High Performance Fluid Handling

GESTRA Control Valves with ZK Radial Stage Nozzle®
for Power Station and Plant Engineering
ZK Control Valves for Power-Station and Plant Engineering

Overview
For many years now, GESTRA control valves of the type ZK have given proof of their reliability under extreme operating conditions. Long experience and know-how form the sound basis for a generation of efficient and tight-closing control valves for applications in power stations. Thanks to the easy maintenance and repair of the valves as well as the extremely high wear resistance afforded by the design, reliable operation is achieved together with a long service life.

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<td>– 400</td>
<td>29, 610</td>
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<td>Main feedwater pump</td>
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<td>2 Feedwater leak-off valve</td>
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<td>– 220</td>
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<td>3 Feedwater control valve</td>
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<td>H.P. preheater</td>
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<td>4 Condensate drain control valve</td>
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<td>29, 210, 610</td>
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<td>Boiler plant</td>
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<td>5 Boiler drain valve</td>
<td>to 280</td>
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Control Valves with ZK Radial Stage Nozzle®
Applications of the ZK Control Valves

ZK control valves are suited for various fundamental applications in industry and power stations:

- Leak-off control (recirculation)
- Drainage and warm-up
- Level control
- Injection cooling
- Steam control

GESTRA offers:

- Complete solutions
- Subsystems with definite interfaces

The ZK control valve consists of a valve body and the ZK RADIAL STAGE NOZZLE® with valve plug integrated into the body to act as the control unit.

The ZK RADIAL STAGE NOZZLE® ensures a rapid and reliable adaptation to the prevailing operating conditions.

If the operating conditions in the plant are changed, the control valve can be adapted to the new situation by repositioning or exchanging the radial stage nozzle. There is no need to remove the valve from the line for this purpose!

The high standard of GESTRA power station equipment is confirmed by a large number of references.

1. Leak-Off Control (recirculation)

GESTRA leak-off controls for feedwater and condensate pumps represent complete systems for on/off or modulating control.

The control valve with ZK RADIAL STAGE NOZZLE®, the actuator with quick-opening function, and the control unit are optimally adapted to the operating conditions prevailing in each case.

2. Drainage and Warm-Up

The control valve with ZK RADIAL STAGE NOZZLE®, actuator, level electrode and control unit together constitute a complete system which can be perfectly adapted to the operating conditions.

Even condensate flowrates with extreme fluctuations are discharged by this system without any problems. Specific warming-up of certain parts of the plant can be achieved with the aid of a temperature acquisition system.
3. Level Control

With the aid of the ZK control valve, level control systems can be realized under difficult technical conditions. The GESTRA level control system consists of a control valve with ZK RADIAL STAGE NOZZLE®, an actuator, a level electrode and a control unit.

The high-pressure probes NRG 211 and NRG 111 offer new possibilities for extreme temperatures and pressure ratings. Reliable operation of the system is ensured by the long life of the radial stage nozzle.

4. Injection Cooling

GESTRA injection cooling systems are offered as complete systems consisting of an injection-cooling valve with radial stage nozzle, an actuator, a temperature acquisition system, and the control unit. Injection cooling valves have to cope with high differential pressures, whilst ensuring extreme wear resistance and good regulating characteristics. The radial stage nozzle meets these high requirements and provides a perfect adaptation of the valve characteristic to the desired regulating characteristic. Thanks to the absolutely tight closure, thermal shock damage is prevented in injection coolers and combined steam pressure reducing and desuperheating valves.
Application Examples of the ZK Control Valves

Leak-off valve ZK 213 with compact electro-hydraulic actuator

Drain control station using ZK 29 valves with electrical actuator

H.P. preheater in a nuclear power station equipped with a condensate drain control valve type ZK 29

ZK 213 as spray injection valve in a high-pressure bypass station
For drainage purposes, the valve can alternatively be used as a hand control valve. In this case, the radial stage nozzle not only acts as a throttling unit, but also provides the function of thermodynamic control.

For this purpose, the control valve is adjusted manually once to the working point. From this time on, the condensate flowrate is determined by the thermal state of the condensate in the nozzle system (cold condensate / boiling hot condensate) without any further modification of the cross-sectional area. The valve is therefore also suitable for varying operational conditions.

Operating Principle

Patented both in Germany and abroad, the ZK RADIAL STAGE NOZZLE® consists of several sleeves with a large number of radial orifices. The orifices are arranged in parallel, but are shifted from sleeve to sleeve so that they partly overlap, forming nozzles mounted in series with intermediate flash chambers.

The flow through the radial stage nozzle is determined by the valve plug. Depending on its position, the individual stage nozzles are either partially or completely set free. The valve plug and the seat together form the shut-off unit of the radial stage nozzle. Due to the successive expansion in the flash chambers, the pressure differential across the cross-sectional flow area of the valve is reduced to a minimum.

