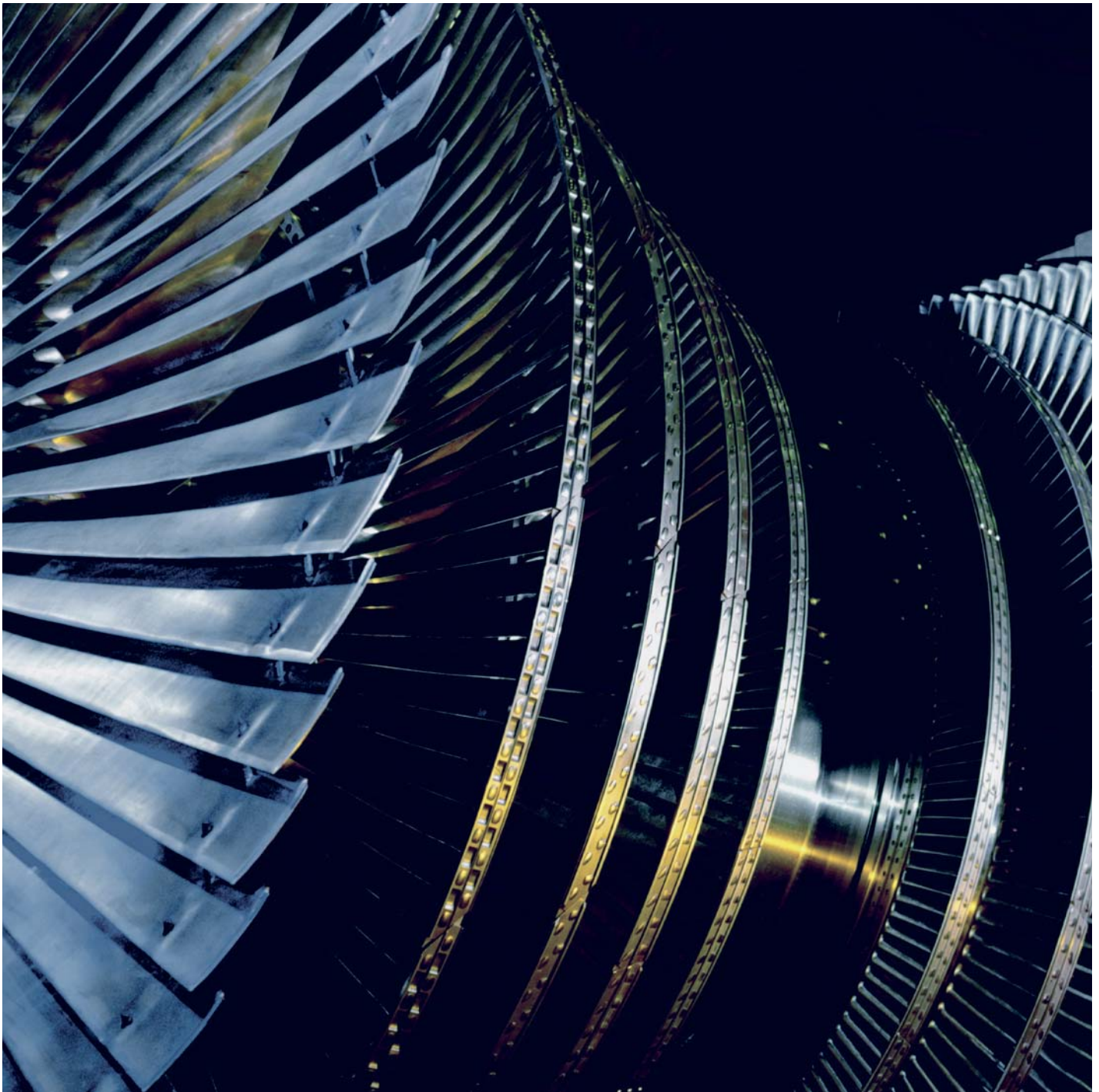


Hydraulic Control Systems in Gas and Steam Turbines



Always the Optimum Solution with Systems & Engineering from Rexroth



Rexroth has set up competence centers for virtually every application area of hydraulic drives and controls: Systems & Engineering. These industry-specific and specialist departments consist of a combination of highly specialized engineers, project designers, and other experts. Rexroth customers are thus able to utilize the extensive application know-how of the world's leading technology supplier.

Application-focused system solutions are developed here to state-of-the-art technology—right through to turnkey systems. This means that customers are then able to concentrate on the core issues of their project design. Systems & Engineering produces the technical details, as it is the integration, in particular, of demanding drive and control functions, that constitutes the success factors of customer-specific systems.

This unique combination of extensive application know-how and reliable Drive & Control technology is maximized to the benefit of the Rexroth customers. For this purpose Systems & Engineering is broken down into four essential competencies:

Market and application competence

Rexroth is able to offer extensive knowledge of the market with decades of experience in this branch and accurate knowledge of the demands and wishes of their customers.

Engineering and project competence

Rexroth meets all the necessary criteria to enable it to develop, simulate, and refine systems in an optimum way. In doing so, we take into account all relevant and internationally specific legal stipulations and, furthermore, also offer comprehensive risk, insurance, and site management.

Technological competence

With Rexroth, as with no other supplier worldwide, customers select from an extensive range of first-class Drive & Control components, such as cylinders, power units, valves, pumps, and control systems.

International competence

Rexroth has sales offices in over 80 countries, service centers in 37 countries, as well as 85 production locations around the world. This means that all products and services are available anywhere and at any time: in close proximity to the customer.

