



STRONG STEEL CONSTRUCTIONS FOR HYDROPOWER PLANTS

ANDRITZ

ENGINEERED SUCCESS

A thin steel against high water pressure - Penstock and Gates

PIMENTAL / BRAZIL



Gates
On-site Lifetime Irrigation
Manufacturing Assessment
Dams hydraulic steel structure
Health and Safety Penstocks Irrigation
Bridge Weires
Water supply River Navigation Pipe
Hydro-mechanical Hydro Automation
Research Storm water management
Flood control
Ship locks



The demand for hydraulic steel structures is growing worldwide

The global demand for hydraulic steel structures such as penstocks and gates for flood control, irrigation, and hydropower plants is continually increasing, especially in developing economies.

Almost every plant in the world using water resources has a reservoir or diversion system to store water for power generation or irrigation, for domestic or industrial water supply, or for the control of flooding.

A spillway with related control mechanisms is almost invariably provided for release of water during excess inflows. Releases of water may also be carried out by control devices provided in conduits in the body of the dam and tunnels.

Hydraulic gates and hoists work on different principles. The correct selection of gates and their hoisting arrangement is essential to ensure the safety of the entire plant and effective control.

The growth of the global penstock market is mainly driven by the growing demand for pumped storage schemes in many countries. In years to come, a further increase is expected due to the demand of major rehabilitation or replacement of penstocks reaching the end of the useful lifetime.

Penstocks and gates are installed at dams, rivers and weirs, water and sewage treatment centers, as well as for storm water management, flood control and irrigation applications.

Typically, penstocks for hydroelectric installations are equipped with a gate system and a surge tank. The flow is regulated by turbine operation. Penstocks are also used in mine tailing dam construction.



„Hydro-mechanical equipment of ANDRITZ guarantees safe and reliable operation of your asset.“

WATER LEVEL AND FLOW

All assets operating with water have to take care to manage water levels they are using. For pump storage plants, the water levels between upper and lower reservoir have to be managed inside defined limits. For hydropower plants, the flow control in closed pipes (penstocks) conveying water for the generators is dealt with by valves. For general applications such as navigation this level is controlled by gates and sluices.

FLOOD CONTROL AND STORM WATER MANAGEMENT

Floods can be caused by heavy rainfalls, snowmelt, high tides, tsunamis, or the failure of dams or other structures that retain water. Flood control and storm management methods are used to reduce or prevent damages to assets and alleviate the danger to life for both humans and wildlife. Hydro-mechanical equipment and dams are essential to guarantee safety.

IRRIGATION

Irrigation is the application of controlled amounts of water to plants at required intervals and is often combined together with drainage, which is the removal of surface and sub-surface water from a given area. Irrigation has been a central feature of agriculture for over 9,000 years, and it remains an important basis for many economies and societies across the globe. Modern hydro-mechanical equipment is an important part of today's irrigation solutions.





We are your reliable partner for strong hydraulic steel structures

For more than 70 years ANDRITZ has been positioned as a reliable partner for hydro-mechanical equipment all over the world. As one of the market leaders with high technical expertise in on-site penstock fabrication, ANDRITZ design for hydraulic steel structures guarantees state-of-the-art technology and high quality.

ANDRITZ AND HYDRO

The ANDRITZ GROUP is a globally leading supplier of plants, equipment, and services for hydro-power stations, the pulp and paper industry, the metalworking and steel industries, and solid/liquid separation in the municipal and industrial sectors. ANDRITZ is always close to its customers, with more than 280 production locations and service and sales companies around the world.

ANDRITZ Hydro is part of the ANDRITZ GROUP and a world-leading supplier of electro-mechanical equipment and services "from water-to-wire" for hydropower plants and other hydraulic assets. Growth, mergers, and cooperation agreements have formed a modern state-of-the-art technology company with about 7,000 employees worldwide.

ANDRITZ' service portfolio supports the entire life cycle of a hydropower plant - from design and engineering, manufacturing, installation, commissioning and training up to operations and maintenance. We provide custom-tailored hydraulic and electro-mechanical solutions including automation "from water-to-wire" for new developments as well as modernization projects - everything from a single source.



More than 1.000 hydropower plants, irrigation, water supply schemes, and navigation locks worldwide have been equipped with penstocks, gates, and hydro-mechanical equipment delivered by ANDRITZ, working to full customer satisfaction.



