KOLEKTOR

www.turboinstitut.com

Pumps

We provide best-in-class pumps solutions for:

- thermal power plants
- nuclear power plants
- water supply systems
- pumped storage
- water and oil transport
- irrigation, drainage and flood control systems
- the process industry
- development & testing services for pump producers

PUMP PROGRAM - AREAS OF EXPERTISE

Established market presence:

- The first model tests performed at the Kolektor Turboinštitut laboratory dated back to 1950!
- The first CFD simulations were performed in 1987!

Our vast experience means we can provide state of the art solutions to the pumps users and producers:

Top pumps performance, high competitiveness and quick ROI

R&D and testing

- Hydraulic and mechanical development of all types of centrifugal pumps
- Vertical pumps intakes - physical model testing and CFD simulations
- Independent in-house laboratory testing of prototype and model pumps according to various international standards (ISO, EN, DIN, JIS, IEC, BS, GOST, etc.)
- Site tests of pumps and systems

Energy efficiency - reducing maintenance costs - increasing the lifetime of the pumps and the availability of systems

Pumps Refurbishment

- Analysis of the existing situation
- Proposals for improvements (hydraulic and mechanical development, CFD simulations, model testing, etc.)
- Implementation of improvements (design, production, assembly, installation, putting in operation, confirmation by testing)

All activities are based on a QA/QC procedure pre-defined and confirmed by the client for each individual project.

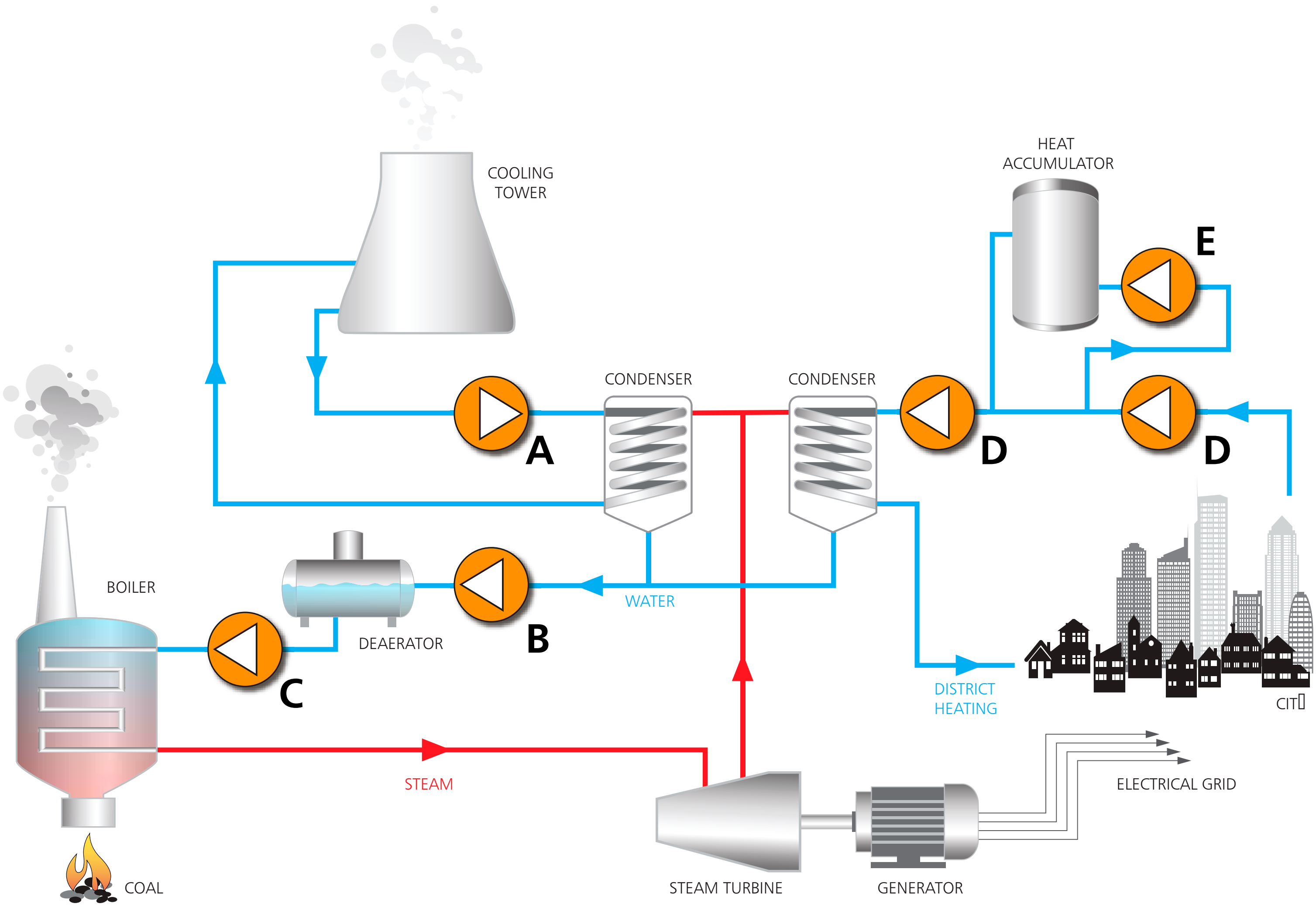
One-stop shop for customer tailored pump solutions!