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Civil Engineering Technology



Dredge Technology



Energy Technology



Entertainment Technology



Materials Handling Technology



Motion Technology



Naval Technology



Offshore Technology



Research Technology



Shiplift Technology



Special Technology



Stage Technology



Testing Technology



Transport Technology



Special Projects

All from One Source: Hydraulic Control Systems in Gas and Steam Turbines

Hydraulic closed-loop control devices have a long tradition of use in turbine construction and are certainly one of the “pioneers” of oil-hydraulic closed-loop control technology in general (e.g. centrifugal governors by J. Watt). Around 20 years ago, and with Siemens in particular, Rexroth started to replace the low-pressure closed-loop control concept, which had been used up to that point and was based on the bearing lubrication system available, with a high-pressure concept. In turbine manufacture the 100–160 bar range is considered to be high pressure.

The most important issues in this range are safety, availability, and life expectancy of the installations.

► **Safety:**

Ensuring that non-permissible operating conditions can be 100% controlled: If faults are not rectified, this results in machine breakdown and potentially accidents and explosions may occur.

► **Availability and life expectancy:**

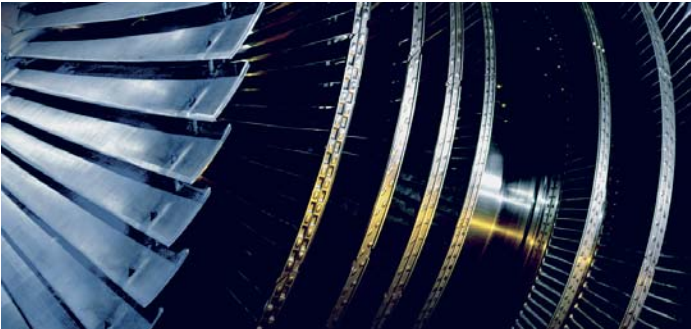
Ensuring that the generators can operate continuously: The most important issue with power stations is a non-interrupted power supply for maximum output. It must be guaranteed that the hydraulic components will last approx. 5 – 6 years without failing and causing a turbo assembly to break down.

The application of hydraulic systems in gas and steam turbines is explained in greater detail in the following description of turbo assemblies.

In the course of development of power plant technology, an increasing number of so-called combined cycle plants are built (combined process of gas and steam turbine). With the combined cycle process, steam is generated with the hot waste gas from the gas turbine by means of a waste-heat boiler, then being fed back to the power generation process via the downstream-connected steam turbine. This process offers a degree of efficiency of up to 60%.

Both the control and the safety functions are met using Rexroth actuator technology.





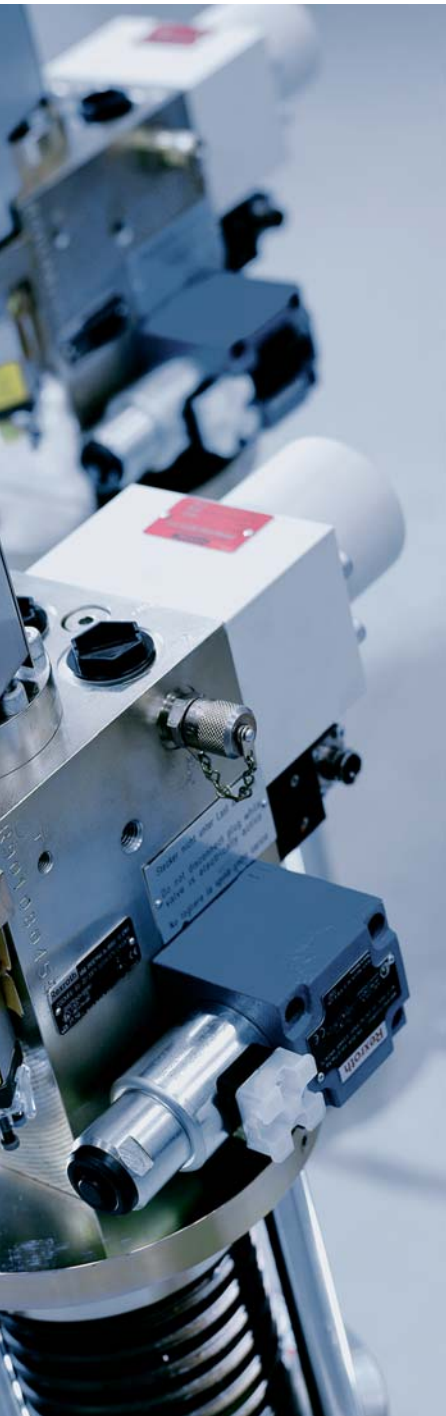
Hydraulic Control System in Gas Turbines

A range of systems is required in the fuel circuit for mastering the closed-loop control and safety functions of a gas turbine. Basically, it is possible to equip the gas turbine with two fuel systems, namely natural gas and fuel oil. Other fuels such as coal gas, synthesis gas, and naphtha can also be used.

The layout of the gas turbine will depend on the application. One relevant example of a fuel gas system is demonstrated in the diagram far right. As can be seen from the diagram, it is possible to operate the gas turbine in pre-mix or diffusion mode. Using these modes requires application of the control and safety devices shown in the diagram. These devices consist of oil or gas valves, which are operated by hydraulic actuators from Rexroth.

