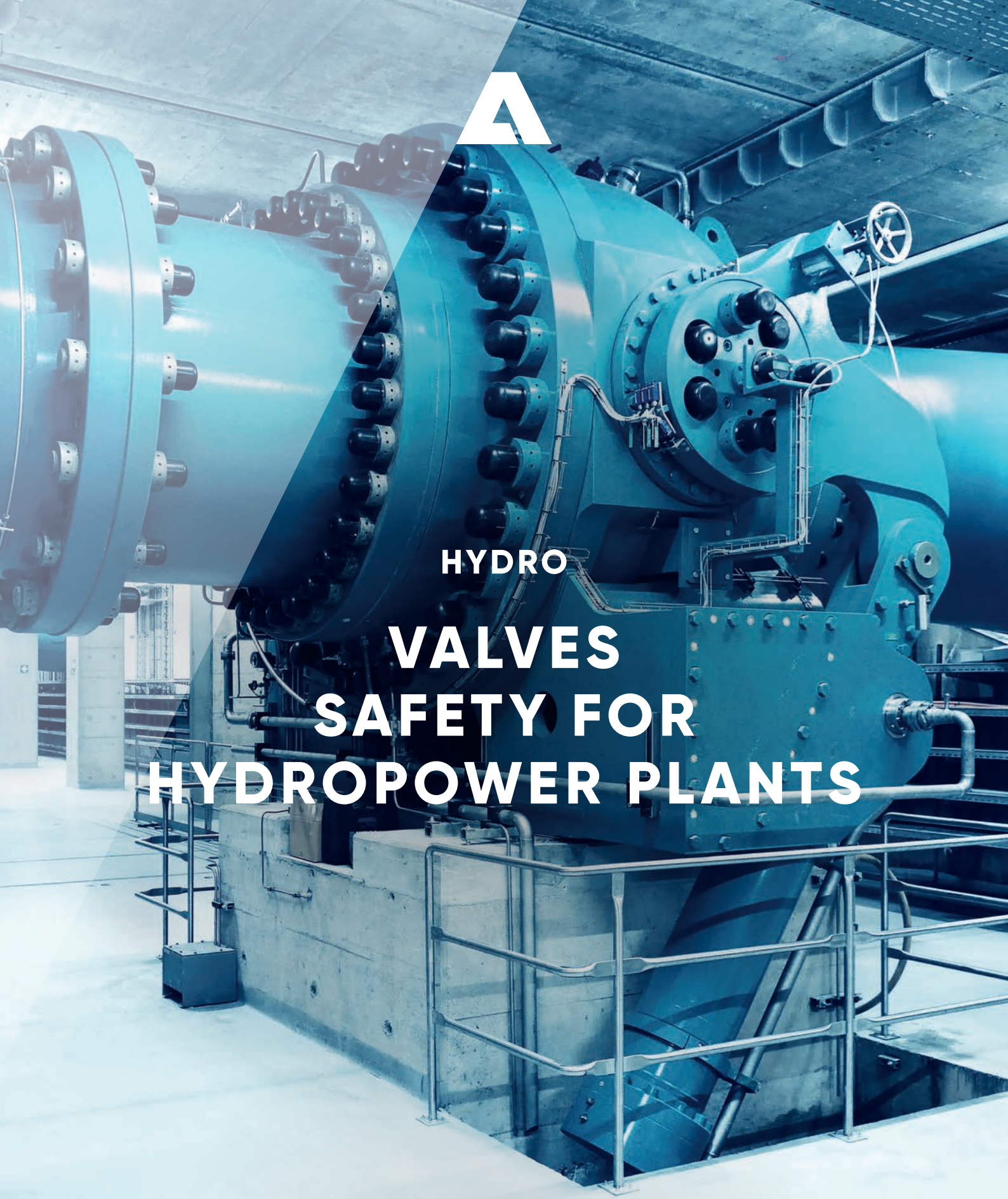


HYDRO

# VALVES SAFETY FOR HYDROPOWER PLANTS

ANDRITZ

ENGINEERED SUCCESS

# Valves are the essential safety element for hydropower plants

Valves have multiple functions and are therefore used for different purposes. Tightness is important and is accomplished by pressing metal or rubber rings into predefined seal seats.

### SAFETY ELEMENT

Essentially, valves are the safety elements to shut-off the water flow in the shortest time possible while respecting the maximum admissable pressure in the penstock. Shutting-off is necessary at quick and emergency shutdown sequences or if the guide vane mechanism or the Pelton nozzles have a malfunction.

### SEALING PLUG

During maintenance works valves are used as sealing plugs of the penstock. This is useful if several turbines are fed by one common penstock. One branch line can be sealed for turbine maintenance while the other turbines remain in operation.

### LEAKAGE PREVENTION

If arranged upstream of Francis turbines, guide vane leakage is prevented due to the tight valve closure, which minimizes the wear on the guide vanes.