OUR STEEL HISTORY

As early as 1947, ANDRITZ launched the production of penstocks and gates in Austria. Since then we have delivered hydraulic steel structures and equipment to more than 1,000 hydropower plants and water management systems worldwide. Additional dedicated groups of experts and engineers and facilities in Norway, Canada, Brazil, India and Indonesia have further strengthened the ANDRITZ team.

OUR PASSION FOR STEEL

Our engineers and employees strive to meet the most stringent quality requirements and tight production schedules to ensure the best quality for our customers. ANDRITZ locations around the globe receive support from our key competence centers to serve their respective markets with the best products and services.



Our product, system, and service portfolio

We offer the best solutions for your penstocks and gate equipment, not only meeting rapidly changing national and international requirements and laws but also guaranteeing the best solutions for your asset as well as the environment.

HYDRAULIC STEEL STRUCTURES

The safe and reliable operation of hydropower and water control plants is based on strong and faultless hydraulic steel structures.

We have the advantage of an integrated system approach and are designing, manufacturing, supplying, installing and commissioning state-of-the-art hydraulic steel structures, including penstocks, manifolds, and gates.

We provide services for all stages of the project, from early concept development and feasibility studies, to front end engineering and detailed design, supply and installation, commissioning, operator training and spare parts.

For existing assets, we offer assessments for comprehensive condition and residual lifetime assessment, rehabilitation and upgrading proposals and the turnkey execution of complete restoration and rehabilitation programs.





ANGOSTURA

Chile

PENSTOCKS

We design, manufacture, supply and install pressure conduits, exposed and embedded penstocks, pipe bridges, steel tunnel linings, bi- and trifurcations, as well as complete manifold systems.

Amongst our reference highlights is a project with a designed head of 2,070 m and one of the world's largest bifurcations with a center sphere diameter of more than 16 meters.

GATES

ANDRITZ designs, manufactures, supplies and installs all types of gates used for power intakes, bottom

outlets, or river diversion works. For low head or run-of-river power plants, our product and service scope comprises all types of hydro-mechanical equipment for weirs, powerhouse inlets, and outlet structures such as intake trash racks, stop logs and draft tube gates. The gates are operated by hydraulic hoisting systems. Solutions with mechanical rope or chain hoists are also implemented based on specific market and customer demands.

CRANES

In line with customer requirements, ANDRITZ also designs and supplies the cranes necessary to move our hydraulic steel structures.

Our outstanding manufacturing capabilities meet every demand

By using top-class modern production processes in our own manufacturing plants, as well as qualified subcontractors, we are able to offer our customers tailor-made solutions for their project construction purposes. Our long-standing experience combined with the continuous training of our supervisory staff and labour guarantees maximum efficiency and reliability of operations throughout the manufacturing cycle.

We recognize and value the view that a company's strength is built on the foundation of its employees' skills. Our production team is comprised of highly skilled experts from a multitude of disciplines to safeguard our high standards of professional workmanship in all operations.

OPTIMIZED MANUFACTURING TECHNOLOGIES

The highest quality welding techniques are of paramount importance in penstock construction. Welding of steels with a yield point of up to 800 MPa is a standard for our workshops, even under most difficult conditions. The technology applied here was also developed in our own laboratories.

Modern and efficient on-site manufacturing keeps the costs low, too. To reduce delivery lead times and to optimize the execution schedule of a project outsourcing activities directly at the project location leads

to more widespread distribution of the social and economic benefits.

Over 50 years ago, we started to fabricate penstocks directly on-site. Typically, a temporary field workshop to house all the necessary machinery for production and testing is set up. Subsequently, deliveries to site are limited to non-machined and flat plates. To date, more than 310,000 tons of penstock equipment have been fabricated and installed by ANDRITZ; more than half directly on-site. Numerous contracts have been successfully completed using this technology under various challenging conditions of climate and terrain.

In using its on-site manufacturing capabilities, ANDRITZ can exercise its strength in engineering and project management to full effect. As more and more projects are successfully executed around the world, the demand for our specialists and engineers for professional management and supervision is also growing.



"Our customers benefit from our long-standing expertise and hundreds of successfully realized projects processing high-strength steel."