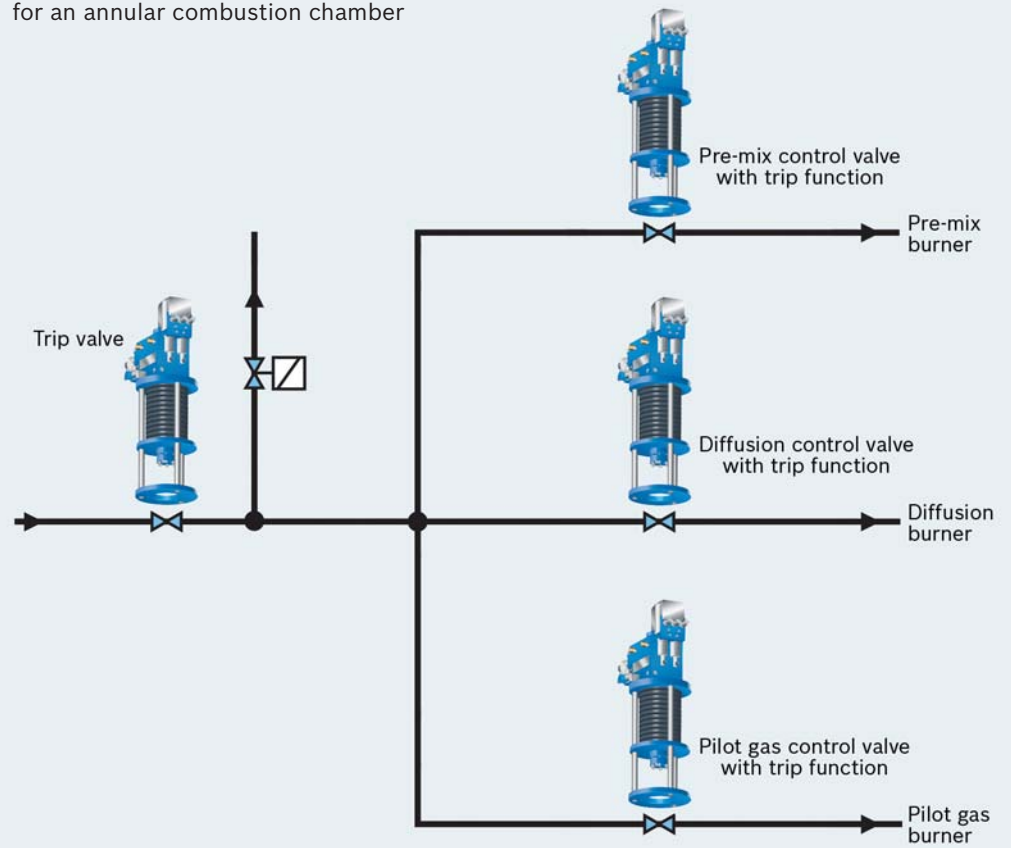
These components cover the complete power range of gas turbines from around 25 MW to 340 MW.