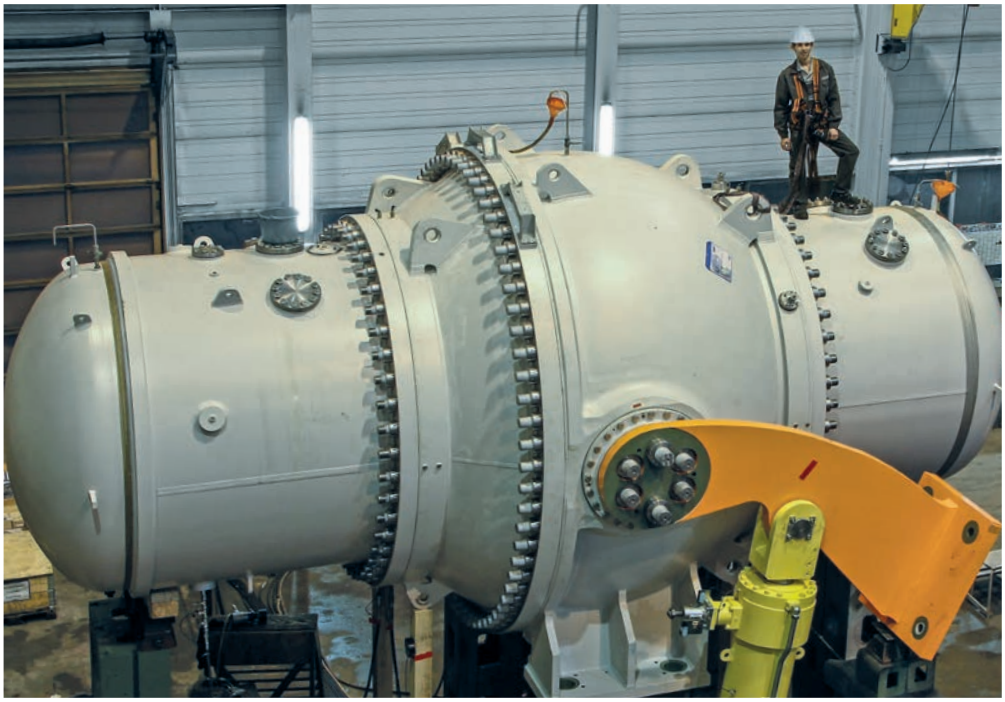
### FLOW REGULATION

In some cases valves are used for flow regulation at the start-up of turbines and pumps.

### SAFE AND TIGHT SEALING

Valves are also providing safe and tight sealings for power plant bottom outlets.

Fitted with service and maintenance seals, valves are minimizing outage time during maintenance. Allowing the water flow in both directions, butterfly and spherical valves are perfectly suitable for the installation with reversible pump turbines.



# From the historic pioneers of technology to a modern global market leader

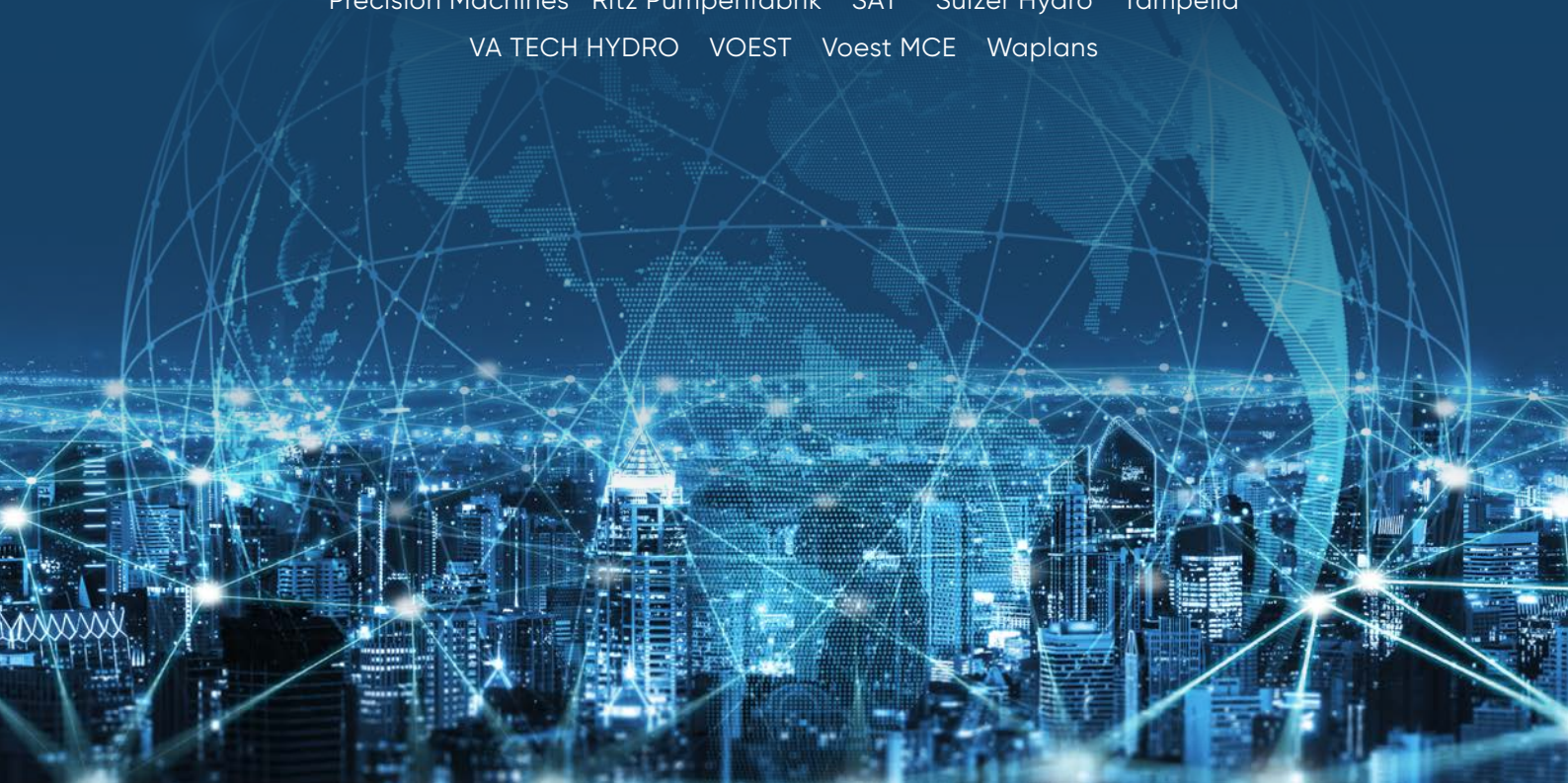
ANDRITZ is an international technology group and its hydro business area is one of the globally leading suppliers of electro-mechanical equipment and services for hydropower plants.