New customer requirements are the driving force for research and development

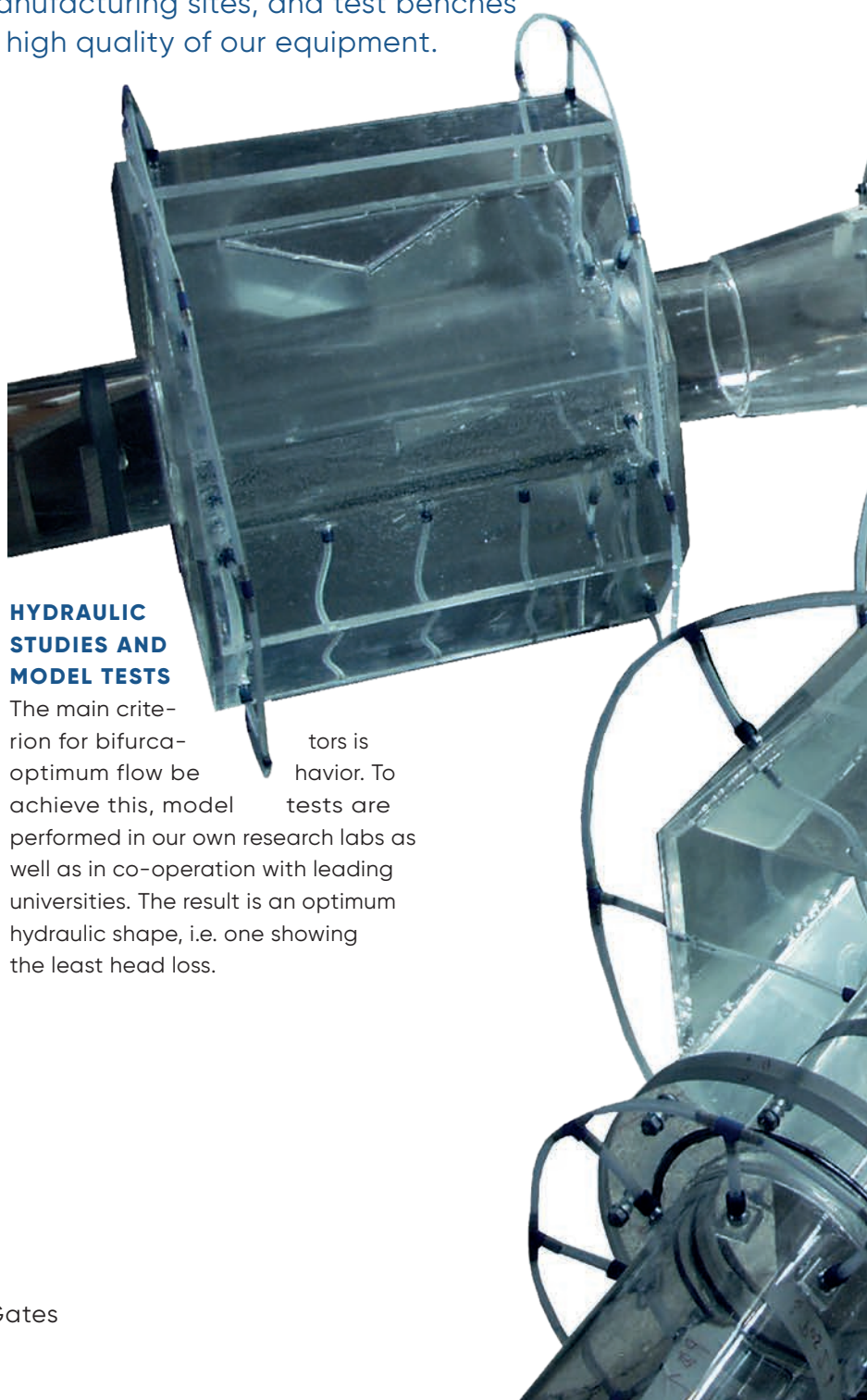
Commitment from our research and development engineers and employees contributes significantly to the company's global market leadership. Constant improvements and further developments of already proven technology are combined and optimized. The comprehensive approach of our laboratories, manufacturing sites, and test benches around the world guarantee the high quality of our equipment.

Research and investigations are very important for the ongoing development of our hydraulic penstocks and gates. Based on numerous model studies, both physical models as well as using CFD methodologies, new insights into hydro-mechanical behavior for high- and low-head applications is gained. This enables us to enhance the operational safety of these structures.

DIGITAL ENGINEERING WITH CFD AND FEA

Hydraulic design and associated thermal distributions require an understanding of complex physical phenomena. Computational fluid dynamics (CFD) and finite element analysis (FEA) provide essential insights into flow and the mechanical structure properties of hydrodynamic parts.

In research and development especially, but also in engineering, ANDRITZ has been using CFD and FEA for the optimal design of customer systems for many years.