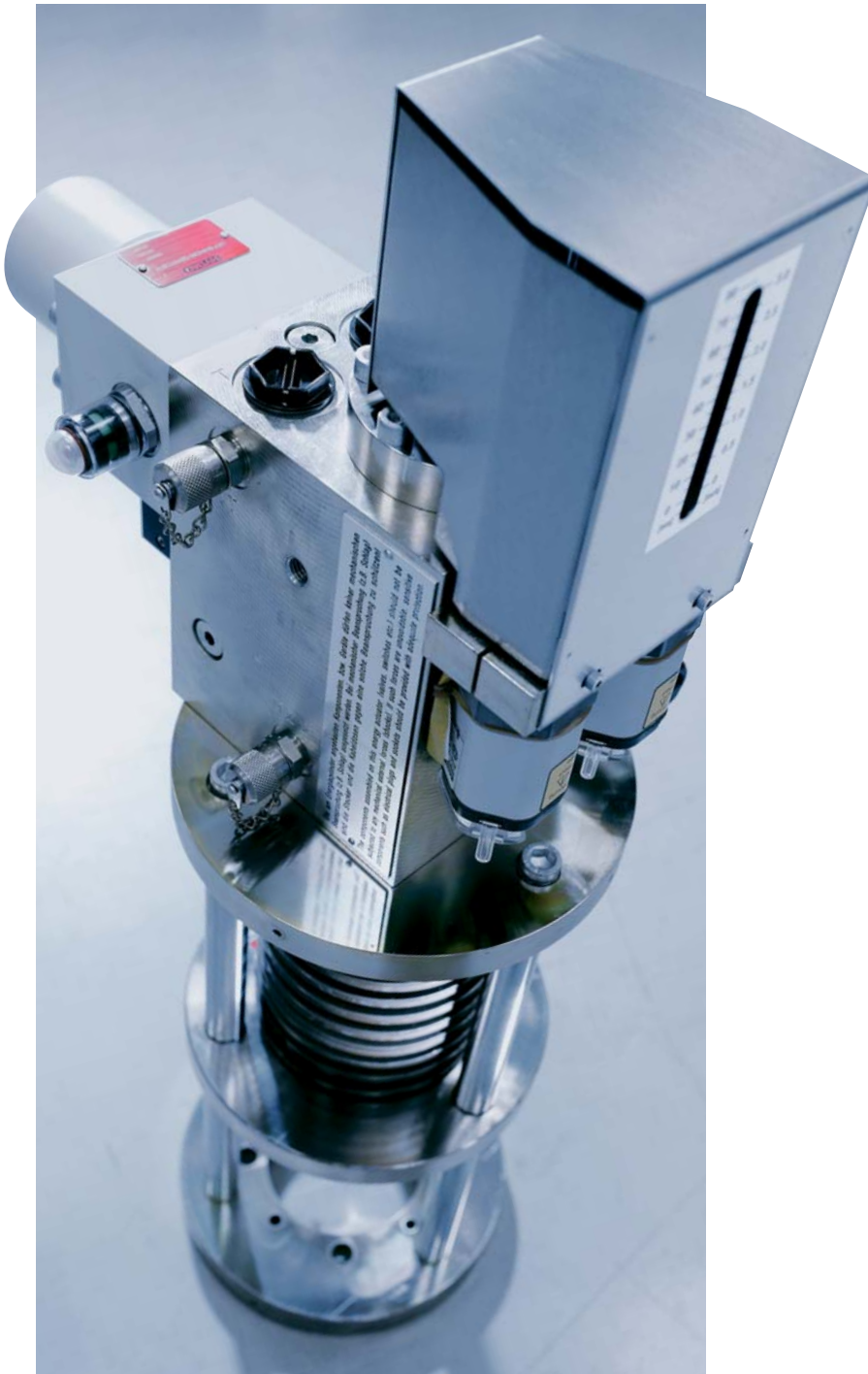


Fuel gas system for an annular combustion chamber

Example of a diagram for a fuel gas system for an annular combustion chamber



Hydraulic Control System in Gas Turbines



All hydraulic cylinders are designed as low friction cylinders. The functional operation of the actuator is carried out in the cylinder housing, which is designed as an integrated control block.

As a special feature, all control valves can be fitted with a superimposed trip function and the valves can match the sealing requirements of the trip valves.

The principle of a redundant safety function is accomplished with a trip valve and a combined trip-control valve. A second isolating valve is not applied. (e.g. with a control valve that is not leak-proof).

All fuel valves are kept open by hydraulic means against a disc spring set arranged inside the cylinder. The spring set closes the valves safely by mechanical means. The cylinders are designed as double-ended cylinders with double piston rods. As the oil volume is the same in both cylinder chambers, the hydraulic oil can be led via the cylinder housing directly to the rear side of the cylinder during the trip function (adjusting time 120 – 300 ms). This design means that, for rapid switching movements, hydraulic oil does not need to be fed back to the power unit. As a result, the available piping is only required for “normal” control mode and therefore only needs to be designed for minimal flows.

With the exception of the servo valve, all hydraulic valves used are designed as leak-proof components. On the one hand, a high level of system security (safety cut-out) is guaranteed (all switching valves are seat valves); on the other hand, the leakage flow of the complete system is drastically reduced (e.g. if the trip actuators are completely leak-proof). The result is that, in many cases, a hydraulic power unit with only minimal electric power will suffice for supplying all the actuators.



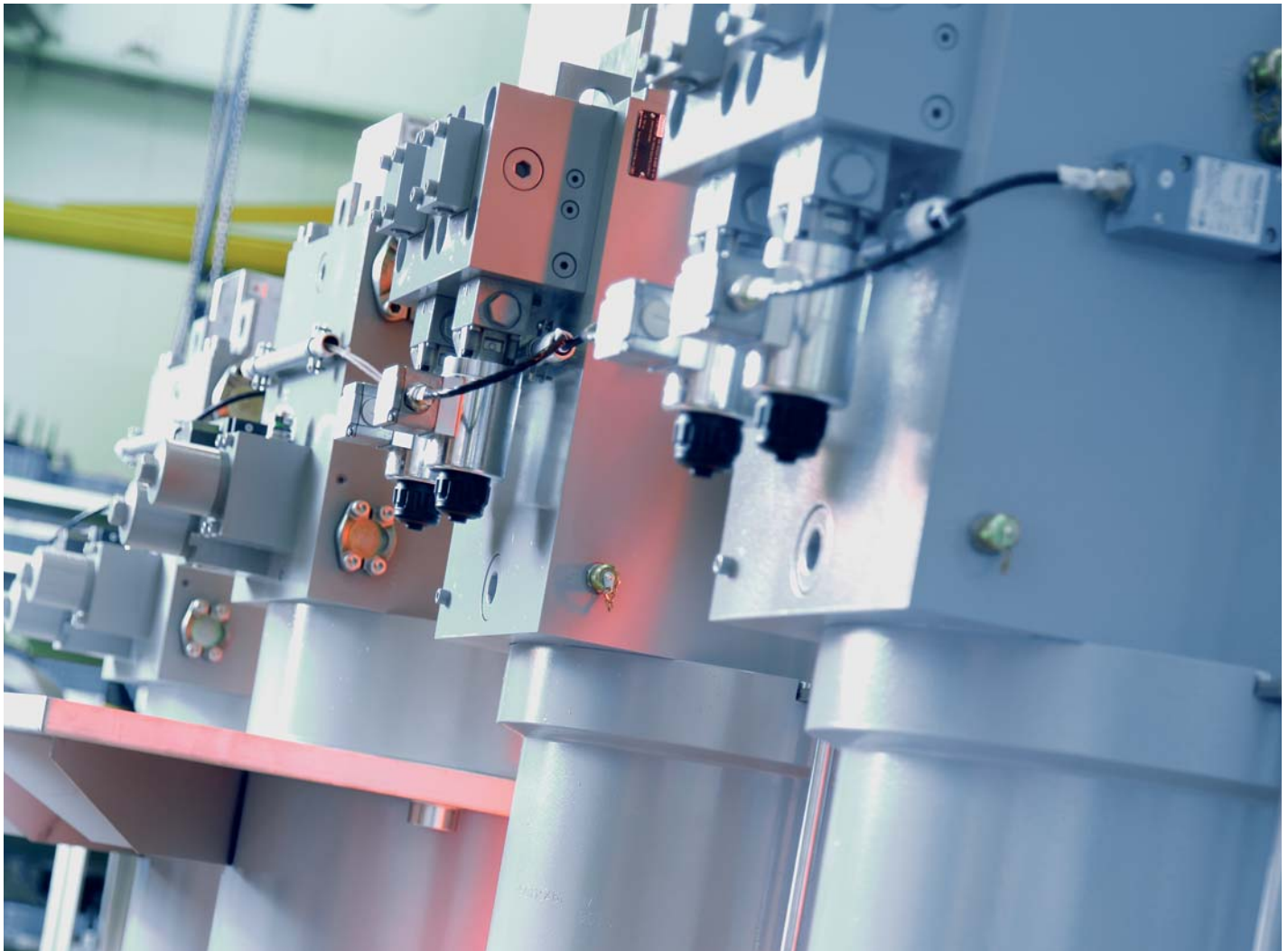
Hydraulic Control System in Steam Turbines

