



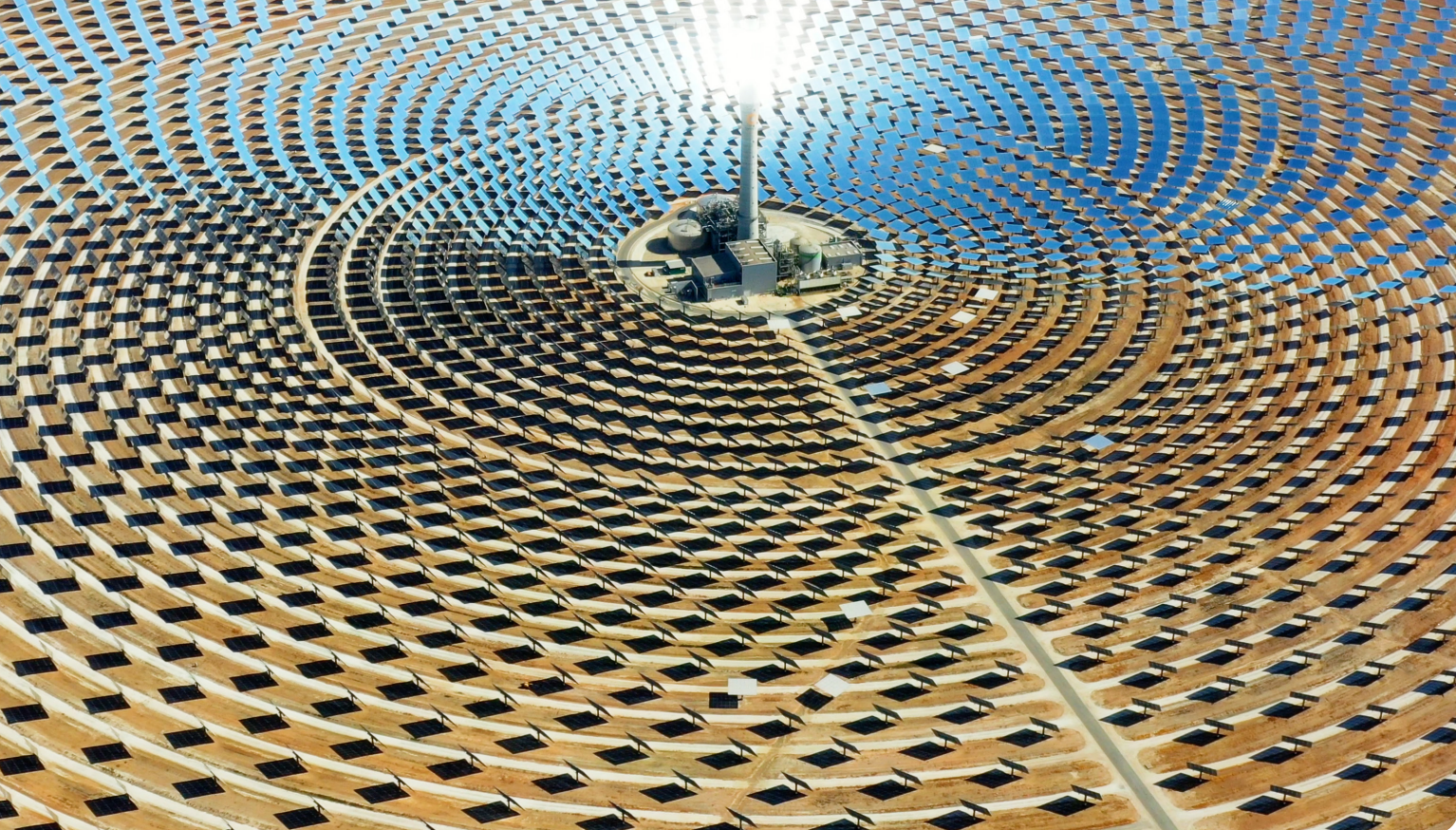
# Concentrated Solar Power Generation

Proven Valve and Actuation Solutions  
for a Challenging Environment



*Gemasolar Plant  
Property of Torresol Energy®*

***Experience In Motion***



## Working for a brighter future since the dawn of the industry

Flowserve products were instrumental in the first commercial-scale concentrated solar power (CSP) project, and we have continued to be a leader in the industry in product innovation, performance and reliability. Constructed on physically optimized global platforms, Flowserve products are precisely engineered and constructed for flawless performance in concentrated solar power generation.

Our portfolio of products for CSP plants provides durable functionality and solid stability in challenging applications such as parabolic trough and molten salt thermal energy storage. No matter what challenges your site is facing, we'll work with you to improve efficiency, maximize throughput, and control process quality.

### Supplier of choice to the CSP industry

With a deep understanding of power generation and heat transfer fluids, plus more than a century of flow control expertise, Flowserve is the trusted choice for the successful application of pre-engineered, engineered, and special-purpose valve and automation solutions for CSP services.

- Valve solutions for molten salt applications
- Thermal oil valves
- Valves and desuperheaters for water steam power block applications
- Anti-corrosion solutions
- Electric heat systems
- Severe service solutions
- Actuation and instrumentation

### Committed to a clean energy transition

At Flowserve, our approach to energy transition begins and ends with our purpose: to make the world better for everyone. To that end, our valve, pump and seal groups collaboratively work to develop optimally designed and fully integrated fluid motion and control systems that incorporate our unrivaled experience with heat transfer fluids — including molten salt — so CSP generators can efficiently harness the clean energy of the sun.