HYDRAULIC STUDIES AND MODEL TESTS

The main criterion for bifurcation optimum flow behavior. To achieve this, model tests are performed in our own research labs as well as in co-operation with leading universities. The result is an optimum hydraulic shape, i.e. one showing the least head loss.



“Continuous investment in Research and Development is the core of our internationally renowned technology.”



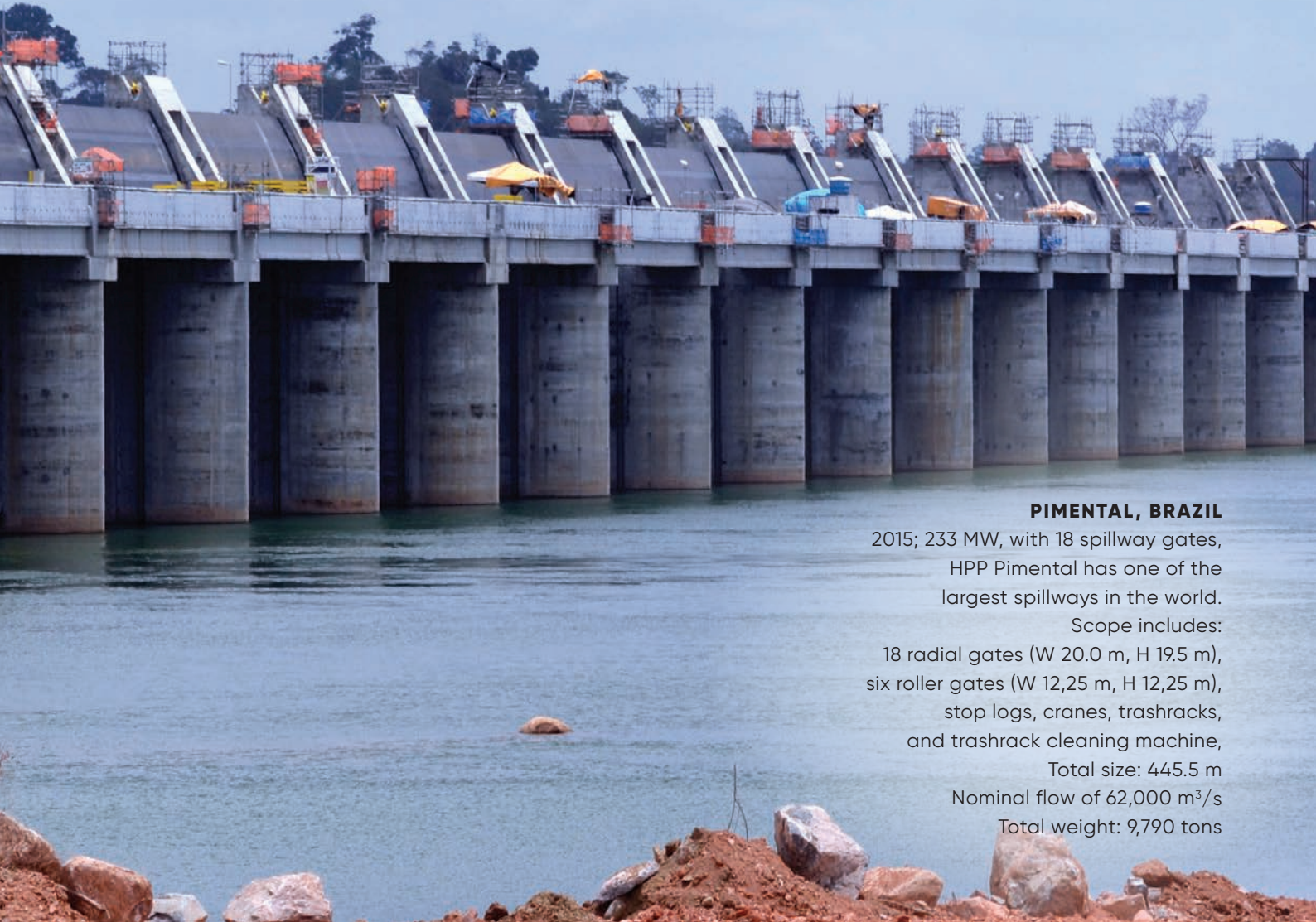
Numerous model studies on high head gates and draft tube gates have helped us to gain new insights into their hydro-dynamic behavior. This enables our designers to enhance the operational safety of such structures.