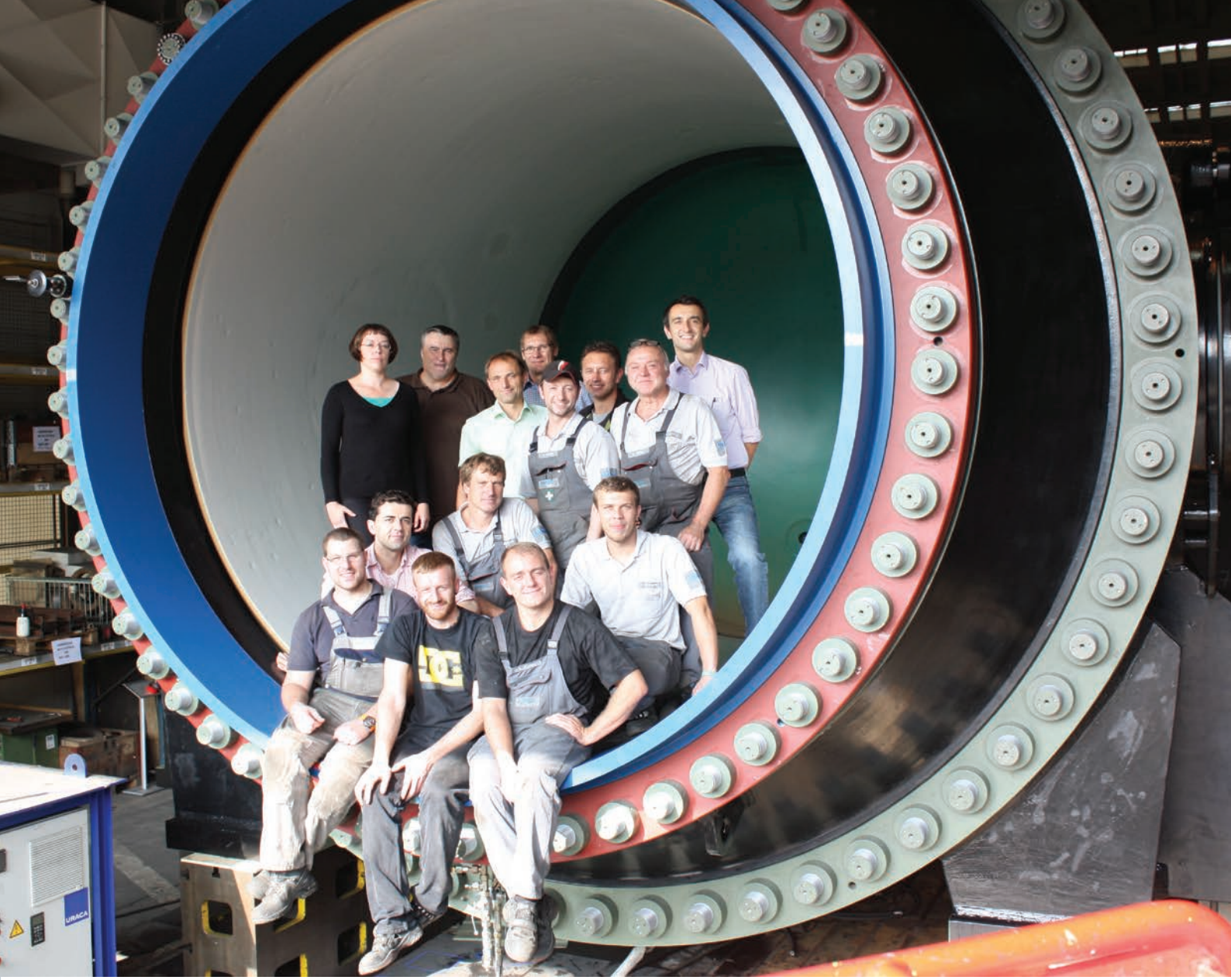
With over 180 years of experience and an installed fleet of more than 470 GW output, we are providing complete solutions for hydropower plants of all sizes as well as services for plant diagnosis, refurbishment, modernization and upgrade of existing hydropower assets. Pumps for irrigation, water supply and flood control are also part of our portfolio.

