

The Gundelfingen plant is one of six run-of-river power stations along the upper Danube. The six plants, built in the 1960s, are all ready for a complete overhaul. Work is scheduled for completion in 2020 and the Gundelfingen plant was the first in line with activities commencing in the autumn of 2014.

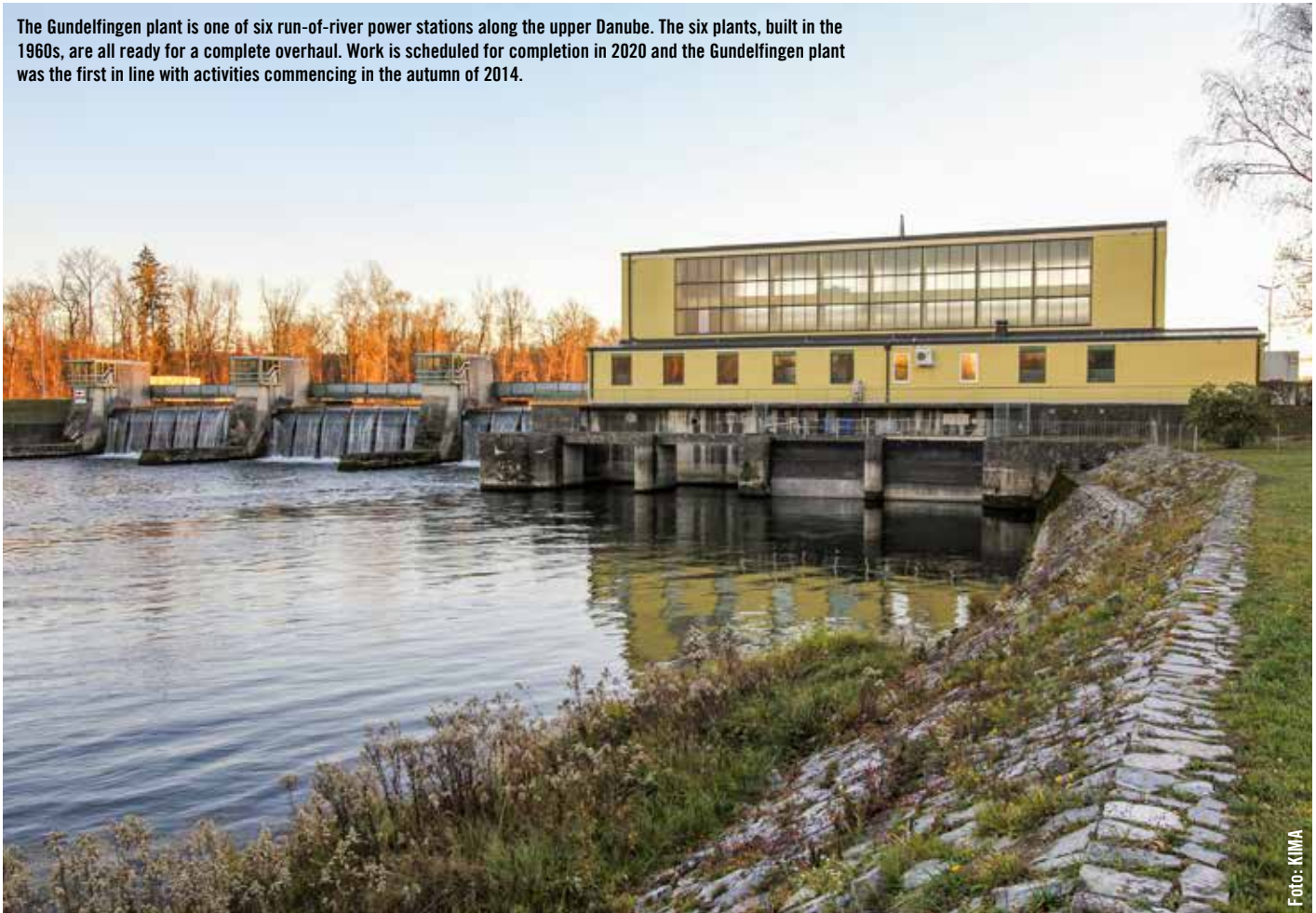


Foto: KIMA

GUNDELFINGEN MARKS THE START OF AN OVERHAUL PROGRAMME FOR THE UPPER DANUBE POWER STATIONS

Bayerische Elektrizitätswerke GmbH operates six run-of-river power stations along the Danube between Oberelchingen and Faimingen, all under the ownership of Obere-Donau-Kraftwerke AG. Now showing their age, all six are to be completely overhauled, mechanically and electro-technically. This project began at the power station in Gundelfingen in September 2014 in the Swabian region of Dillingen on the Danube. The general contractorship for the completion of the project and modernisation of the turbines was awarded to Wiegert & Bähr. The task of updating all the process control, electro-technology and machine control infrastructure was handed to KIMA Automation from Gronau in Westphalia. The overhaul needs to be both ecologically sound and sustainable, so the decision was made to ask Federal-Mogul DEVA GmbH to supply their superior standard, maintenance-free sliding bearings. Completion of the modernisation and improvement of the first machine set at the power station in Gundelfingen has provided important initial experience for the comprehensive series of tasks to come.