# Concentrated solar power technologies



## Parabolic trough

Parabolic trough CSP stations require a broad range of valve solutions to handle arduous applications involving high-temperature heat transfer fluids (HTFs) such as synthetic oil, air, CO<sub>2</sub>, water and molten salt. The most demanding of these valve applications are heat collection, fluid circulation and molten salt heat exchange storage. Synthetic (thermal) oil is one of the most frequently used fluids in parabolic trough CSP stations, presenting difficult sealing challenges with temperatures approaching 400°C (752°F). Flowserve has successfully and routinely surmounted these hurdles.



## Power tower systems

Whether using air, molten salt or superheated water, power tower systems present intense operating temperature conditions which demand reliable valve solutions. Operating plants using water and molten salt as an HTF medium can reach temperatures up to 600°C (1,112°F), whereas demonstration plants using air operate at 700°C (1,292°F). Flowserve offers a comprehensive suite of unique product designs and custom engineered solutions capable of delivering unmatched performance and fit for power tower applications.

## Valve and actuation solutions for parabolic trough and power tower CSP systems

- Gate, globe, check, ball, triple-offset butterfly and control valves for high-temperature applications
- Severe service anti-cavitation and noise attenuation trims
- Actuation and positioning solutions

### Brands of distinction

- Valtek<sup>®</sup>
- Anchor/Darling<sup>®</sup>
- Kämmer<sup>®</sup>
- Valbart<sup>™</sup>
- Durco<sup>®</sup>
- Logix<sup>™</sup>
- Edward<sup>®</sup>
- Argus<sup>™</sup>
- Limitorque<sup>®</sup>



## Molten salt solutions

A mixture of sodium nitrate ( $\text{NaNO}_3$ ) and potassium nitrate ( $\text{KNO}_3$ ), molten salt possesses high thermal conductivity, allowing temperatures to reach  $600^\circ\text{C}$  ( $1,100^\circ\text{F}$ ). Its high thermal capacity makes it one of the most commonly used substances for heat transfer fluids as well as thermal storage.