The cornerstone was laid by the turbine and generator pioneers in Europe and North America in the 19th century. Over time, growth, mergers, and co-operation agreements have created a state-of-the art technology company with more than 7,000 employees.

**OUR PIONEERS (ALPHABETICAL ORDER):**

AFI ANDRITZ Andritz VA TECH HYDRO Ateliers des Charmilles
Ateliers de Constructions Mécaniques de Vevey (ACMV) Baldwin-Lima-Hamilton
Bell Bouvier Boving C.E.G.B. Dominion Engineering ELIN English Electric
Escher Wyss Finnshyttan GE Hydro GE Hydro Inepar General Electric
Hammerfest Strom Hemi Controls HMI Construction Hydro Vevey I.P.Morris
KAMEWA KMW Kvaerner Møller NOHAB Pelton Water Wheel Pichlerwerke
Precision Machines Ritz Pumpenfabrik SAT Sulzer Hydro Tampella
VA TECH HYDRO VOEST Voest MCE Waplans





## EXTENSIVE EXPERIENCE IN VALVES

Fore more than 100 years, ANDRITZ guarantees hydropower plant safety with valves designed and manufactured in our own modern workshops. More than 4,500 valves installed worldwide demonstrate availability and sustainability every day. Our range of products and services covers the whole life cycle of a valve and comprises feasibility studies, assistance in hydraulic layout and dimensioning, design, manufacturing, transportation, installation and commissioning, inspection, risk analysis, life cycle analysis, as well as service and rehabilitation.

ANDRITZ is supplying the whole range of valves including spherical valves, butterfly valves, cone valves, and ring gates. Additionally, we have a vast experience for regulating valves, needle valves, ring piston valves and aeration valves.

For every single hydropower plant, each special case, ANDRITZ offers the perfect valve, its control and necessary service. We deeply care about the smooth operation and the safety of our customer's assets and personnel. With dedication and extensive experience for decades, we develop top-tier valves and all associated equipment.

## HIGHLIGHTS

- Technical world market leader
- More than 4,500 valves installed worldwide
- More than 100 years of experience in valves
- Global network of locations and partners
- Global manufacturing capabilities in own workshops

# Different valve types suitable for every occasion

Every hydropower plant is customized and has special characteristics, hence, the equipment of penstocks and valves has also to be tailor-made to the plant specifics. ANDRITZ has a wide range of valves in its portfolio and offers the perfect solution for our customers, technical wise, efficiency wise and safety wise.

Each valve has a special application case; spherical valves are normally used in high-pressure applications, whereas butterfly valves, cone valves and ring gates are applied in low and medium pressure power plants.

### BUTTERFLY VALVES

Butterfly valves are equipped with either a lens type or a lattice door (flow-through) type valve disc. The lattice door types are optimized in model tests to achieve a minimum flow head loss coefficient and are commonly installed at new installations. Water flow through the valve is possible in both directions. This type of valve is mainly used as safety valve, turbine inlet valve, and pump inlet valve for low to medium design pressures.

They are operated by oil hydraulic systems for opening and closing or by closing weight and hydraulic pressure for opening. For turbine inlet valves, oil pressure can also be taken from the turbine governor hydraulic oil system. The sealing system is of a flexible, adjustable rubber or metallic material to reduce leakage to a minimum.

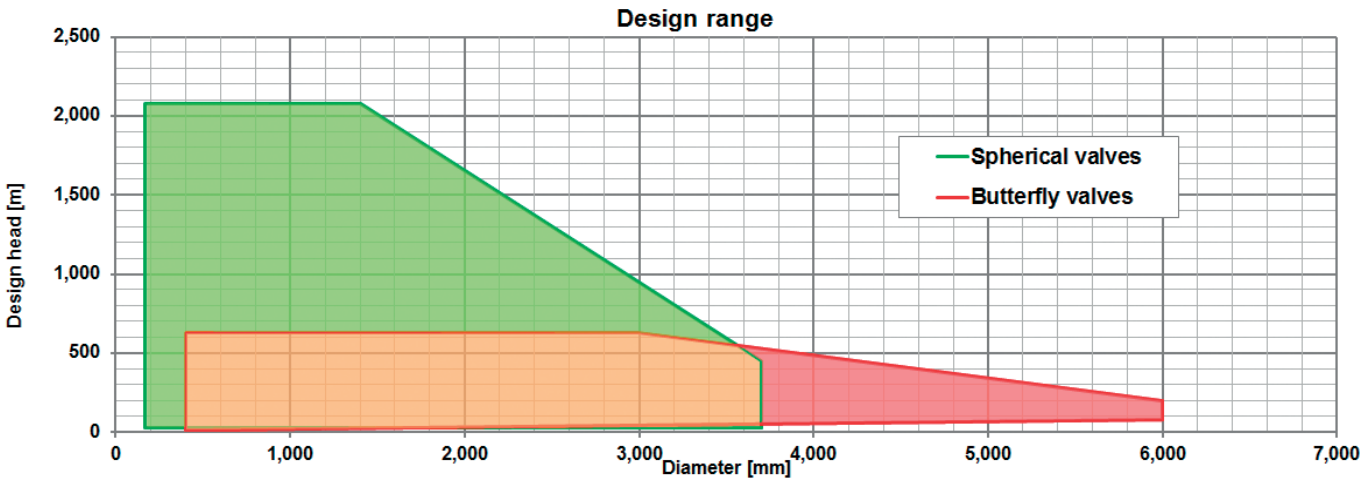
The lattice door type valves may also be equipped with a maintenance seal. The hydraulic and electric/electronic control system is part of the delivery.