The ‘Obere Donau Kraftwerke AG’ with its headquarters in Munich is a subsidiary of the Rhein-Main-Donau AG, partly under the ownership of Energie Baden-Württemberg, and owns six run-of-river along the upper Danube. Operational management of the plants is the responsibility of Bayerische Elektrizitätswerke GmbH in Augsburg. The six power stations in question are Oberelchingen, Leipheim, Günzburg, Offingen, Gundelfingen and Faimingen. All of these stations went into operation at roughly the same time between 1960 and 1965 and are equipped with identical technology. Each

power station is fitted with two machine sets, producing an overall power output of between 7.35 and 10.1 MW. Since there is no drastic difference in the height drops, ranging from 5.00 to 6.61 metres, all six stations produce an average of 49.5 GWh each per year. Every year one of the plants is to be thoroughly overhauled and the technology will be brought completely up to date.

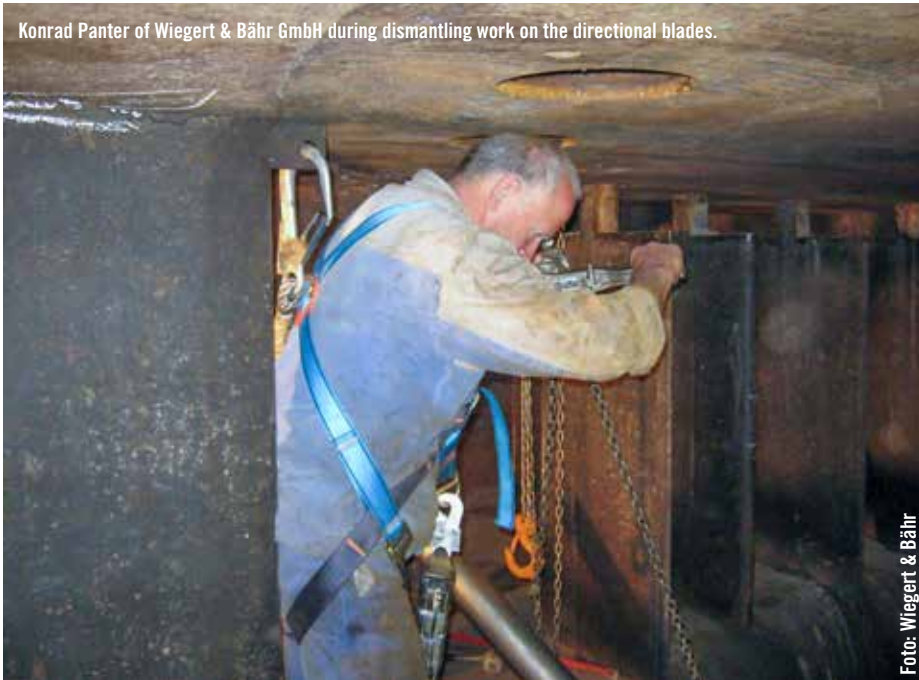
SMALLEST FIRST

The series of overhauls began in September 2014 at the Gundelfingen station, built in the town of the same name in Bavaria in 1964.