However, using molten salts presents specific challenges, such as crystallization of salt during normal operating conditions at temperatures below  $221^\circ\text{C}$  ( $430^\circ\text{F}$ ), which can damage equipment and lead to process downtime. Molten salt is a strong oxidizing fluid at high temperatures and can cause electrolytic corrosion if valve materials are not carefully selected. Galvanic corrosion is also a common phenomenon which occurs in valve equipment due to the use of graphite in combination with carbon or alloy steel and an electrolyte such as molten salt.

As a leading provider of molten salt valves, Flowserve understands the detrimental effects of heat distortion and corrosion on valve equipment. That's why Flowserve utilizes advanced thermal validation techniques and engineered product designs to neutralize distortion and corrosion, increasing process yield and uptime.

Flowserve molten salt solutions are constructed on physically optimized global platforms using standardized parts and components to ensure performance stability and longevity — under even the harshest conditions and for years to come.

## Flowserve molten salt severe service solutions

The use of molten salt as a heat transfer fluid is limited to 600°C (1,112°F). At higher temperatures, the molten salt degrades and the resulting carbonates tend to plug valves and pumps. The industrial-grade salt contains impurities such as perchlorates and chlorides, which are known to cause metal corrosion.

Longer service life and lower maintenance costs are made possible through Flowserve custom engineered valve and trim options. Multiple advanced anti-corrosion, anti-cavitation selections neutralize the detrimental wear and tear that too often reduce valve life or lead to failures. Maximum flexibility is achieved through severe service products that incorporate a range of material, pressure and temperature options.



### GLOBE CONTROL

## Valtek Mark One™

#### Specifications

Sizes: to DN 400; to NPS 16  
Pressures: PN 10 to 400; Class 150 to 2500  
Materials: Carbon Steel; Stainless Steel;  
Special Alloys  
Temperatures: -196°C to 815°C  
(-320°F to 1,500°F)

#### Solutions

The industry's first choice for a reliable and tough globe control valve. The Valtek Mark One valve is flexible, servicing a wide range of applications from molten salt to heat transfer fluids as well as severe service applications required in a solar power plant. Available with a variety of options, including bellows seals to eliminate packing leakage and severe service options to eliminate cavitation and noise. The Mark One valve provides solid solutions to difficult applications.

*For more information, see document VLENTB0001.*



### GLOBE CONTROL

## Valtek FlowTop

#### Specifications

Sizes: DN 15 to 400; NPS ½ to 16  
Pressures: PN 10 to 40; Class 150 to 300  
Materials: Carbon Steel; Stainless Steel;  
Special Alloys  
Temperatures: -46°C to 425°C (-50°F to 797°F)

#### Solutions

The Valtek FlowTop general service control valve offers reliable and high-performing service and is available with a number of options, including bellows seals to eliminate packing leakage. It also offers superior performance in steam and water applications.

*For more information, see document SAENBRV740.*



### GLOBE CONTROL

## Edward Univalve

#### Specifications

Sizes: DN 15 to 100; NPS ½ to 4  
Pressure Class: PN 290, 460 and 760;  
Class 1690, 2680 and 4500  
Materials: A105, F22, F91, F316, F347  
Temperatures: -29°C to 816°C  
(-20°F to 1,500°F)

#### Solutions

This high-performance isolation valve is designed for manual throttling of heat transfer fluids and molten salts.

*For more information, see document EVENCT0001.*



TRIPLE-OFFSET BUTTERFLY  
**Valtek TX3 Molten Salt**

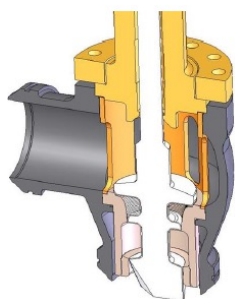
**Specifications**

Sizes: DN 80 to 600; NPS 3 to 24  
 (other sizes may be engineered to order)  
 Pressures: PN 20 to 260; Class 150 to 1500  
 (other pressure classes may be engineered to order)  
 Materials: Carbon Steel; Stainless Steel;  
 Special Alloy  
 Temperatures: up to 600°C (1,112°F)

**Solutions**

The Valtek TX3 Molten Salt valve boasts reliable, long-lasting, zero-leakage shutoff — even in CSP applications. It has obtained numerous industry certifications, so it can be used around the world. Multiple valve body configurations available.