Design, engineering, production, after sales

- "custom-made" pumps and pumps parts
- generic spare parts based on reverse engineering
- turnkey electro – mechanical equipment for pumping plants and systems
- small-hydro – "PAT" (Pump running as Turbine)
- After sales activities for the pumps
- Technology transfer for production and testing
- Design, manufacturing and calibration of flow meters based on differential pressure
- Calibration of flow- and energy meters

REFERENCE MARKET SEGMENT: PUMP PROGRAM IN THERMAL & NUCLEAR PP

Presentation of the most important pumps for a combined cycle coal fired thermal power plant:



Kolektor Turboinštitut's areas of expertise cover the complete pump segment for a THERMAL and NUCLEAR power plant:

- Cooling water pumps (A)
- Condensate extraction pumps (B)
- Boiler feed pumps (C)
- District heating circulating pumps (D)
- Heat accumulator circulating pumps (E)
- Vertical pumps sumps
- Reactor cooling pumps
- FGD pumps
- Pumps for other applications (service water, drainage, etc.)
- Systems hydraulic analysis, optimization and design

The main objectives of our pump/system refurbishment projects are to achieve cost savings by

- improving energy efficiency
- reducing of maintenance costs
- increasing pump lifetime
- improving of environmental efficiency
- increasing of plant availability

WHY to invest?

WHAT DO OUR CUSTOMERS GET BY INVESTING IN REFURBISHMENT AND PUMP AND SYSTEM OPTIMIZATION PROJECTS?