Producing a total of 735 MW with a drop height of just 5 m it is, along with the plant in Offingen, the smallest of the six power stations. In an average year the station produces a total of 42.6 GWh. As both power stations are very similar, Offingen is second on the list for renovation and modernisation.

DISMANTLING THE MACHINES

The system in Gundelfingen is based on two doubly-regulated Kaplan turbines with a standing shaft and a directly set-up synchronised generator. The first step taken by Wiegert & Bähr was to overhaul the mechanical infra-



Konrad Panter of Wiegert & Bähr GmbH during dismantling work on the directional blades.

Foto: Wiegert & Bähr

structure of machine no.1, dismantle the whole control device, the turbine wheel mechanism and the entire shaft bearing and mounting. The mechanical components were completely overhauled on the company's own premises in Renchen. All the obsolete components were replaced with the latest technology. The old regulating motor unit was replaced with a state-of-the-art hydraulic system. A dual circuit cooling system has now replaced the old bearing lubrication and cooling system. Furthermore, the hydraulic pipes were replaced with new stainless steel pipes. The additional integration of a track bearing lifting pump ensures the turbine can be positioned and released with a minimum of damage risk. The entire network of sensors and monitoring technology has also been completely modernised. The existing steering was replaced with hydraulically pre-tensioned safety steering, and all of the bearings, such as the axial bearing and the guide bearing, were

completely overhauled. The decision regarding the flow distributor mechanism was made in favour of replacing the main directional blade bearing with superior quality sliding bearings that do not require extra maintenance or lubrication. The operators chose to

rely on the expertise of the acknowledged sliding bearing specialists at Federal-Mogul DEVA GmbH. Once the corrosion protection had been renewed the flow distributor was reinstalled on site by experts from Wiegert & Bähr.

A CHALLENGING SCHEDULE

Size was much less of a problem than the uncertainty about the exact dimensions of the lower directional blade system bearing. This meant that the engineers had to wait right until the system had been dismantled before each of the specific dimensions could be determined. Consequently, production of the new bearing had to be carried out and completed while the mechanical overhaul was underway, so the delivery schedule was very tight and left no room for errors.

RECONSTRUCTION OF THE TURBINE WHEEL FOR HIGH PRESSURE STRESSES

During the process of renewal the turbine wheel and mountings had to be adapted to cope with high pressure use. The mechanism with the old 900 mm pistons was rebuilt to take new 520 mm pistons, enabling the amounts of oil consumed to be reduced signi-



Improvements to the upper directional blade unit at the FA Wiegert & Bähr plant.

Foto: Wiegert & Bähr



KRAFTWERK GUNDELFINGEN



wiegert & bähr
Turbinen- und Stahlwasserbau

Im Muhrhag 3 | D-77871 Renchen | Germany
Fon +49 (0) 78 43.94 68-0 | Fax +49 (0) 78 43.94 68-20
info@wb-wasserkraft.de | www.wb-wasserkraft.de



Foto: Wiegert & Bähr

Gundelfingen receives a new piston accumulator and a new regulating motor.