BEYOND MERE THEORY

Verification of computer-based testing methods play an important role for ANDRITZ. In addition to the operational feedback and information of our installed equipment, we routinely check computer-calculated stresses in complex geometrical structures such as bifurcators by strain gauge measurements. The derived data is subsequently used to improve our stress analysis programs.

We utilize 3D modeling in conjunction with NX for design and manufacturing accuracy. We optimize our designs through finite element and motion analysis, and validate structural designs through S-Frame software use.

The world of Penstock & Gates



PIMENTAL, BRAZIL

2015; 233 MW, with 18 spillway gates, HPP Pimental has one of the largest spillways in the world.

Scope includes:

18 radial gates (W 20.0 m, H 19.5 m), six roller gates (W 12,25 m, H 12,25 m), stop logs, cranes, trashracks, and trashrack cleaning machine,

Total size: 445.5 m

Nominal flow of 62,000 m³/s

Total weight: 9,790 tons



Cleuson-Dixence, Switzerland

2009; 423 MW

Pressure shaft rehabilitation of the highest high-head scheme worldwide
Head / Length: 1,883 m / 4,030 m
Diameter: 3.1 - 2.55 m
Total weight 12,700 tons



Angostura, Chile

2014; 316 MW

Supply of 14 gates and six stop logs
Total weight: 6,470 tons



Kaunertal, Austria

2016; 392 MW

Renewal of the existing penstock and supply of steel tunnel lining and manifold
Head / Length: 1,007 m / 2,290 m
Diameter: 6.3 - 2.5 m
Total weight; 9,300 tons



Tsankov Kamak, Bulgaria

2003; 80 MW

Supply of various gates
Head / Length: 143 m / 640 m
Diameter: 4.4 - 2.25 m
Total weight: 1,800 tons





NEW ASSIUT BARRAGE, EGYPT

2017; 32 MW

Supply of hydro-mechanical equipment including sluiceways, sector gates and mitre gates for shiplock (W 17 m, H 9.60 m). At more than 100 years, this is the oldest dam on the Egyptian section of the Nile. The replacement will significantly improve conditions for irrigation and navigation.



GOUVÃES, PORTUGAL

2016; 880 MW

Supply of penstocks and three bifurcators. PSCP Gouvães will be the heart of the Alto Tâmega hydropower scheme, one of the largest in Europe. Head / Length: 1,016 m / 2,640 m Diameter: 6.0 - 2.8 m Total weight: 11,280 tons



Mingtan, Taiwan

1989; 1,602 MW

Penstocks and conduits
Head / Length: 575 m / 2,000 m
Diameter: 7.5 - 2.3 m
Total weight: 25,949 tons

Foz Tua, Portugal

2011; 254 MW

Penstocks, gates, trashracks, steel liners
Head / Length: 49 m / 65 m
Diameter: 6.5 - 5.0 m
Total weight 1,462 tons

Inga II, DR Congo

2013; 1,424 MW

Complete renewal of penstocks, intake trashracks and gate rehabilitation
Head / Length: 93 m / 110 m
Diameter: 8.0 - 6.5 m
Total weight: 2,745 tons

Ulu Jelai, Malaysia

2013; 382 MW

Penstock, manifold, high head gates, stop logs, trashracks, desilting system
Head / Length: 359 m / 200 m
Diameter: 5.2 - 2.5 m
Total weight 1,133 tons





MUSKRAT FALLS, CANADA

2017; 206 MW

Five large wheel gates, mechanical hoists, hoist tower, hoist bridge, fully closed with internal heating; W 10.5 m, H 23.0 m;

The scope of this contract is one of the largest in the world, with deliveries totaling 9,000 tons.



Musi, Indonesia

2002; 210 MW

Penstocks, gates, trashrack cleaner, spillway, desilter, cranes, and hoists
Head / Length: 411 m / 590 m
Diameter: 5.4 m
Total weight: 1,487 tons



Pirris, Costa Rica

2010; 138 MW

Exposed penstock and steel liner, bifurcator and spherical guard valve
Head / Length: 990 m / 2,341 m
Diameter: 2.3 - 1.4 m
Total weight: 3,411 tons



Mount Coffee, Liberia

2014; 64 MW

Rehabilitation of hydromechanical equipment for the second largest HPP in Liberia
Head / Length: 35 m / 45 m
Diameter: 5.3 m
Total weight 900 tons



Karebbe, Indonesia

2011; 128 MW

Penstocks and gates
Head / Length: 80 m / 74 m
Diameter: 5.5 m
Total weight: 500 tons