Auxiliary equipment such as bypass, air and vacuum valve, pipe rupture device, and connecting pipes are part of the system.

### SPHERICAL VALVES

Spherical valves have a minimum head loss due to a complete free flow-through. They are usually installed as high-pressure turbine inlet valves or pump valves and are equipped with automatically controlled service and maintenance sealing. Flow is possible in both directions.

The control system is operated by oil-hydraulic and the water pressure system. The water for the valve control system can be taken from the upstream side. Oil pressure for the control system can also be supplied from the turbine governor oil-hydraulic system. Bypass, hydraulic and electric control as well as connecting pipes are part of the system.



## CONE VALVES

Cone valves are installed for flow regulation from 0% to 100%, for energy dissipation, bottom outlet application and as pressure relief valves. They are often installed in combination with an upstream guard valve (e.g. butterfly valve) for maintenance and emergency shut-down purposes.

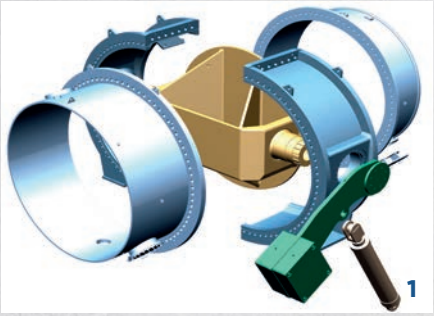
Cone valves allow high discharge flows at high water pressures. The valves are controlled by an oil-hydraulic or electro-mechanical operator. Flow is only possible in one direction. Local operator instrumentation, control system (hydraulic, electric, and electronic), discharge liner, and connecting pipes are part of the system.

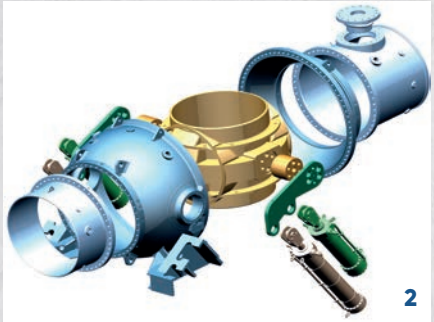
## RING GATES

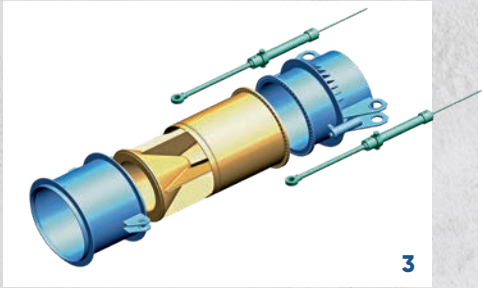
Ring gates consist of a cylindrical ring which is located between the stay vanes and the guide vanes of a Francis or a pump turbine. By means of hydraulic servo motors the ring gate can be lifted into a recess in the head cover in order to free the hydraulic passage for operation.

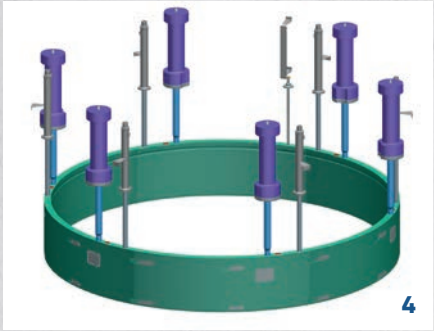
ANDRITZ design and longtime experience ensure synchronous operation to avoid jamming of the gate in its guidance due to tilting.

Synchronization can be achieved either mechanically or electronically resulting in a shut-off device which is capable of emergency shutdown.