DEVA SLIDE BEARINGS

Federal-Mogul DEVA slide bearings have already been used for gigantic international projects such as the world's largest clock tower in Mecca, for the Three Gorges Dam and for the 1310 m suspension bridge over the Hardangerfjord in Norway. One of the company's key areas of expertise is the provision of bespoke solutions for unique challenges, as was required in Gundelfingen. All of DEVA's bearings and thrust washers were from the 'deva.bm 392' series with the 'dg22' running film. deva.bm 392 self-lubricating material consists of a bimetal structure i.e., support in stainless steel and sliding layer in sintered bronze with small particles of graphite solid lubricant homogeneously distributed in its structure. The self-lubricating concept is based on surface activation of the self-lubricating material when in contact with a shaft in movement and under load. During this process, the material solid lubricant is transferred to the shaft surface then forming a film of solid lubricant, so-called transfer-film, around the shaft. This film of solid lubricant will ensure a low and stable coefficient of friction. When the bearing / shaft environment contains dirt or sand, it is recommended to design the bearing with cross cleaning grooves. These cross cleaning grooves facilitate the dirt to go out of the bearing / shaft contact surfaces therefore minimizing the impact of the dirt on the bearing performance and lifetime.

ificantly. The entire oil distribution system of the new servomotor including the hydraulic valve, the pipes and the rotary unions, was brought completely up to date. Plant efficiency was significantly enhanced by separating the turbo oil for turbine positioning and the bearing lubrication and cooling oil into two separate cycles. This enables each oil cycle to be optimised in terms of operational quality, volume and temperature.

RENEWAL OF THE CONTROL TECHNOLOGY

While the mechanical infrastructure was being overhauled, KIMA Automation was given the task of updating all the electrical and control technology. The Westphalian specialists provided machine control solutions, including fully automatic SIMATIC S7-based control and regulation units, synchronisation for isolated operation or connection to the na-

tional grid, and ensured the plant was ideally hooked up to the existing excitation and protective devices. Dam control and general control infrastructure was within KIMA's remit and the company delivered a control system to monitor activity and relay signals from the superordinate plant units and the weir. The scope of provision also included the entire 400 V switch system with an automatic site power switch and a diverse redundancy back-up unit with a battery supported direct current system. All of the available plant components were integrated into the new process control set-up including the 110 kV and 3 kV switch systems and the rack cleaning machine. KIMA installed a redundant SCADA system (Siemens WinCC) to operate the entire power plant. The next step is the installation of a fully automated regulator to control the amount of water passing the dam.

**ELECTRICAL
ENGINEERING WITH
PROSPECTS - WORDLWIDE**

KIMA Automatisierung
Gesellschaft für elektronische Steuerungstechnik und Konstruktion mbH

Anna-Merian-Straße 5
48599 Gronau/Germany

Tel.: +49 2565 9346-0
Fax: +49 2565 7848

E-Mail: office@kima.de
Internet: www.kima.de

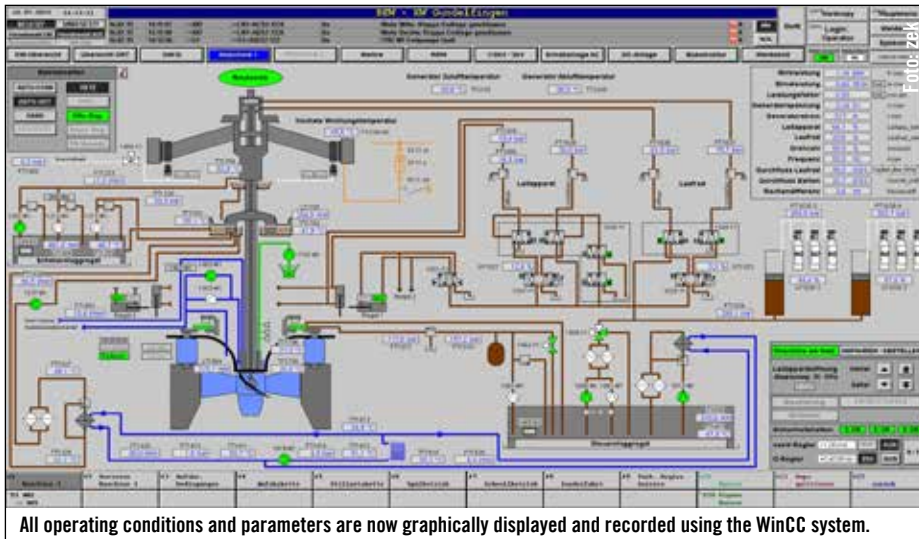


Foto: zek

All operating conditions and parameters are now graphically displayed and recorded using the WinCC system.