From its supply, the steam is fed to the HP-part of the turbine via two inlet valve combinations 1.1 and 1.2. After the initial expansion, it is directed via intercept valve combinations 2.1 and 2.2 into the IP-part. From the IP-part, the steam is led to the condenser via the LP-stages, from where it is fed back into the process as feed water.

For handling interruptions or faults, and for particular turbine operating conditions, provision is made for

HP-bypass station 4, IP-bypass station 5 and LP-bypass station 6. With the bypass stations it is possible to operate the steam supply independently of the turbine.

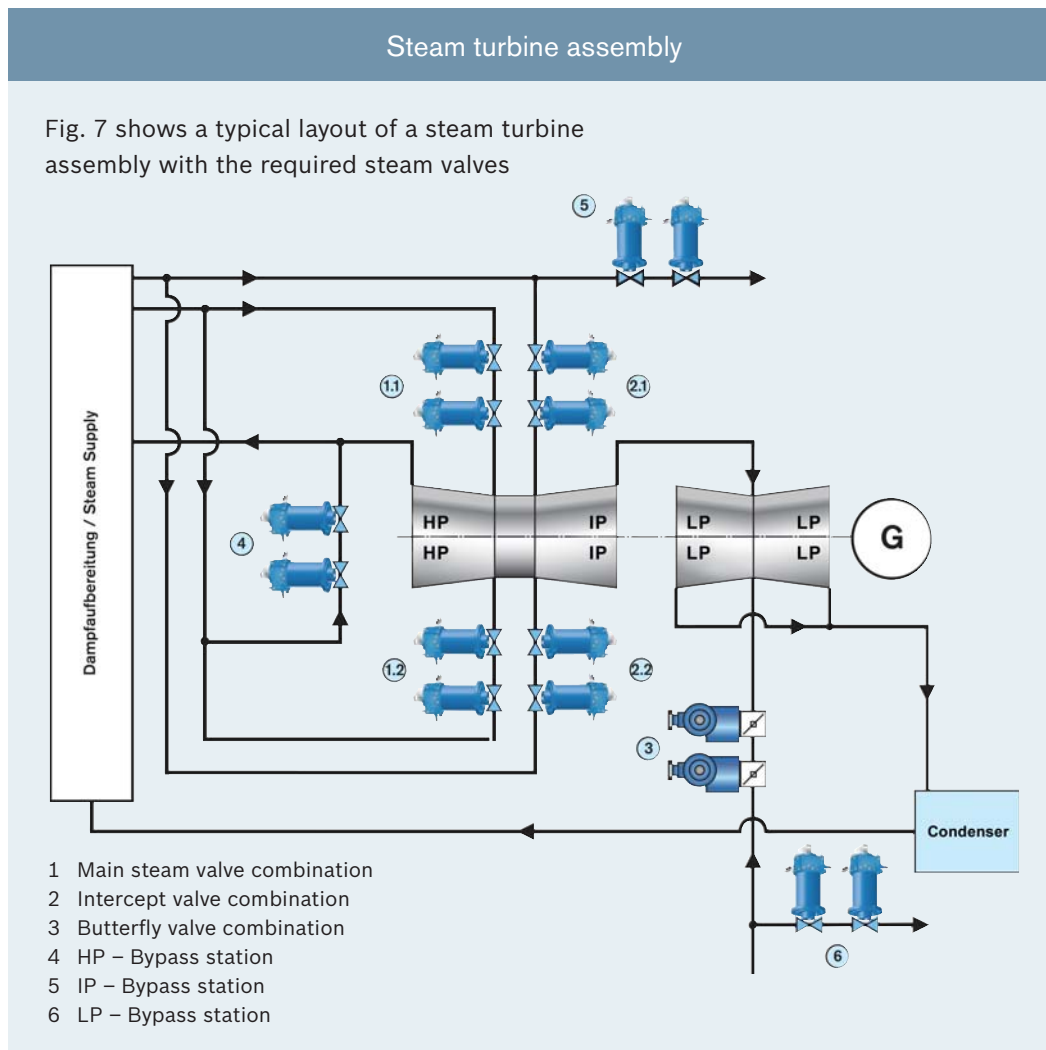
The valves installed for turbine control are designed and built by the turbine manufacturer. The temperature range is up to 550 °C, with the pressure ranging from 8 – 300 bar depending on the position of the valves in the installation. Each valve combination consists of a trip valve and a con-