Customer benefits

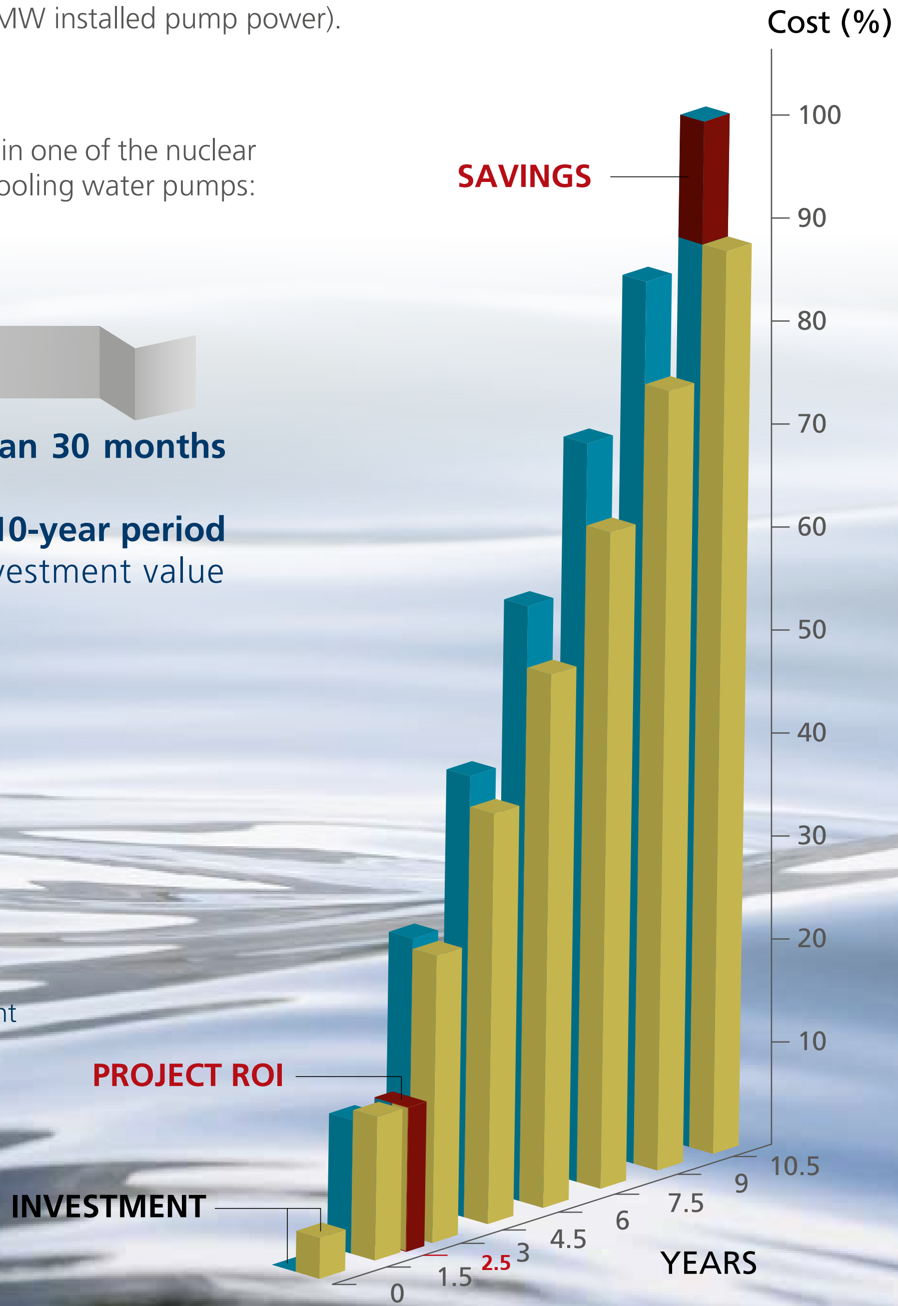
1. **Substantial energy savings**
2. **Reduction of maintenance costs (personnel & spare parts)**
3. **Improved reliability of the plant operation**

Typical refurbishment/optimization project outcome: we achieve a reduction in energy costs of at least 6 % (e.g. on 6 MW boiler feed pumps) and a reduction in energy costs of up to 60 % (e.g. by refurbishing a water supply system with 1 MW installed pump power).