Various stage nozzles and valve plugs are available to account for the pressure drop in a particular application. For extremely high pressure gradients, control valves with tandem shut-off are applied.

Due to the special design of the ZK RADIAL STAGE NOZZLE®, the sound level is reduced to a minimum. As a result of the expansion through a multitude of individual nozzles, the sound level is normally below 85 dB(A) within the entire control range of the valve.
The ZK RADIAL STAGE NOZZLE®

Technical Properties

ZK control valves are designed to meet the highest operational requirements. They offer a number of special features in comparison with conventional control valves.

◆ Extreme wear resistance
  The successive expansion of the fluid in the throttling sleeves of the radial stage nozzle produces a considerable reduction in pressure drop across the cross-sectional flow area. Special design details at the seating surfaces ensure safe and reliable valve operation. In addition, the mass flow is split up into many partial flows.

◆ Leakage rates
  The following leakage rates apply, depending on the valve type: FCI 70-2-2003, at least class V (test procedure B) and class VI (test procedure C) and EN 12266-1, leakage rate A.

◆ Variable valve characteristics
  For the ZK control valves, stage nozzles are available with linear or equal-percentage characteristics. A subsequent change is possible by repositioning throttling sleeves (orifices) or by exchanging the complete nozzle insert.

◆ Easy installation and inspection
  The entire nozzle insert, including seat, can be completely dismantled without the need for any specialist work and without removing the valve body from the line.

◆ Tandem shut-off
  Control valves for an extremely high pressure gradient are provided with a tandem shut-off (dual seat). In this way, the ZK control valve combines the functions of a conventional shut-off valve and a control valve, even for very high pressures.

◆ Low sound level
  The continuous reduction of the flow velocity in the radial stage nozzle ensures a low sound level, usually a maximum of 85 dB(A) within the valve’s control range. For differential pressures up to Δp_{max} 100 bar, the sound level is even below 80 dB(A).

◆ Different capacity ranges
  The k_{vs} values can be adapted to the operating conditions by repositioning or exchanging the radial stage nozzle. Intermediate lift positions of the valve plug can thus be avoided.

The complete ZK product range offers k_{vs} values from 0.5 m³/h to 969 m³/h. By exchanging the internals, it is possible to adjust ZK control valves to account for changes in differential pressure.

◆ Actuators
  ZK control valves can be used with most types of actuators available on the market.
Changing the valve characteristics using the ZK 29 as an example

- Position of the sleeves for linear characteristic
- Cross-sectional flow area
- Position of the sleeves for equal-percentage characteristic

Graph:
- Valve lift [%] vs. \( k_v [%] \)
- Linear characteristic
- Equal-percentage characteristic
Control Valve ZK 29, Valve Plug in Open Position

Option for special applications: Adjustable lift limitation in closing direction

ZK 29: Valve plug in closed position

ZK 29: Valve plug no longer in closed position; control edge does not yet set free any orifices

ZK 29: Valve plug in control position
Control Valve ZK 29

PN 160
Δp max 100 bar (1450 psi)
kₚ 0.7 – 130 m³/h

With its permissible differential pressure of 100 bar, the ZK 29 control valve covers a large range of kₚ values.

The valve plug and seat of a control valve are as a rule subjected to very high flow velocities during the opening and closing processes. To reduce this effect, the valve plug of the ZK control valve is provided with a special control edge above the seating surface.

At the beginning of the opening process, the plug lifts off the seat, yet the flow admitted is very low. Only once a certain lift has been reached, and hence a large annular channel has been opened between the seat of the valve and the sealing surface of the plug, are the annular rings of the radial stage nozzle set free one after the other by the control edge.

During the closing process, the flow is first considerably reduced by the control edge and then the sealing surface of the plug reaches the seat to close the valve completely.

Connections
- Butt-weld ends, socket-weld ends, flanged ends (EN, ASME)

Actuators
- Electric (rotary, linear or lever actuator), pneumatic, handwheel

Body material
- DN 25-50: 13 CrMo 4 4 (1.7335)
- DN 80-150: GS-17 CrMo 5 5 (1.7357)
- Other butt-weld ends and body materials on request

The ZK 29 offers the possibility of adjusting for various kₚ values and characteristics at a later time, by rotating the stage nozzle.

Control Valve ZK 210

PN 250
Δp max 100 bar (1450 psi))
kₚ 0.7 – 28 m³/h
Δp max 180 bar (2610 psi)
kₚ 0.5 – 5 m³/h

The control valve ZK 210 supplements the valve type ZK 29 primarily by extending the pressure rating to PN 250.