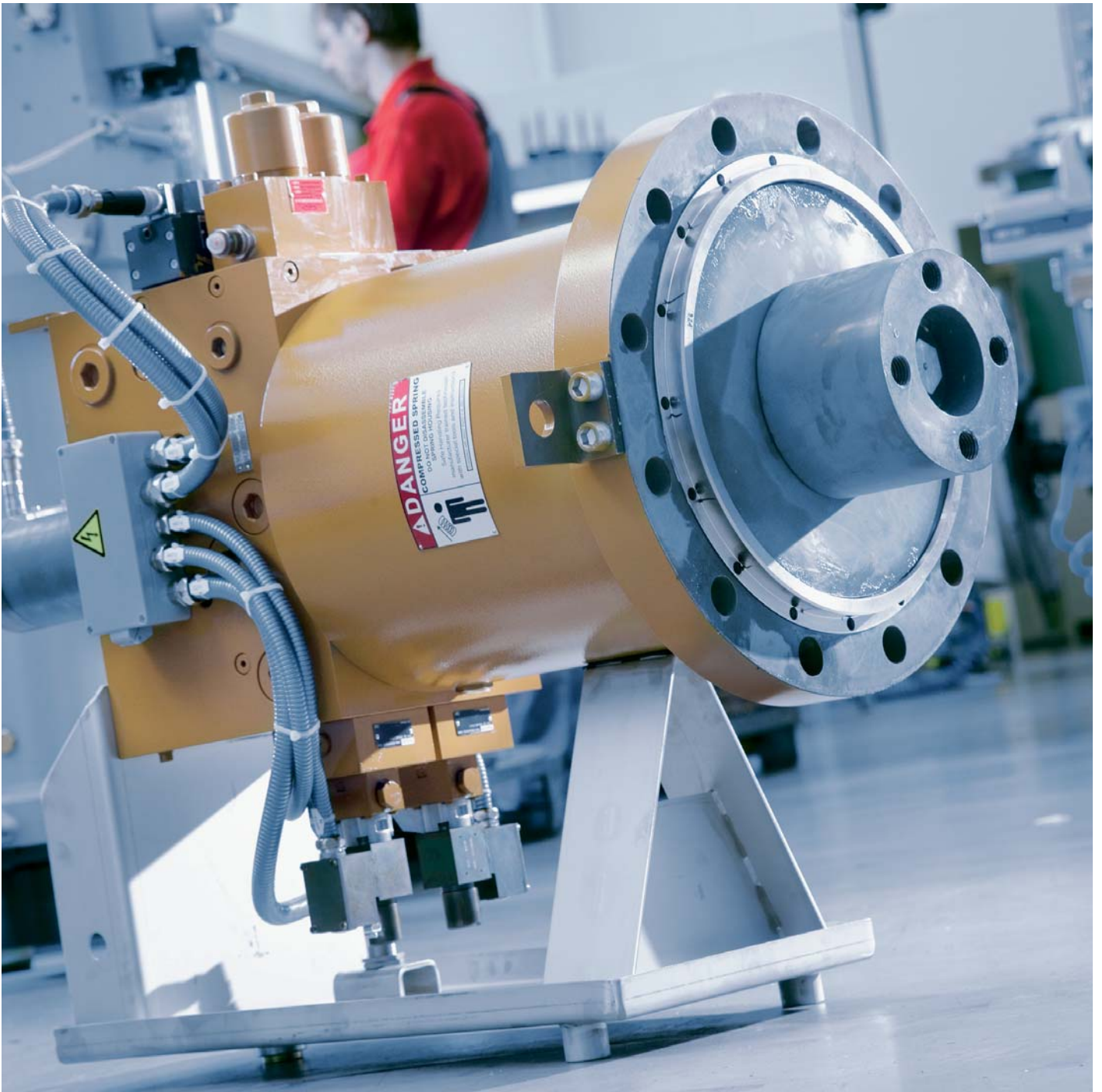
In contrast to a gas turbine, the total thermal power of a steam turbine has to be controlled by means of safety and control devices. With a gas turbine the quantity of fuel fed is closed-loop controlled (e.g. on a small scale comparable with the injection pump on the diesel engine); on the steam turbine, however, the complete steam flow has to be controlled by the steam valves. The steam valve nominal diameters, the steam pressures, and temperatures on these components are many times higher than on the gas turbine. This results in a considerably higher force requirement and thus greater diameters and spring forces of the hydraulic actuators used.

trol valve. The safety and control functions are combined in a valve housing, onto which two hydraulic cylinders are mounted.

Rexroth has a complete series of hydraulic cylinders with spring packs for use with various nominal diameters and pressure stages of these steam valves. The diameter can vary between 110 – 330 mm and the strokes range from 50 – 250 mm.



Hydraulic Control System in Steam Turbines



As can be seen from the preceding descriptions, Bosch Rexroth is in a position, via its modular system, to supply the complete hydraulic functions required in gas and steam turbines, the closed-loop control, and safety functions for the power range 25 – 1600 MW. A wide range of relevant reference projects, together with experience, are available and on hand if required.

The complete actuator design is modular i.e. the diameter range is covered by three housing sizes and the spring forces by appropriate spring package sizes. As both cylinder sizes and spring packs can vary, this series meets the requirements of steam valves for turbine powers ranging from 50 – 1600 MW.

All necessary control functions are realized in a single cylinder housing, which is designed as an integral control block. Both cylinder chambers are directly connected via the housing. The corrosion-proof spring packages ensure the system is closed and thus safe, once again purely by mechanical means (i.e. cut-off of the steam supply and thus that of the turbine). The steam valves are kept open by hydraulic means against the disc springs, respective the steam control valves are position controlled via servo valves.

Each valve combination consists of a trip and a control part. Due to the steam cut-off already described, the control actuator is also equipped with a superimposed rapid closing feature.

Here, too, as with the gas turbine cylinder, the high volume of oil occurring during trip and short switching times is fed directly to the rear of the double-ended cylinder.