Case study:
Refurbishment of the cooling water pumps in one of the nuclear power plants in Europe. The plant uses 3 cooling water pumps:

The financial analysis revealed , that:

- The project **ROI was less than 30 months**
- The **overall savings over a 10-year period exceeded 3.5 times** the investment value



Pumps in operation: **3**

Hours of operation per year: **8000**

Time between scheduled overhauls: **18 months**

Situation before refurbishment	**Situation after refurbishment**
INVESTMENT	
None	Investment into the refurbishment project: development of the new impeller
RESULTS	
Energy consumption:	
P=1.2 MW	P=1.116 MW **7% of energy savings**
Maintenance:	
The impellers needed to be replaced frequently: 10 impellers in the last 10 years ~ approx. 1.5 impellers every 18 months for each scheduled overhaul	Since 2006 no impellers have been changed (due to improved design, reduced cavitation, etc.). Replacements are planned to be carried out for every third scheduled overhaul **Significant reduction in maintenance costs – 67%**

Refurbishment projects
Our approach:

We provide pump refurbishment solutions which are tailored to each customer's specific requirements and budget.

Step 1

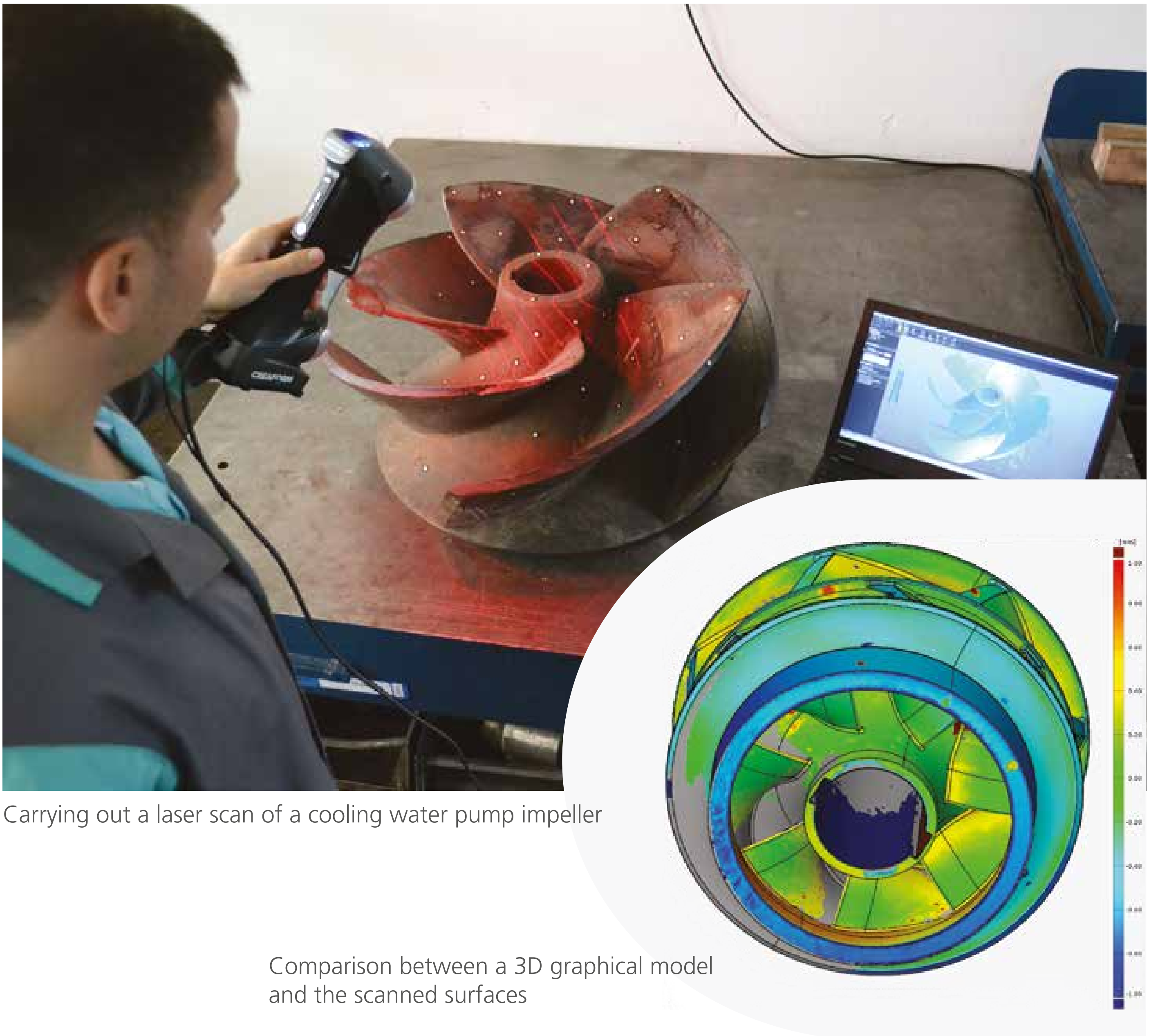
Testing of the & pumps system characteristics

