

# Systems for the Control and Regulation of Gas and Steam Turbines – Tested, Reliable, Safe





## Stable energy supply – field-proven system solutions in Rexroth quality increase availability

Gas and steam turbines in conventional power generation plants secure the stability of electricity supply networks in conjunction with facilities generating renewable energy. To combat rising energy costs, there are growing demands for reliable system solutions for power plants directly linked to an increase in availability. The demand is shifting away from standard components and toward specially designed control and safety systems. This is exactly what you obtain from Rexroth!

### Partners with many years of industrial experience

In power generation plants, components must function fault-free for at least five years. Unscheduled downtimes are extremely costly. At the same time, as much electricity as possible must be generated at the lowest possible costs using highly flexible and environment-friendly processes. This sounds very simple but it is only achievable if the latest networked solution concepts are applied in every detail.

The complex plants require tailor-made systems due to their high temperatures and pressures and their extensive safety devices, which are hopefully rarely tripped. Rexroth has built up a pool of application expertise over several decades. This is demonstrated by numerous innovations and certifications that are unique on the market.

The results: an extensive portfolio from ready-to-connect control and safety systems through to worldwide service, maintenance, and project-engineering services. Leading

power-plant operators and plant and turbine manufacturers have relied on this for many years – certainly, there is every reason to do so in such an essential field as power supply.

### Quality – a Rexroth trademark

Striving toward greater availability and lower maintenance costs is directly linked to continuous quality assurance in the manufacture of components and subsystems.

Rexroth has demonstrated its willingness to accept the obligations connected with meeting the highest quality and demands when it comes to its products and processes in order to achieve long-term customer satisfaction. Proof of this is provided by certification to various standards, such as ISO 14001:2004, BSOHSAS 18001:2007, and ISO 9001:2008, for example. Well-known customers confirm Rexroth's quality strategy through the successful certification of suppliers.



**In addition to field-proven system components, Rexroth offers innovative system solutions – to achieve greater safety, better supervision options, greater plant availability, and reduced maintenance costs all at the same time. Here are two examples:**

- ◀ **STSS – the revolutionary Self-Testing Safety System**
- ▶ **EMA(G) – the new electromechanical actuator with hydrostatic gear – stand-alone, compact, robust**



# Ready-to-connect systems enhance safety, controllability – and TCO

To achieve safety in gas and steam power plants and improve the greatest possible plant availability and cost efficiency at the same time, thinking in single components is no help at all. Rexroth experts have developed a wide range of ready-to-connect systems which offer practical solutions for essential control and regulation functions. They reduce overall system complexity and increase reliability and availability. At the same time the total cost of ownership is improved.



You specify the requirements for your plant and turbines – we supply the systems to match. In Rexroth quality.

#### Control/Regulation:

- ▶ Hydraulic actuator for gas and steam valves
- ▶ New: Electro-Mechanical Actuators EMA(G)
- ▶ Complete assemblies consisting of actuators and valve



- ▶ Cylinders for position control
- ▶ Hydraulic motors for turning gears



#### Safety:

- ▶ New: Self-Testing Safety System STSS
- ▶ Fast-acting control manifolds
- ▶ Control manifolds for turning gears



- ▶ Combined oil supply for cooling, lubrication, and high pressure hydraulics
- ▶ Switchable inline filters – a key component for oil supplies



# Control and regulate with continuous directional control valves – for reliable turbine operation

The option to operate control devices installed in a turbine by control and regulating equipment is essential to achieve trouble-free, safe turbine operation. A wide range of continuous valves with or without integrated valve electronics is available for hydraulic control and regulating equipment.



## Directional servo valves

For example, when it comes to rapid response times which require complex dynamics in the closed loop control, directional servo valves are used in hydraulic actuators. Double piloted directional servo valves consist of a torque motor in redundant design realized by two or three coils and a hydraulic amplifier. This electrohydraulic amplifier converts an electronic valve set-point into a hydraulic power signal to adjust the valve piston. Use of these valves is dependent on a high degree of cleanliness of the hydraulic oil.

## Directional control valves

An excellent alternative to the use of directional servo valves is the use of directional control valves. They are less sensitive to soiling since they are activated directly by control magnets and not by an electrohydraulic amplifier. These valves are only a little less dynamic than the response of directional servo valves.

## Proportional directional valves

They are similar in construction to directional control flow valves. The dynamic response of these valves is sufficient for open loop control applications. They can also be used as proportional throttle valves, e.g. in turning gears for turbine rotors.



- ▲ Directional servo valve
- ◀ Directional control valve

# Fast-acting control – for gas and steam valves with fast-acting shut-down or opening function

Fast-acting controls are installed when an actuator in normal operating mode, i.e. in shut, open, or control position, must immediately adopt a predetermined safety position after signal output.