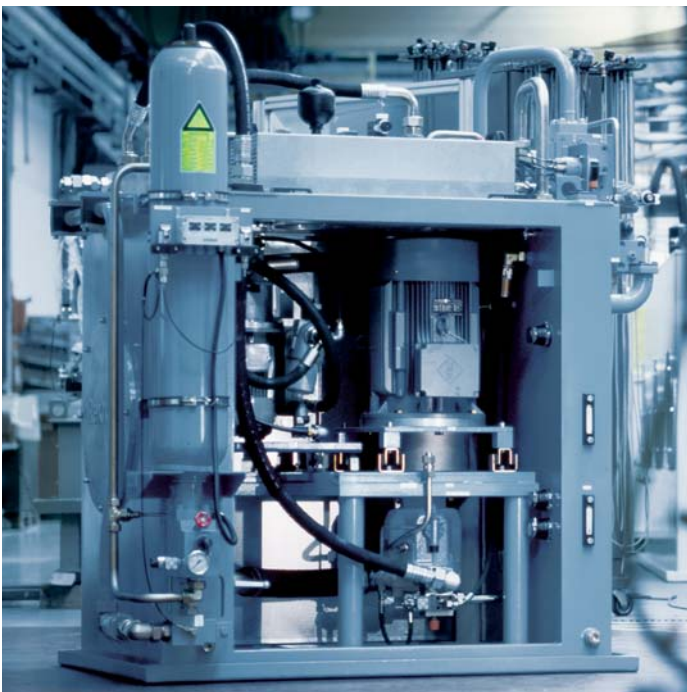
Accordingly, the connections to the hydraulic power unit are only designed for closed-control operation, as no oil needs to be fed back to the power unit during the trip function. Modular hydraulic power units, matched to the particular system and with the relevant performance data, are also available.



Hydraulic Control System Power Units for Gas and Steam Turbines



- ▶ Supply hydraulic pressure for control of fuel and gas valve actuators
- ▶ Steam turbine safety and control systems
- ▶ Electronic control systems for the auxiliary functions for turbines such as gas diverter control, turbine starters, and steam bypass stations
- ▶ Redundant motor pump groups and valving for uninterrupted continuous safe operation
- ▶ Trip controls for fast shut down in the event the load on the turbine is lost
- ▶ Low noise designs possible – 85 dB(A)
- ▶ Jacking/lube oil supply
- ▶ Turbine starting



Power Unit Accessories

All Rexroth sites worldwide operate in accordance with the same standards. This guarantees a supply of spare parts at every production site worldwide.



Rexroth has a worldwide unique range of spare parts for power units – such as flanges, screw fittings, measuring and display devices, filters etc.

There are group-owned production sites, subsidiaries, country units, sales offices and service centers in over 80 countries around the world. You can be assured that your power units are being maintained throughout their complete service life – and beyond: from installation and maintenance right through to modifications and modernization.



Blocks, Plates, ... Multifunctional System Components



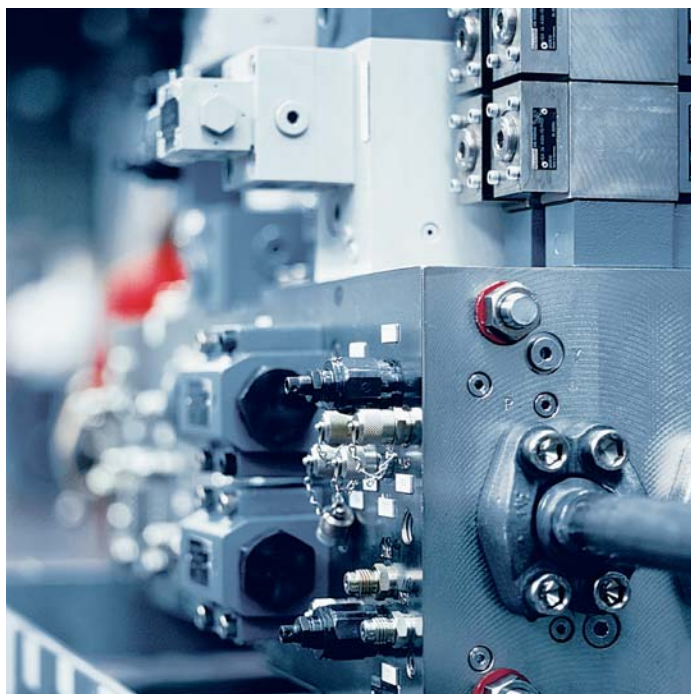
Whether check, pressure control, flow control functions, combined pressure-check functions, or rapid traverse and creep functions—Rexroth offers ready-to-install hydraulic control plates in modular design for your power unit. This modular solution offers a high level of variability, even in combination with complex functions. Segments with branch or customer-specific circuits can also easily be integrated.

Standard or Special Designs

In cooperation with the customer Rexroth development engineers transform the required functions into a detailed and optimally matched hydraulic schematic. Using in-house developed simulation programs all process steps are tested and matched under dynamic loading conditions, and then combined to form logical functional units.