Foto: KIMA

SIMATIC S7-based machine control cabinet.

AUTOMATIC FUNCTIONS AND SPECIAL PROGRAMMES

In terms of efficiency the machine control infrastructure incorporates a wide variety of automatic functions and special programmes. In this way the system supports direct automatic sequences in a number of operational modes, such as standstill, idling with and without excitation, mains link-up, isolated operation to supply power for the plant's own requirements, frequency-supported operation and a special turbine operation mode to ensure minimum water release for the cooling cycle of the adjacent nuclear power station in Gundremmingen. All of the operative mode transfers are portrayed in the graphics and recorded in detail in the WinCC.

COMPLETE LINK-UP OF ALL POWER STATIONS

The Ethernet network is an optical failsafe ring. The Gundelfingen power plant was linked up to the central control room in Gersthofen, the emergency unit in Günzburg and the overall grid control centre in the Bavarian city of Augsburg. Once the entire programme of overhauls has been completed in 2020 all six power plants will be linked up to a superordinate control and regulation system which is currently being developed by KIMA in cooperation with the University of Kassel. The greatest challenges were posed by water management goals such as flood damage prevention and a modern system for regulating and stabilising input into the mains power grid.

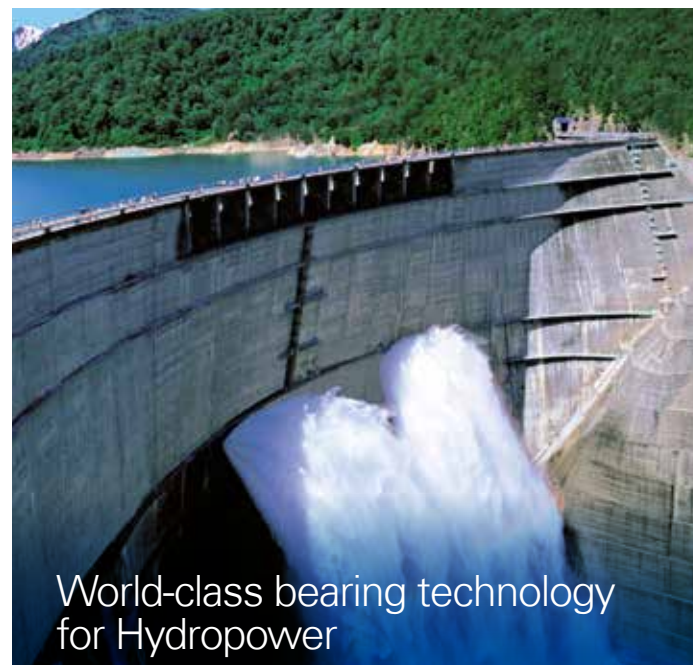
WORK COMMENCES ON MACHINE SET NO.2

The first machine set went back into operation after an overall renovation period of 10 months in July 2015. The main part of the plant went back online in March 2015. At the same time the contract was awarded to overhaul the identical power output power station in Offingen. This renovation work was carried out parallel to the overhaul of the second machine in Gundelfingen, which was taken offline in September 2015. The next power plant is due to be overhauled in 2016. If the subsequent one-plant-per-year plan can be adhered to the entire revitalisation programme should be completed in 2020. The aim is to equip the six upper Danube power stations to deal with the challenges of the next 50 – 60 years of service.



View of the 400 V switching system in the new switch room.

Foto: KIMA



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Federal-Mogul DEVA GmbH · Schulstrasse 11 · 35260 Stadtallendorf/Germany
Phone +49 6428 701-0 · Fax +49 6428 701-108 · www.deva.de · info@deva.de