## Basic principle

A control cylinder which is mounted on a gas or steam valve is prestressed hydraulically against a spring and moves to the predetermined working position. If the gas or steam valve must shut down or open rapidly, the preloaded cylinder chamber is relieved to the depressurized cylinder side via a cartridge valve. The safety function spring in the actuator moves the cylinder piston to the intended safety open or closed position of the gas or steam valve.

## Safety aspects

The signal output for the fast-acting shut-down or opening of a valve is based in most cases on the operating condition of a turbine which requires rapid and safe action, e.g. load rejection. For this reason, two-way redundant hydraulic cartridge valves are used in the majority of cases.

## Safety circuit structures

Compared with a hydraulic dual-channel structure (1oo2 safety circuit), there are other circuit structures which are used dependent on customer requirements and dependent on the specified SIL capability of a gas or steam valve: e.g. 1oo1, 1oo2, 1oo3, 2oo2, 2oo3 (oo = out of), etc.

For example, a 2oo3 safety circuit means that three operating elements (e.g. directional valves) must be fitted to execute a function. To execute the function safely, however, only two operating elements (2 out of 3) are required. One element may fail without endangering the function.

For fast-acting functions which require a specified SIL capability, safety characteristics are attributed to Rexroth actuators.



# STSS – the intelligent control system for a high level of functional reliability

The Self-Testing Safety System (STSS) checks the functional reliability of safety gas and steam valves operated very rarely and detects their operational readiness without interrupting or affecting ongoing plant operation. It can be used irrespective of the diversity of components made by different vendors in the plant. It can operate any actuator, it tests the systems and prevents standstill damage due to regular oil changes.

▼ **STSS in the simple configuration of the hydraulic system section: a valve block with two serial-switched active cartridge elements, pilot poppet valve, and sensors for position measurement**



## **Danger from non-operation**

With drives that are only operated at long intervals as opposed to normal operation, there is a risk of loss of function due to the oil resinating (the chemical composition of the fluid transforms to a sticky or solid substance), or from the silting effect (valve spool blocked by deposits of dirt particles between piston and housing).

## **Cyclic functional test prevents standstill damage**

At preset time intervals, pilot signals are output reciprocally to the pilot valves of the cartridge elements by a safety-related programmable control system. The response of the complete system is recorded and evaluated, e.g. the switch movements of the cartridge valve pistons, the movements of the stroking cylinder piston rod within their elasticity range, and the pressure ratios of the medium in the gas or steam valve.

This system test allows conclusions to be drawn regarding the operational readiness of an actuator without affecting plant operation. At the same time it causes continuous oil exchange in the pipes.

# Hydraulic actuator – safe, field-proven, and recognized

Compared to gas turbines, the complete thermal power of steam turbines must be controlled by valves. In gas turbines, only the fuel supply quantity is controlled, and this is reflected in the dimensioning of the actuators. They are available in various designs for a turbine power range from 25 to 1600 MW for steam turbines and from 25 to 375 MW for gas turbines, dependent on customer requirements.



## **A recognized system solution**

The hydraulic actuator has a modular design and can be combined in various configurations. The required actuators can be assembled from a selection of hydraulic cylinders, spring assemblies, measuring systems, and valves dependent on customer specifications. All control functions are accommodated in the cylinder housing, which is also executed as a valve control block.

## **Safety is integrated**

The fail-safe function of the actuator is ensured mechanically by the spring assembly.

## **Use of field-proven components**

All hydraulic valves used are designed using poppet valve technology, with the exception of continuous valves. On the one hand, this guarantees a high degree of plant shut-down safety. On the other hand, it drastically reduces leakage oil flow within the complete system.

## **Key technical features**

- ▶ Electrical and hydraulic interface for signal and power transfer
- ▶ Positioning by controlled linear actuator
- ▶ Limitation of maximum shut-down speed during fast-acting shut-down
- ▶ Integrated cushioning
- ▶ SIL 3-capable configuration

# EMA(G): Electro-Mechanical Actuator with hydrostatic Gear – stand-alone, compact, and preconfigured

The new electro-mechanical actuator with hydrostatic gear and spring-assisted fast-acting shut-down function operates as a stand-alone in a compact housing – with no additional oil supply unit and pipework. It is particularly easy to handle. This significantly lowers commissioning and maintenance costs.



### The secure plug-and-play solution

The compact electro-mechanical actuator offers an alternative to the complex installation of an hydraulic actuator, comprising power pack, control block, pipework, control and amplifier cards, and large fluid quantities.

### Preconfiguring makes commissioning easier

The electro-mechanical actuator is a preconfigured system comprising tried and tested components which only have

electrical and mechanical interfaces routed to the exterior. Parameterization is therefore simple and the control system is well-arranged to minimize the commissioning costs. The actuator is ideal for use in power plants due to its sensitivity to vibration and its capacity to generate high positioning forces and strokes. Long service life and maximum safety (SIL 3-capability) with minimized maintenance meet the demand for high availability.