Site testing example – flow measurement with current meters (Other methods available).

Step 2

Reverse engineering

3D scanning of existing impeller and other pump elements.
Various technologies: laser scanning, coordinate measuring device, traditional methods.



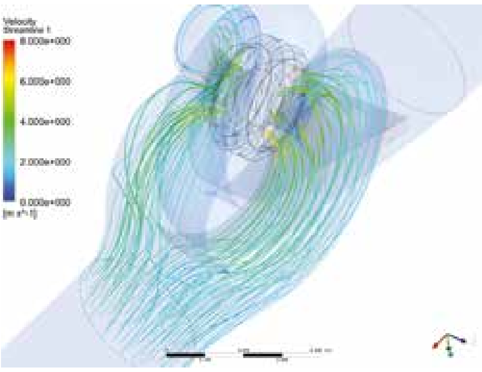
Carrying out a laser scan of a cooling water pump impeller

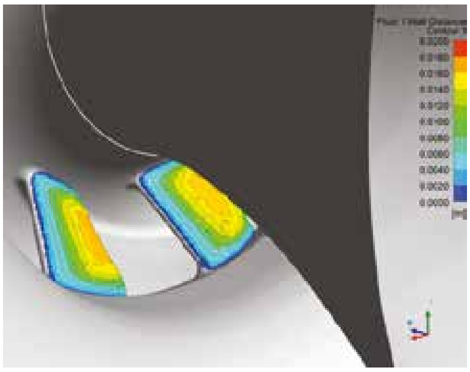
Comparison between a 3D graphical model and the scanned surfaces

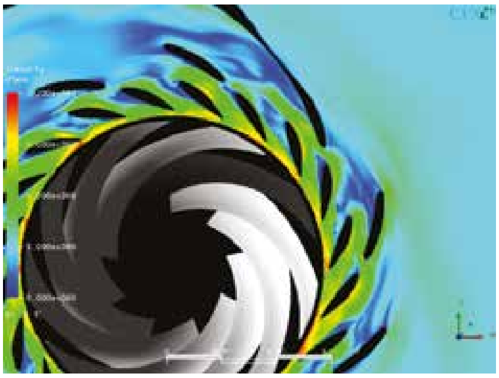
Step 3

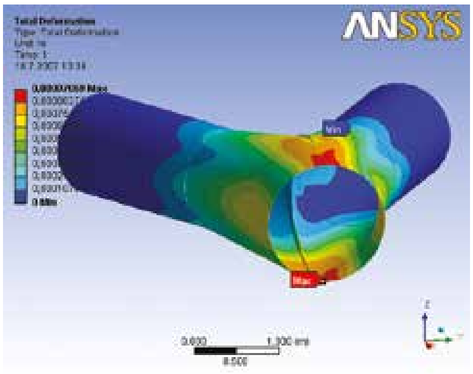
Existing geometry analysis

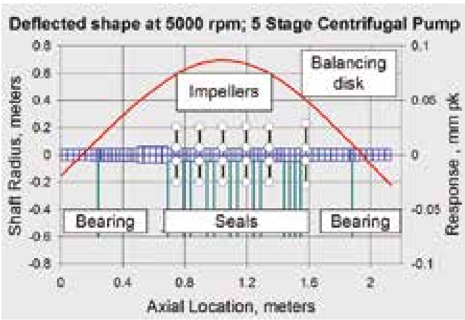
Computational flow dynamics – CFD (provides a detailed insight into the dynamic processes in the machine), stress-strain analysis (stresses, deformations, temperatures distribution), rotordynamics analysis (eigenfrequencies, mode shapes, deflections).