*For more information, see document VAFLY000710.*



MULTI-STEP TRIM  
**Multi-Step**

**Specifications**

Design: Angle Type Valves F

**Solutions**

Multi-Step trim features a contoured seat designed to facilitate draining of the pipe system. Optimized to guarantee good controllability at extremely low load below 10%, the design guarantees low seat leakage over a long operational period, as the sealing area is not exposed to a high flow velocity. The multi-step trim avoids critical operating conditions at high differential pressure.



ANTI-CAVITATION TRIM  
**Valtek CavControl**

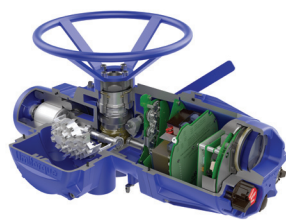
**Specifications**

Sizes: DN 25 to 600; NPS 1 to 24  
 $K_v$  (C<sub>v</sub>) Range: 1.3 to 865 (1.5 to 1,000)  
 Flow Direction: Over the Plug  
 Pressure Stages: 1

**Solutions**

This cost-effective trim minimizes cavitation damage to valve components with a special seat retainer that controls the location and concentrates vapor bubble implosion away from metal parts.

*For more information, see document FCENBR0068.*



NON-INTRUSIVE, ELECTRIC  
**Limitorque MXb**

**Specifications**

Sizes: From 73 to 2,300 Nm;  
 55 to 1,700 ft lb  
 Flanges: F/FA10 to F/FA25  
 Temperatures: -60°C to 70°C  
 (-140°F to 158°F)

**Solutions**

Limitorque MXb non-intrusive, intelligent motor-operated electric actuators are able to withstand significant temperature fluctuations while also controlling and monitoring solar power processes with unparalleled reliability.

*For more information, see document AIBR000087.*



#### PISTON-TYPE

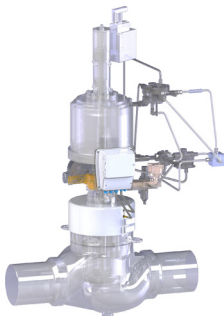
## Hydraulic Damper

### Solutions

The hydraulic damper for piston-type actuators prevents valve oscillation and protects the actuator from pressure shocks and hammering by increasing the robustness of the construction. A hand pump is included for manual override.

## Flowserve electric heating and temperature control

The melting point of molten nitrate salt is 221°C (430°F) at atmospheric pressure. To guarantee reliable valve sealing performance, the packing or bellow seal of the molten salt control valve needs to be maintained approximately 50°C (90°F) above the melting point of the fluid, or ~271°C (520°F). The Flowserve electric heat system maintains proper temperature at the sealing areas to mitigate crystallization and ensure optimum leakage resistance. The compact and highly energy-efficient system automatically switches off upon reaching a defined temperature, protecting the sealing components and improving the useful service life of the valve.



## Cast-in Heater With Integrated Thermocouple Type K

### Specifications

Material: Brass Casting  
Design: Two-part Design for Easy Assembly  
Temperature: Max. 600°C (1,112°F)  
Power Cable With Metal Protection  
Nominal Voltage: 230 V, IP65, CE

### Solutions

This cast-in heater has an integrated type K thermocouple to provide additional safety levels to protect from overheating.