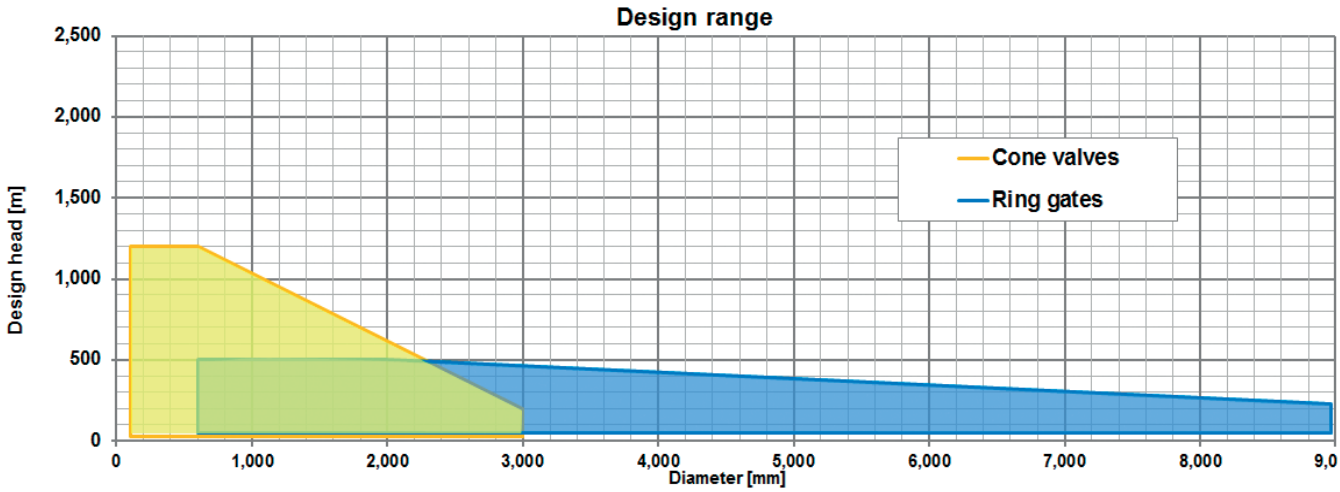



**1** Butterfly valve
**2** Spherical valve
**3** Cone valve
**4** Ring gate



# Circumspect service by ANDRITZ for lifetime extension of your valve

Several factors such as water quality or number of opening and closing movements influence the life expectancy of valves significantly. Therefore, it is very important to closely monitor the condition of these safety components to prevent function or safety relevant defects early on. To reduce the risk of an unplanned failure to a minimum, ANDRITZ recommends having all valves inspected in periodic intervals including risk assessment and lifetime analysis. In order to plan necessary preventive actions thoroughly, interventions are divided in six categories.

### RENEWAL OF ANTICORROSIVE PROTECTION

The anticorrosive protection is removed and newly applied to restore the anticorrosive abilities.

### REPLACEMENT OF SEALS

All seals including metallic and main seals are replaced to restore tightness. In this process, material pairing can be optimized.

### REPAIR WELDING AND / OR STAINLESS PLATING

Structural defects such as cracks can be assessed by crack propagation and residual life analysis. Appropriate corrective measures may range from leaving the parts in current condition to excavation or repair welding. Additionally, sections, which are subject of increased erosion, can be plated with an adequate welding material.

### REPLACEMENT OF BEARINGS, COUPLING ELEMENTS AND / OR GEOMETRY IMPROVEMENTS

Modifications to the maintenance free trunnion bearings prevent water pollution through leaking lubricants and reduce significantly operation and maintenance expenses at the same time.

Drainage and geometry optimization of the trunnion axle reduce crack initiation and increase the plant security.

Furthermore, replacement of old bolts with multi-stud bolt tensioners or hydraulic prestressed bolts increases the safety and the quality of the assembly during the revision process.

### UPGRADE OF FUNCTIONALITY / REPLACEMENT OF AUXILIARIES

Changes in the operation regime of a hydroelectric power plant often results in new and advanced requirements for valves such as increased number of operation cycles, higher flow or emergency close functionality, which requires an upgrade of the valve itself. Complete components have to be updated or replaced, e.g., sensors, actors, servo motors, hydraulic pressure units or the valve control.

By modernizing the valve control with a hydro-mechanic interlocking system or a system to detect auto-oscillations in the pressure tube, the operational safety can be increased even further.

> Regular inspection reduces the risk of malfunction and therefore downtime

### REPLACEMENT OF VALVE

If the condition of the valve is very poor and the necessary upgrades are too extensive it might be more feasible to replace the complete safety element with a new, modern one.

ANDRITZ is using Finite Element Analysis (FEA) of damaged parts and offers solutions for repair and replacement to increase the operational safety. To avoid long outage times, keeping a provident stock of OEM spare parts is highly recommended. Regardless of the scope of our order, ANDRITZ offers tailor-made solutions for the equipment of our customers to ensure a maximum in operational safety and lifetime.

# ANDRITZ global valves manufacturing capabilities for best worldwide supply

ANDRITZ has an extensive global network of locations and local partners with a wide range of manufacturing possibilities for all valve dimensions.

Our workshops are equipped with top-tier machinery for milling, horizontal and vertical lathe, drilling as well as polishing for dimensions up to 12 m in diameter and 320 t in weight.

In addition to the chipping technologies, our staff is highly qualified in all installation and welding works. Modern measurement equipment for dimensional testing and experienced non-destructive testing inspectors are always at disposal to safeguard flawless quality in all processes. At the end of the revision, the completely assembled valve is thoroughly tested in purpose-built testing facilities ensuring function, pressure, and leak tightness. If all requirements of the customer are fulfilled, the valve is shipped to the site, ready for installation and for being put into operation.

## ANDRITZ MANUFACTURING LOCATIONS FOR VALVES

# ANDRITZ valve controls, the best choice for each valve

As manifold the types and requirements for main inlet valves are as extensive and specific is also the control of them. Each hydropower plant has its own characteristics and therefore, the control needs to be customized for each application.

The primary selection is the determination of the operation power source for opening and closing of the valve. While power sources can be solely hydraulic fluids, combinations utilizing gravity forces may be considered as well. When selecting the closing power source the main focus has to be the permanent availability for plant safety.

The secondary selection is the arrangement of the hydraulic control. Several decisions have to be made regarding the involved oil, the arrangement of the valves, the distributed system, the water control, and the drive transmission.

