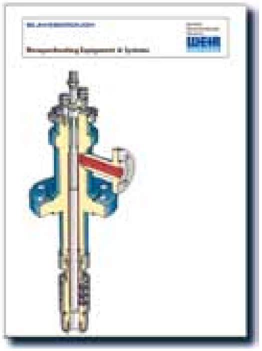
Atwood & Morrill
Engineered Valve Products & Solutions



Batley Valve
Isolation & Control Butterfly Valves

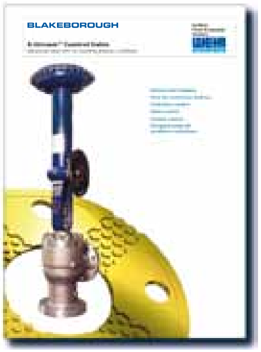


Blakeborough
Choke Valves

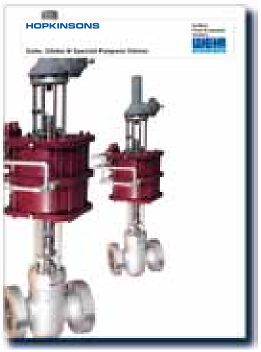


Blakeborough
Desuperheaters

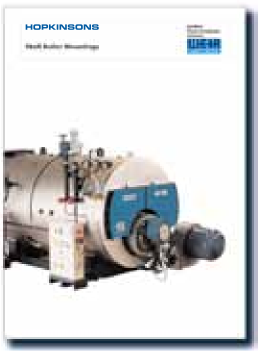
Blakeborough
Process Control Valves



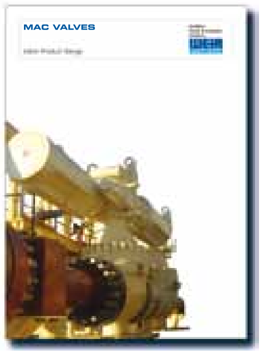
Blakeborough
X-Stream™ Control Valves



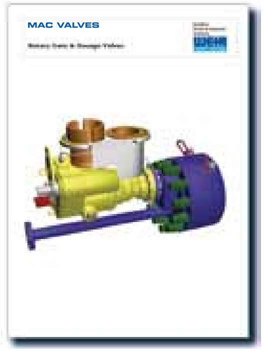
Hopkinsons
Gate, Globe & Special Purpose Valves



Hopkinsons
Shell Boiler Mountings



MAC Valves
Valve Product Range



MAC Valves
Rotary Gate & Dosage Valves

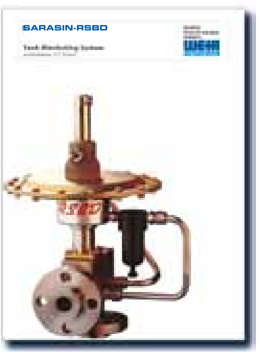
Sarasin-RSBD
Safety Relief Valves - Series 9

Sarasin-RSBD
Spring Loaded Safety Relief Valves - 63 Series

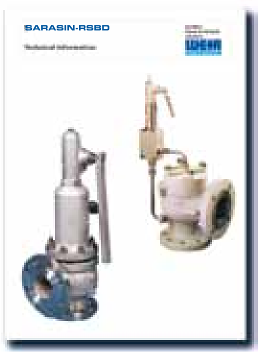
Sarasin-RSBD
Changeover Valves - Starvalve

Sarasin-RSBD
Pilot Operated Safety Relief Valves - 71, 76, 78 & 86 Series

Sarasin-RSBD
Safety Relief Valves - Starflow



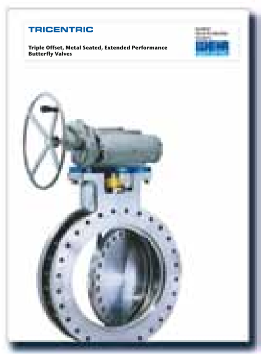
Sarasin-RSBD
Tank Blanketing System Starblanketer - 77 Series



Sarasin-RSBD
Technical Information

Sarasin-RSBD
Pressure Safety Valves & Safety Devices

Sebim
Nuclear Pilot Operated Safety Relief Valves



Tricentric
Triple Offset Butterfly Valves

Roto-jet Pump
High Pressure Pumps - Models 2100 & 2200

Roto-jet Pump
High Pressure Pumps - Models RG & RO

Roto-jet Pump
High Pressure Pumps - Models R11, API R11 & RD11

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Hydrogritter

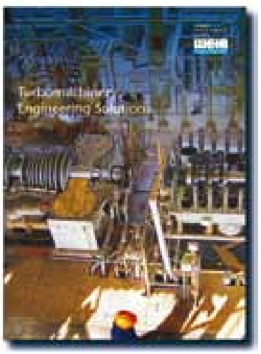
Wemco Pump
Model CF Chop-Flow Pump

Wemco Pump
Wemco Hidrostal Pumps

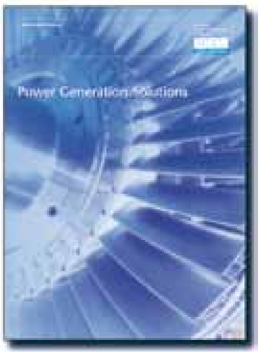
Wemco Pump
Wemco Submersible Pumps

Wemco Pump
Torque-Flow Pumps

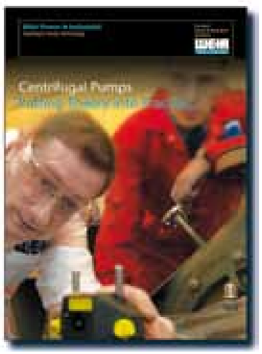
Wemco Self Primer
Self Primer



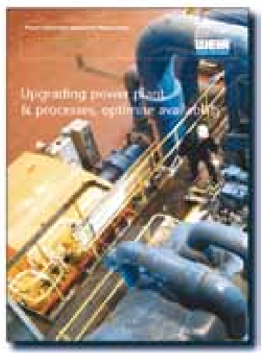
Weir Power & Industrial Services
Turbomachinery Engineering Solutions



Weir Power & Industrial Services
Power Generation Solutions



Weir Power & Industrial Services
Centrifugal Pumps



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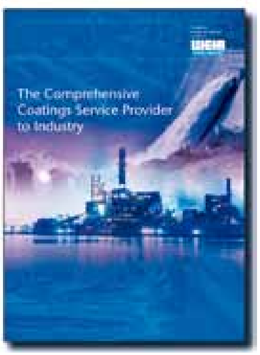
Weir Power & Industrial Services
Hydroelectric Plant Rehabilitation

Weir Power & Industrial Services
High Integrity Spare Parts



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