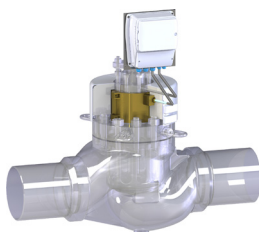
## Junction Box With Overheating Protection

### Specifications

Material: Metal Casting (DIN 1725),  
RAL7035/RAL7040, CE, IP65  
Integrated Temperature Transmitter  
4-20 mA Standard or HART on Demand

### Solutions

This junction box regulates the temperature in the heat element with an integrated temperature sensor and protects against overheating. The setpoint default value is 590°C (1,094°F); other values are possible.



## Thermal Insulation

### Specifications

Type: Fiber Blanket up to 1,200°C (2,192°F)  
Material: Metal Sheet (Stainless Steel)

### Solutions

Thermal insulation provides effective protection from rainwater (seal tape and silicone [high-temperature]).



## Other heat transfer fluid solutions

Regardless of the heat transfer fluid, Flowserve valves can take the heat — be it steam, water, air or thermal oil.

Flowserve solutions for heat transfer fluid applications combine platform standardization, high performance and simplified maintenance to deliver a lower total cost of ownership.

Flowserve engineers a broad range of valves and ultra-high precision positioners for CSP and HTF applications. These high-performance solutions offer greater reliability, precise

operation and significantly reduced packing leakage. Quality production ensures dramatic improvements in process uptime, reliability and yield. Because Flowserve valves for CSP and HTF services are constructed on global platforms using standardized parts and components, up-front engineering is held to a minimum.



## TRUNNION MOUNTED CONTROL BALL

### Valbart TMCBV



#### Specifications

Sizes: DN 75 to 1400; NPS 3 to 56  
Pressures: Class 150 to 2500; API 3000, 5000 and 10 000  
Materials: Carbon Steel; Stainless Steel; Special Alloys  
Temperatures: -196°C to 450°C (-320°F to 842°F)

#### Solutions

Cost-efficient and compact, the Valbart TMCBV control ball valve provides excellent flow capacity and high rangeability. It is flexible, servicing a wide range of applications from heat transfer fluids to severe service applications required in a solar power plant. Available with numerous trim designs to eliminate cavitation and noise, this valve offers greater capacity than comparable globe valves, achieving the same flow with a smaller TMCBV which costs less, weighs less and requires less space.

*For more information, see document VLENBR0067.*

## AXIAL FLOW VALVE TRIM

### Valtek Multi-Z



#### Specifications

Sizes: DN 25 to 200; NPS 1 to 8  
Pressures: PN 40 to 400; Class 300 to 2500  
Materials: Carbon Steel; Stainless Steel; Chrome-Moly; Special Alloys  
Temperatures: -196°C to 550°C (-320°F to 1,020°F)

#### Solutions

The Valtek Multi-Z severe service valve provides milestone advancements in axial flow valve sizing. With balanced sigma distribution across the stages, cavitation is eliminated in the intermediate pressure drops, extending the life of the trim. With the abilities to pass large solids and control low Cv ranges, the Multi-Z valve is well suited for some of the most taxing CSP applications.

*For more information, see document VABR000360.*

## DESUPERHEATER

### Valtek VariCool



#### Specifications

Steam Line: DN 150 to DN 1000; NPS 6 to 40;  
Cooling Water DN 25 and DN 40; NPS 1 to 1½  
Pressure: PN 40 to PN 160; Class 300 to 2500  
Material: Carbon Steel; Stainless Steel  
Temperature: -10°C to 530°C (14°F to 986°F)

#### Solutions

The Valtek VariCool desuperheater integrates the precision of a control valve into a desuperheater to attain maximum rangeability, responsiveness and control. The multi-stage design of the piston tube allows the VariCool desuperheater to manage a wide spectrum of differential pressures as it directly injects atomized cooling liquid to cool process steam.