An additional radial stage nozzle arranged downstream makes it possible to overcome pressure differentials Δp max of up to 180 bar, thus closing the gap to the existing high-pressure types. In comparison to the ZK 29, the required actuator forces are lower.

By exchanging the internals, pressure differentials of Δp max = 100 bar or Δp max = 180 bar can be achieved. The ZK 210 offers the possibility of adjusting for various kₚ values and characteristics at a later time, by rotating the stage nozzle.

Connections
- Butt-weld ends, socket-weld ends, flanged ends (EN, ASME)

Actuators
- Electric (rotary or linear actuator), pneumatic, handwheel

Body material
- 13 CrMo 4 4 (1.7335)
- Other butt-weld ends and body materials on request
Control Valve ZK 313 with Tandem Shut-Off

ZK 313: Valve plug in closed position

ZK 313: Valve plug no longer in closed position; valve cone still in closed position; control edge does not yet set free any orifices

ZK 313: Valve plug in control position
Control Valve ZK 313

PN 630 & Class 2500
Δp_{max} 40 bar
k_v 20 – 46 m³/h
Δp_{max} 300 bar
k_v 1 – 17 m³/h
Δp_{max} 370 bar
k_v 4.5 – 9.5 m³/h

The control valve ZK 313 is also available as an ASME version as per ASME B 16.34. Due to the tandem shut-off, it combines the function of a conventional isolating valve and control valve, and offers long service lifetimes. The leakage rates are in accordance with the highest EN and FCI classifications.

At the beginning of the opening process, first the valve plug is lifted off the main seat, but the valve core follows only after a certain lift. At the moment of closing and at the beginning of opening, the flow velocity at the valve seat is therefore zero, which means that wire drawing is prevented. Through the use of the steel type 1.4903 / A 182 F91 and special seat materials, the ZK 313 permits a maximum temperature of 620 °C. The ZK 313 valve with additional nozzle can be used for differential pressures up to Δp_{max} 370 bar.

Connections
Butt-weld ends, socket-weld ends (EN, ASME)

Actuators
Electric (rotary, linear or lever actuator), hydraulic, pneumatic, handwheel

Body material
16 Mo 3 (1.5415), A 182 F1
10 CrMo 9 10 (1.7383), A 182 F 22
X10 CrMoNb 9 1 (1.4903), A 182 F 91

Nozzle Versions for ZK 313

Standard nozzle Δp_{max} 300 bar / 4350 psi
Special nozzle Δp_{max} 40 bar / 580 psi
(without tandem seat)
Special nozzle Δp_{max} 370 bar / 5365 psi
(only angle-type design)
GESTRA System Solutions ZK 213

Leak-off control consisting of:

- ZK 213-E4/40 DN 200 with 6-stage nozzle and tandem seat
- Hydraulic actuator with opening spring
- Control cabinet with SIEMENS S7 PLC
- GESTRA software with stored characteristic for leak-off valves

ZK 213 with tandem shut-off \( \Delta p_{\text{max}} \) 560 bar (8120 psi)
Control Valve ZK 213

\[ \Delta p_{\text{max}} \geq 300 \text{ bar (4350 psi)} \]
\[ k_v \geq 10 - 90 \text{ m}^3/\text{h} \]
\[ \Delta p_{\text{max}} \geq 560 \text{ bar (8120 psi)} \]
\[ k_v \geq 10 - 70 \text{ m}^3/\text{h} \]

The tandem shut-off of the control valve type ZK 213 ensures stable and low-wear operation as a control and shut-off valve for a pressure drop of \( \Delta p_{\text{max}} \geq 300 \text{ bar or } \Delta p_{\text{max}} \geq 560 \text{ bar} \).

For this control valve, the maximum differential pressures of \( \Delta p_{\text{max}} \geq 300 \text{ bar or } \Delta p_{\text{max}} \geq 560 \text{ bar} \) depend on the design. A subsequent change is possible by exchanging the internals. The two additional throttling elements fitted in the high-pressure version provide effective protection against wear. Due to the tandem shut-off, it combines the functions of a conventional isolating valve and control valve, and offers long service lifetimes. The leakage rates are in accordance with the highest EN and FCI classifications.

<table>
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<tr>
<th>Connections</th>
<th>Butt-weld ends (EN, ASME)</th>
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<tr>
<td>Actuators</td>
<td>Electric (rotary, linear or lever actuator), hydraulic</td>
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<tr>
<td>Body material</td>
<td>16 Mo 3 (1.5415)</td>
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<td>15 NiCuMoNb 5 (1.6368, WB 36)</td>
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</table>

Internals of a leak-off valve ZK 213, DN 100, after 13 years of operation with \( p_1 = 374 \text{ bar (5420 psi)} \); \( p_2 = 11 \text{ bar (159.5 psi)} \), \( t = 172 \text{ °C} \), \( m = 35 \text{ kg/s} \).
Control Valve ZK 610 and ZK 613

Modular System of the ZK Radial Stage Nozzle® for ZK 610, ZK 613
The multi-stage pressure drop is adapted precisely to suit the operating conditions.