ANDRITZ valve controls are always state-of-the-art, not only in technical but especially in safety aspects.

In principle, the control of the various parts such as bypass valves, operating seals, main shutters are made via solenoid valves (pilot control).

These valves are acting depending on the actual size of the main valve directly or via amplifier valves (mainly cartridge valves) on the main distributor. All used components are either specifically in-house designed products or carefully selected products from reliable and proven suppliers to fulfill each specific requirement, ensuring long life cycles as well as easy maintenance. Either pure oil hydraulic or pure water hydraulic or a combination of both - valve controls by ANDRITZ are always state-of-the-art in technical as well as safety aspects.

ANDRITZ offers integrated and all encompassing valve solutions including auxiliary controls. With a long standing experience, we provide special safety

features like auto-oscillation detection devices. Auto-oscillation is phenomenon, which can seriously harm the plant and may lead to penstock rupture due to self-excited pressure pulsation with increasing amplitudes.

Further hydraulic interlocking mechanisms can be provided to avoid collisions of the service and maintenance seal with the main shutting elements. These mechanisms are fitted with roller plunger valves activated mechanically and releasing/blocking the hydraulic operating pressure if this is permitted without risk.

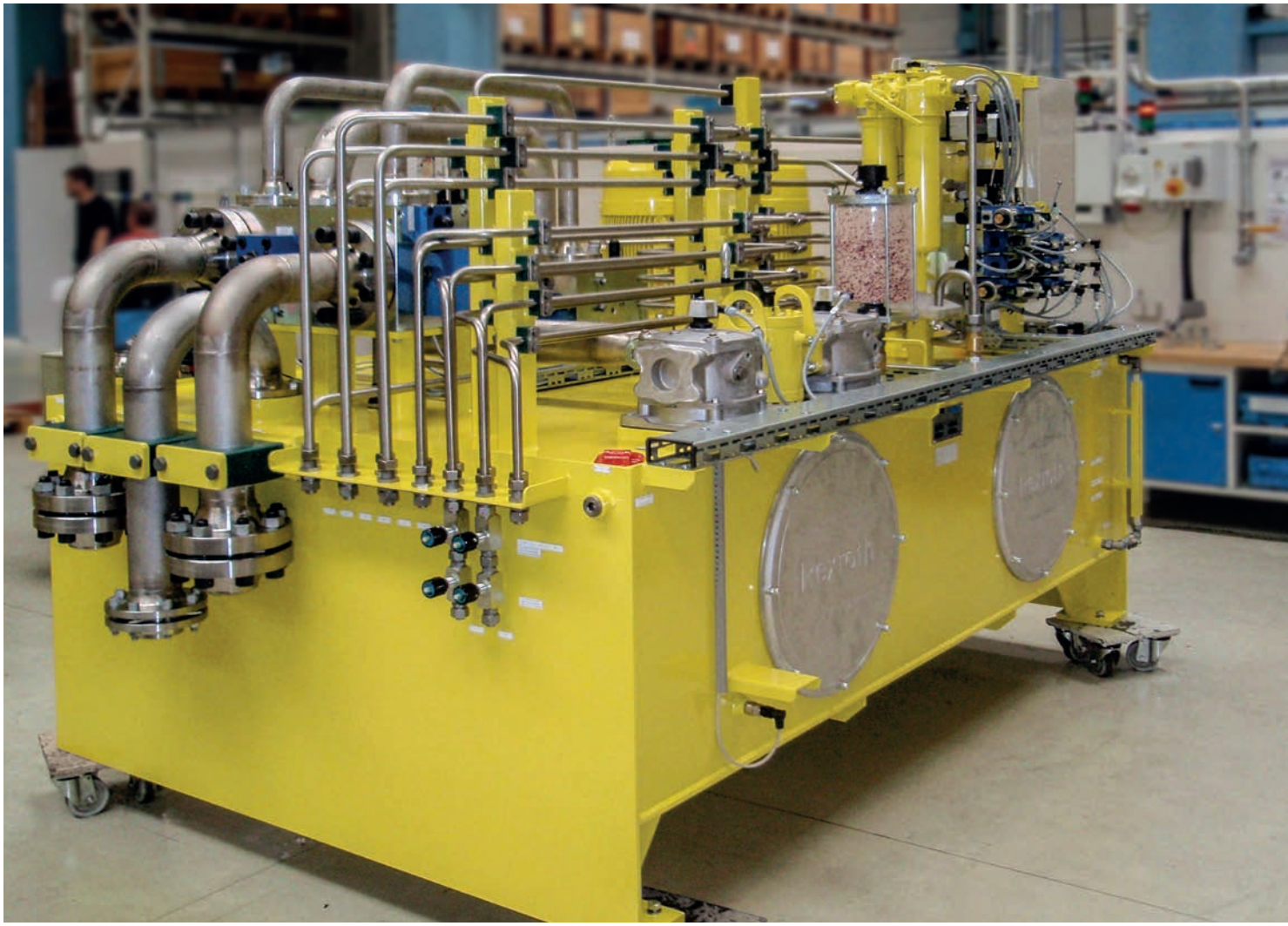
## DEVELOPMENT

With experience for decades in manufacturing of valves and valve controls, ANDRITZ is constantly developing our valve technology to the benefit of our customers.