*For more information, see document SAENBRV901.*

## POSITIONER

### Logix 3800



#### Specifications

Air Cap: 20.4 Nm³/h @ 4 bar (12 SCFM @ 60 psi)  
Air Con: 0.5 Nm³/h @ 4 bar (<0.3 SCFM @ 60 psi)  
Repeatability: <0.05%  
Temperatures: -40°C to 80°C (-40°F to 176°F)

#### Solutions

This latest generation digital HART and Foundation Fieldbus smart positioner delivers superior performance and reliability in tough environments. Ideal for most double- or single-acting linear or rotary applications that require precise, accurate control. For use in hazardous locations worldwide.

*For more information, see document AIBR000110.*

## SOFTWARE

# ValveSight DTMs for HART or Fieldbus Communications



### Specifications

System Requirements: Windows XP,  
Windows 7, Windows 8, Windows 10  
Compatibility: Foundation Fieldbus;  
HART 6 and 7; FDT 1.2 and 2.0  
Equipment: Valves

### Solutions

ValveSight software is designed to help engineers and maintenance personnel responsible for managing HART or Fieldbus positioners by simplifying setup, calibration, configuration and diagnostics.

*For more information, see document LGENSF0014 or LSENB0004.*

## IoT CONDITION MONITORING

# RedRaven for Valves



**REDRAVEN™**

### Solutions

RedRaven advanced IoT condition monitoring from Flowserve helps plant operators monitor valve performance and proactively identify and address issues before they become failures.

It works with existing digital positioners or additional sensors to alert you when a valve deviates from normal operating conditions. With real-time performance data and analytics, you can take prompt action to keep valve problems from evolving into production-stopping failures.

Our valve conditioning monitoring programs make it easy to prevent valve failures, increase uptime, lower maintenance costs, and improve safety across all of your sites.



Ask your Flowserve representative about optional RedRaven IoT monitoring packages or visit [flowserve.com/iot](https://flowserve.com/iot) to learn more.

## Sales and service



### Unparalleled service: Day or night, worldwide

Flowserve services precision-quality pumps, control valves, seals and automation equipment for a diverse range of industries worldwide. Our Quick Response Centers (QRCs) are equipped with thousands of parts, including OEM and Flowserve custom-built products. And each has the personnel and equipment to expedite time-sensitive repairs of any size.

Flowserve service technicians can restore all types of control, manual-operated or pressure relief valves to original quality.

Should any valve prove unrepairable, we can usually replace it with a new valve within the same time frame.

### Service when and where you need it most

Flowserve QRCs are strategically located around the world to ensure rapid response to your time-critical repair needs. They serve as a local, single point of contact for the full inventory of Flowserve products and services, including the machinery to manufacture custom-built units. We offer better than 95% on-time performance for all repairs and can turn around new and custom-built units within 72 hours.

### Time-critical repairs

Flowserve offers 24-hour emergency repair, free pick-up and delivery within QRC service areas, mobile and on-site repair. When a service technician is needed, we can have one on-site within 24 hours anywhere in North America, and 48 hours outside of North America.





## Flowserve – Solutions to keep you flowing

Flowserve is one of the world's leading providers of fluid motion and control products and services. Globally, we produce engineered and industrial pumps, valves, seals, systems and automation equipment, and provide a range of related flow management services. Our solutions move even the most volatile and corrosive fluids safely and securely through some of the most extreme temperatures, terrain and challenging operating environments on the planet.

Flowserve products and services are specified for use in a vast range of industries, including oil and gas, chemical, power generation and various general industries.



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Flowserve Corporation has established industry leadership in the design and manufacture of its products. When properly selected, this Flowserve product is designed to perform its intended function safely during its useful life. However, the purchaser or user of Flowserve products should be aware that Flowserve products might be used in numerous applications under a wide variety of industrial service conditions. Although Flowserve can provide general guidelines, it cannot provide specific data and warnings for all possible applications. The purchaser/user must therefore assume the ultimate responsibility for the proper sizing and selection, installation, operation, and maintenance of Flowserve products. The purchaser/user should read and understand the Installation Instructions included with the product, and train its employees and contractors in the safe use of Flowserve products in connection with the specific application.

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