#### Advantages

- ▶ Stand-alone solution without installing a hydraulic system
- ▶ Compact design for space-saving installation
- ▶ Preconfigured system for easy parameterization and low commissioning costs
- ▶ Field-proven components with excellent performance
- ▶ Robust and safe: minimum maintenance requirements and long service life
- ▶ Reduced fire hazard

#### Key technical features

- ▶ Electrical interface for power and signal transfer
- ▶ Operating and safety functions separate
- ▶ Positioning using a controlled synchronous motor and hydraulic transmission
- ▶ Combined fast-acting shut-down due to spring-supported shut-down function
- ▶ Limitation of maximum shut-down speed during fast-acting shut-down
- ▶ Integrated cushioning
- ▶ SIL 3-capable design

#### Optional:

- ▶ Alternative design as switch actuator with no control function



# Turbine rotor turning gear – prevents thermal deformation and standstill damage

To avoid temperature-related deformation after a turbine is shut down, the turbine rotor must be rotated slowly for some time to cool it down (cool-down turning). It is just as important to turn the rotor at regular intervals during long periods of standstill to prevent static deformation and monitor the smooth mechanical movement of rotation (turning at regular intervals). The hydraulic turning gear reliably prevents damage to the turbine.



Rexroth offers all system components for hydraulic turning gear to meet all turbine manufacturer requirements: hydraulic motor, control block, and hydraulic cylinder. The construction of the turning gear, which can be designed for direct connection or with a transmission, is adaptable to the turbine power output.

There is a selection of field-proven motor model series for the hydraulic motor, operating on the axial or radial piston principle. The recommended hydraulic cylinder is the mill type design which easily meets the robust requirements of heavy mechanical engineering. The control block contains the control functions of the hydraulic motor and the hydraulic cylinder. The valve configuration is primarily tuned to the range of hydraulic motor functions.

# Tailor-made oil supply – hydraulic energy, cooling, lubrication

In turbine plants, two hydraulic worlds meet: Cooling/lubrication circuits feature low system pressures and operate at high flow rates; pressurized oil supply helps to transfer hydraulic power. This requires medium to high operating pressures at comparatively low flow rates. Rexroth has demonstrated that it is a competent partner capable of designing the two systems and supplies both separate supply units and the two systems mounted on a tank.



The redundant design of the pumps and filters also guarantee ongoing turbine operation during filter maintenance or faults. The sensors for pressure, temperature, filter contamination, and oil reservoir fill level ensure a reliable overview of system status at all times.

## Hydraulic energy for high pressure circuits

Rexroth offers a wide range of tailor-made solutions that contain proven components integrated in gas and steam actuators, turning gears and other systems. They are supplied with hydraulic energy for high pressure circuits.

## Cooling/lubricating oil supplies

Both the hydrodynamic turbine shaft bearing and the transmission between turbine and generator require lubrication and cooling. One exception is the jacking oil supply, which is otherwise assigned to the pressurized oil supply due to the required high system pressure. However, it must be operated with lubricating oil.

- ▲ Oil supply reliability
- ▶ Of course, all Rexroth components and systems comply with all national and international safety regulations



The key parameters of the cooling/lubricating oil circuit include flow rate, temperature, and the level of contamination and aging in the turbine oil. This in itself has a decisive impact on the service life of the turbine plant.

# Rexroth Service – Your Key to Higher Productivity

Maximum equipment availability and high efficiency throughout the entire lifecycle of your machines and plants: These are key factors that determine the productivity of your manufacturing processes. Rexroth offers a comprehensive spectrum of services to maximize the availability of your machines. Your benefit: a higher productivity.



Our complete service portfolio is reducing the complexity and costs for maintaining and repairing your production equipment. We guarantee quick access to qualified technicians who solve problems at the root, thanks to their comprehensive knowledge of all drive and control technologies. Besides we ensure fast diagnosis and quick delivery of spare parts while minimizing costs by standardized processes and test procedures. All carried out by uniformly high qualified personnel, covered by our network extended to more than 80 countries.

In addition, we keep your machines fit throughout their entire lifecycle with our preventive/predictive services e.g. fitness checks and oil analysis. Our offer also includes upgrading their efficiency to the latest state of the art as well as analyzing the benefits of modernization/retrofit measures, taking over the implementation in a practical manner – working together with you. Summarized, we combine higher productivity with better energy efficiency and defined safety standards – reducing your total cost of ownership significantly. Rexroth – your one-stop service partner: Just configure our services to your specific needs.



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- ✓ Increased reliability
- ✓ Avoided standstill times
- ✓ Secured competent services
- ✓ Reduced maintenance costs
- ✓ Extended life span
- ✓ Reduced TCO significantly

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