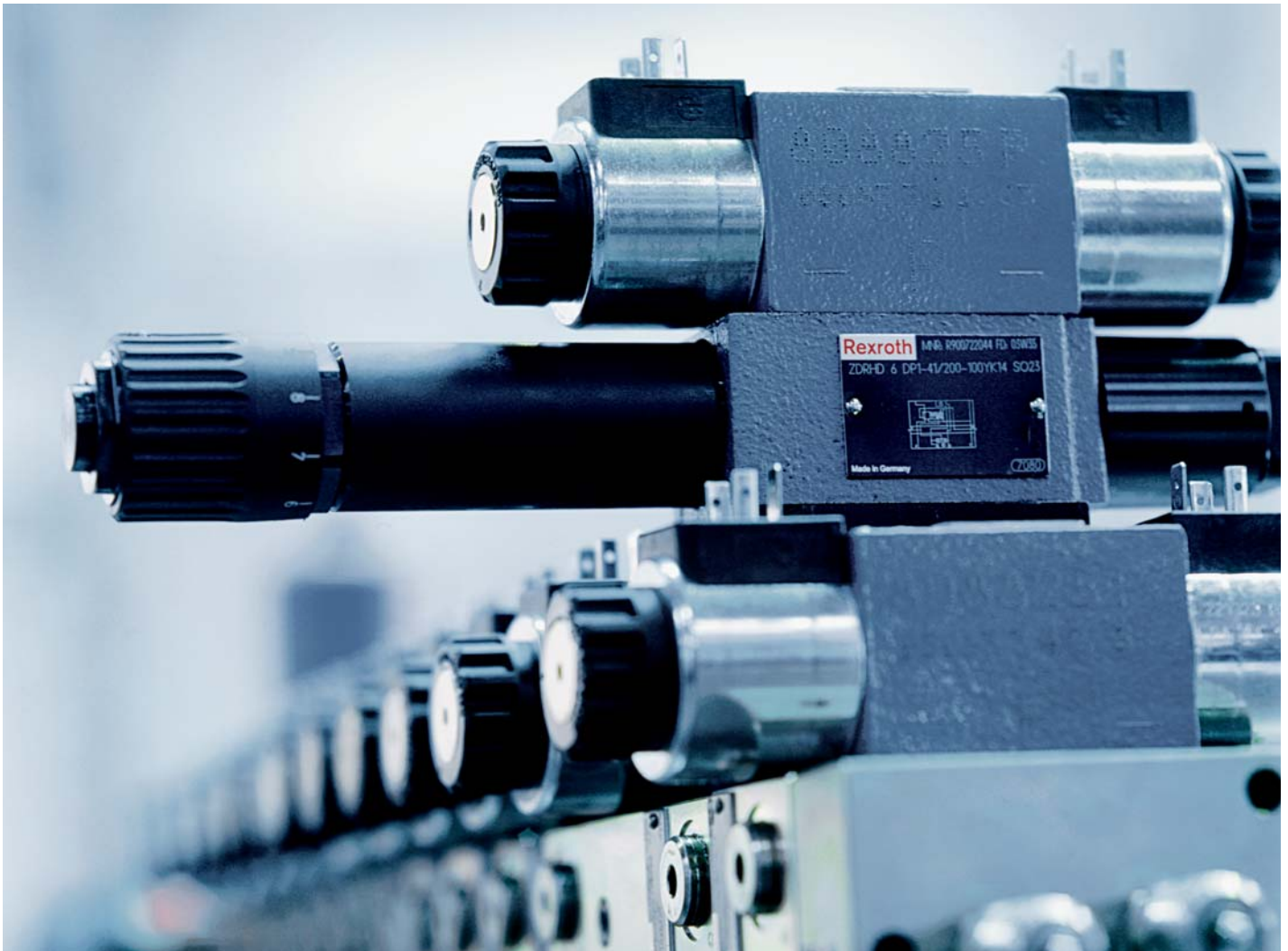
Manifold Assemblies for Power Generation include:

- ▶ Safety trip modules
- ▶ Turning gear blocks



Quality Determines the Function

Experienced design engineers, production specialists, and assembly workers guarantee smooth functional operation of the subassembly. Not only all of the components, but also the complete subassemblies are tested once more before dispatch and installation.



Service Competence – World-wide

Rexroth Service offers world-wide professionally coordinated services on the highest level. All services are available to the same standard all around the world.



Intelligent Hydraulics in New Dimensions

Whether it's a case of raising or lowering loads smoothly, undertaking linear or rotational movements, achieving even acceleration or accurate positioning, maintaining preset speeds, transmitting power or linking motion sequences—in fact, wherever economical power is required, this is where hydraulics comes into its own.

Rexroth is the technology and market leader in industrial hydraulics with an extensive product program and proven applications know-how. With the widest selection of hydraulic products in the world, Rexroth will provide you with standard products, application-orientated systems, and customized solutions of the highest quality. Furthermore, with the aid of the latest microelectronics, Rexroth has made hydraulics even more powerful than ever.

Rexroth is the ideal partner if you want to develop highly efficient machines and production facilities—from the first point of contact right through to commissioning and across the complete life cycle. Teams operating worldwide will take on the complete project design work of your systems, even producing a turnkey solution, if required.

Whether it's competent support on the telephone, urgent repairs or supply of spare parts, or a callout by one of our engineers—whichever service you require, experienced personnel and a worldwide service network will guarantee that the problem is swiftly solved.

Using hydraulic drive and control technology from Rexroth will help you become more competitive than ever.

Efficient Hydraulics Paired with Multi-technology Competence

Intelligent hydraulics in new dimensions: As leading supplier in industrial hydraulics, Rexroth takes an outstanding position with components, systems, distinct application know-how, and high engineering competence.



With Rexroth, you can choose from the world's largest product range of application-related systems and customized special solutions of high quality. In conjunction with advanced microelectronics, Rexroth has made hydraulics even more efficient. The products can be easily integrated into modern machine concepts, are extremely powerful and feature high energetic efficiency. Being a supplier for all technologies, Rexroth always offers the ideal application-specific drive solution. Rexroth is your ideal development partner for highly efficient machinery and production facilities—from the first contact through to commissioning and over the entire life cycle. Teams who are active all around the world assume the complete engineering of your plant and machinery, if requested, until maturity for series production or turnkey handover. With multi-technological competence and the use of drive and control technology from Rexroth you will be more competitive than ever.

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