1-stage expansion

2-stage expansion
Control Valve ZK 610, ZK 613

ZK610, PN 250  
ZK613, PN 630

$\Delta p_{\text{max}} \leq 40 \text{ bar} - \Delta p_{\text{max}} \leq 250 \text{ bar (3625 psi)}$

$k_v \geq 13 - 969 \text{ m}^3/\text{h}$

The control valve types ZK 610 and ZK 613 round off the ZK valve range with large $k_v$ values. Thanks to the modular design, it is possible to adapt the throttling units optimally to the operating conditions. In addition, leakage-free pressure balancing can be used to reduce the actuating forces.

As for the ZK 29, the seating surfaces are protected against high flow velocities by means of a control edge at the valve plug. This design measure achieves the highest leakage-rate classifications according to EN and FCI with long service lifetimes. The entire ZK radial stage nozzle® including seat is easy to exchange, ensuring the highest level of availability.

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<th>Connections</th>
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3-stage expansion  
4-stage expansion  
5-stage expansion
GESTRA Stands for Quality

Quality is our Strength

For GESTRA, the concept of “Quality” not only includes the product itself, but applies equally to planning, handling and service. It is our aim to recognize and eliminate the sources of potential errors during all phases of order processing by means of comprehensive internal strategies. The ideal basis for this is a quality management system in accordance with EN ISO 9000. Of the three possible levels, our quality assurance system achieved certification according to EN ISO 9001. The high quality standard of GESTRA products has been confirmed time and again through a large number of recognized type-approvals issued by TÜV (German Technical Supervisory Association), Germanischer Lloyd, Lloyd’s Register of Shipping and many other classification societies. The company thus also fulfills the conditions of the new Pressure Equipment Directive.

Extract from our List of References

- Loy Yang B Power Station | Australia
- Collie Power Station | Australia
- Energy Brix Australia | Australia
- AUSTRIAN ENERGY | Austria
- Electrabel | Belgium
- JP Elektroprivreda | Bosnia
- Tracktel | Brazil
- Becancour Power Plant | Canada
- Methanex | Chile
- BASF YPC Project Nanjing | China
- Walgaqiao | China
- INA Raffinerie | Croatia
- ČEZ | Czechia
- Škoda | Czechia
- Elsam | Denmark
- Teollisuuden Voima Oy | Finland
- EDF | France
- ALSTOM | Germany
- BASF | Germany
- Bayer | Germany
- BEWAG | Germany
- Clarifiant | Germany
- E.ON | Germany
- EnBW | Germany
- Hitachi Power Europe | Germany
- KSB Pumpen | Germany
- RWE Power AG | Germany
- SIEMENS PG | Germany
- STEAG | Germany
- Sulzer Pumpen | Germany
- SWB | Germany
- Vattenfall | Germany
- Volkswagen | Germany
- Weller Pumpen | Germany
- BHEL | India
- Tjiiwi Kimia | Indonesia
- Ansaldo | Italy
- ENEL | Italy
- Incheon Power Plant | Korea
- Panglima Power | Malaysia
- EPZ | Netherlands
- Elektrownia Kozenice | Poland
- Ribatejo Power Plant | Portugal
- AL Shuweihat | Saudi Arabia
- Eskom | South Africa
- Campo de Gibraltar | Spain
- Kernkraftwerk Trillo | Spain
- Sagunto | Spain
- C4 ENERGI AB | Sweden
- SSAB | Sweden
- Kernkraftwerk Leibstadt | Switzerland
- Kuo Kuang Power | Taiwan
- British Energy | UK
- Alabama Power | USA
- Ameren UE | USA
- Con Edison | USA
- Electric Energy | USA
- TVA | USA
- Phu My | Vietnam

On request, we will gladly provide references for other countries and customers.
Overview of the Product Range

kvs values [m³/h] (Linear Characteristics, Design, Pressure/Temperature Ratings)

### ZK 29

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**Straight-through / angle**

![Graph](image1)

### ZK 210

<table>
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<th>Δp 180 bar</th>
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**Straight-through / angle**

![Graph](image2)

### ZK 313

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**Straight-through / angle**

![Graph](image3)

### ZK 213, sizes 1–5

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**Angle / Z-pattern**

![Graph](image4)

### ZK 610 und ZK 613

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**Angle / Z-pattern**

![Graph](image5)

### ZK 610 Angle / Z-pattern

![Graph](image6)

### ZK 613 Angle / Z-pattern

![Graph](image7)

Adaptation of nominal sizes is possible.