A new generation of water hydraulic controls suiting expectations in regard to functional safety and durability has been developed recently. In particular, the susceptibility to corrosion and wear of control valves could be eliminated through the use of new materials as well as by optimized water treatment.

The operational safety of our main valve controls is based on a special quality control. Starting during the design phase with design-reviews, risk analyses, and fail-safe design with redundant control devices for safety relevant circuits, it is continued during manufacturing according our internal quality measurements and during functional tests of the control equipment in our workshops, ending only after commissioning.

ANDRITZ tailor-made valve controls are always designed with respect to the type of valve, the special requirements of the whole hydro power plant as well as the environmental circumstances.



# The world of hydro valves

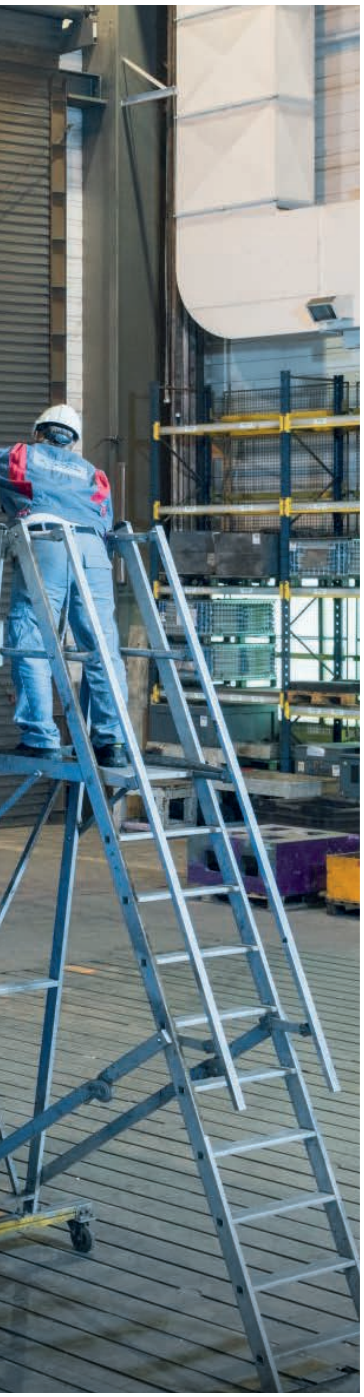
**UPPER TAMAKOSHI, Nepal**
1 Spherical valve
Nominal diameter: 2,500 mm
Nominal pressure: 88 bar
Welded design for high pressure.

**TONGBAI, China**
4 Spherical valves
Nominal diameter: 3,100 mm
Nominal pressure: 42 bar
Large-sized spherical valve application.

**BIEUDRON, Switzerland**
3 Spherical valves
Nominal diameter: 1,400 mm
Nominal pressure: 207 bar
World record in design pressure.

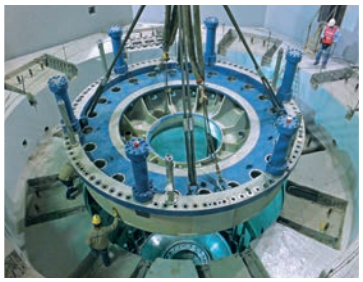
**KANDIL, Turkey**
2 Butterfly valves
Nominal diameter: 2,800 mm
Nominal pressure: 31 bar
High-pressure application.

**LA YESCA, Mexico**
2 Cone valves
Nominal diameter: 2,500 mm
Nominal pressure: 14 bar
Largest cone valve by ANDRITZ Hydro.

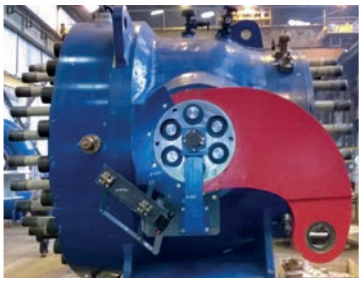


**NANTE DE DRANCE, Switzerland**
2 Butterfly valves
Nominal diameter: 6,000 mm
Nominal pressure: 10 bar
Closing against 270 m²/s flow.

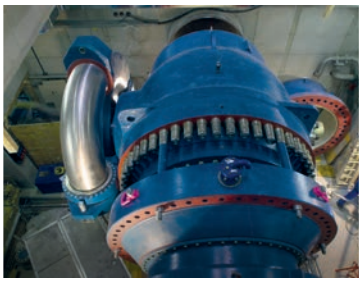
**CERRO DEL ÁGUILA, Peru**
3 Butterfly valves
Nominal diameter: 3,150 mm
Nominal pressure: 36 bar
Optimized head loss characteristic.



**SOGAMOSO, Colombia**
3 Ring gates
Nominal diameter: 6,405 mm
Nominal pressure: 22 bar
Electrical synchronization.



**THUONG KON TUM, Vietnam**
2 Spherical valves
Nominal diameter: 1,200 mm
Nominal pressure: 115 bar
First high head application in Vietnam.



**GERLOS II, Austria**
1 Spherical valve
Nominal diameter: 1,800 mm
Nominal pressure: 72 bar
Latest design with ring piston drive.

**MATRE HAUGSDAL, Norway**
1 Spherical valve
Nominal diameter: 1,300 mm
Nominal pressure: 66 bar
Forged design for high pressure.

iha | gold member
advancing sustainable hydropower

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