GHAZI BAROTHA, PAKISTAN

2003; 1,450 MW
 5 penstocks
 Head / Length: 79 m / 225 m
 Diameter: 10.6 m
 Total weight: 9,400 tons



NANTE DE DRANCE, SWITZERLAND

2017; 900 MW
 Penstocks, steel tunnel lining, manifold,
 four high pressure gates
 Head / Length: 614.5 m / 740 m
 Diameter: 7.0 - 3.2 m
 Total weight: 8,000 tons



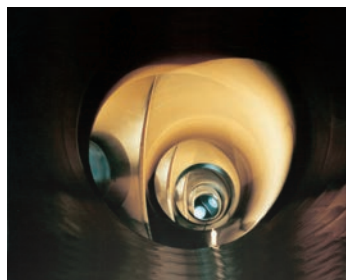
WALLSEE-MITTERKIRCHEN, AUSTRIA

2006; 210 MW
 Refurbishment of the shipping
 lock on the Danube.



Ilisu, Turkey

2010; 1,224 MW
 Penstocks and gates
 Head / Length: 125.8 m / 267.5 m
 Diameter: 11 - 5.1 m
 Total weight: 12,000 tons



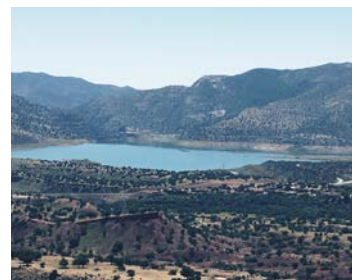
Tarbela, Pakistan

1993; 3,478 MW
 Penstocks (world record), manifolds and
 gates for the largest HPP in Pakistan
 Head / Length: 159 m / 364 m
 Diameter: 13.26 - 3.66 m
 Total Weight: 11,808 tons;



Yusufeli, Turkey

2016; 558 MW
 Penstock, gates, trashracks, spillway,
 hydraulic lifting systems, and valves
 Head / Length: 255 m / 245 m
 Diameter: 9 - 3.8 m
 Total weight: 5,350 tons



Abdelmoumen, Morocco

2018; 350 MW
 Penstocks and shafts for a new
 pumped storage plant
 Head / Length: 900 m / 2,000 m
 Diameter: 5.0 - 3.6 m
 Total weight 8,950 tons



Health and safety are a priority for ANDRITZ



Dams for hydropower generation or multipurpose schemes and their hydro-mechanical equipment have to meet extremely stringent health, safety and environmental requirements. ANDRITZ processes are diligently set-up to ensure all of our services and supplies are in full conformity with all applicable rules and regulations.

For ANDRITZ safety in every aspect of project execution is a first priority. This includes designing, engineering, planning, coordinating and executing the scope at the site. A safety culture is created in which all employees of ANDRITZ, all contractors, any sub-contractors and workers hired locally become a part. This has resulted in a high level of production performed to strict quality standards, and accomplished in the best possible environment.

The objective is to complete the job in a timely manner with top quality results, preventing damage to the plant, the equipment and the environment, all with zero injuries. Safety is incorporated in all aspects of the work executed by ANDRITZ under all relevant national and international legislation and any applicable standards.

Continuous training and risk assessment is an essential requirement for our staff, which have to meet stringent health, safety and environmental procedures. ANDRITZ also employs an internal quality management team which monitors all our manufacturing sites worldwide.

OUR CERTIFICATIONS INCLUDE:

- **ISO 9001:2015**
Quality Management System
- **ISO 14001:2015**
Environmental Management System
- **BS OHSAS 18001:2007**
Occupational Health and Safety Management System



“Safety and efficiency are the hallmarks of ANDRITZ’ hydro-mechanical equipment for dams and hydraulic structures.”





ANDRITZ HYDRO GmbH
contact-hydro.hpg@andritz.com

ANDRITZ.COM/HYDRO

ANDRITZ

All data, information, statements, photographs and graphic illustrations in this brochure are without any obligation and raise no liabilities to or form part of any sales contracts of ANDRITZ GROUP or any affiliates for equipment and/or systems referred to herein. All rights reserved. No part of this copyrighted work may be reproduced, modified or distributed in any form or by any means, or stored in any database or retrieval system without the prior written permission of ANDRITZ HYDRO GmbH or its affiliates. Any such unauthorized use for any purpose is a violation of the relevant copyright laws. © 2019 ANDRITZ HYDRO GmbH, Eibesbrunnnergasse 20, 1120 Vienna, Austria.