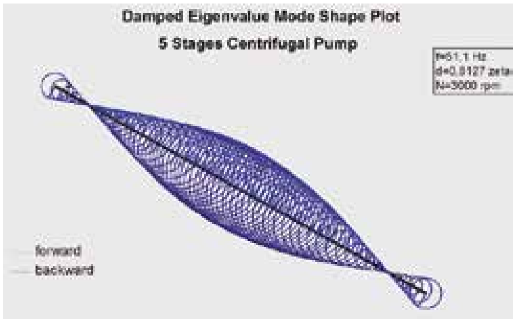












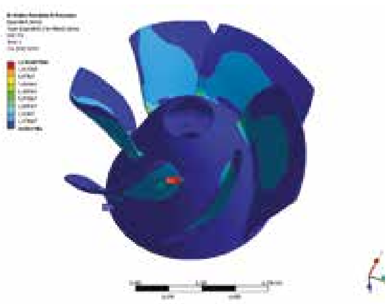
Step 4

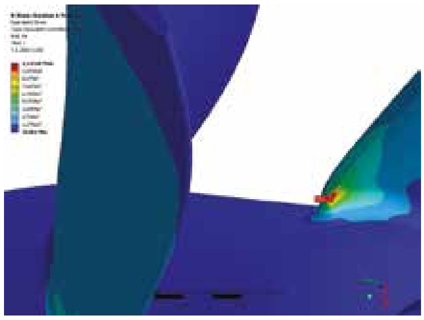
Design of modifications

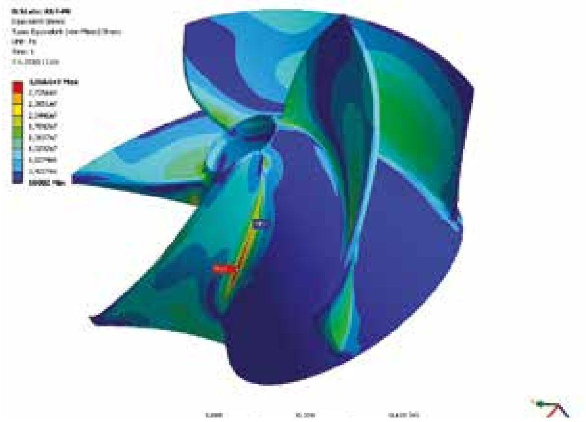
Cooling water pump impeller – refurbishment project:

Existing impeller:
high stress concentration at the blade inlet.
Problem: weak point - broken blades.

Modified impeller:
A 4-times reduced stress level and the peak is shifted away from the blade inlet.
Result: the blades no longer break!





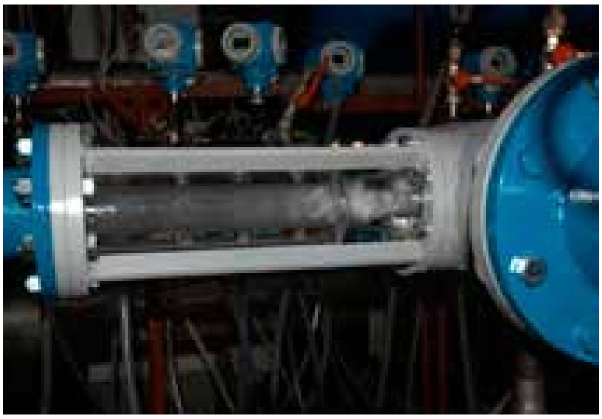


Step 5

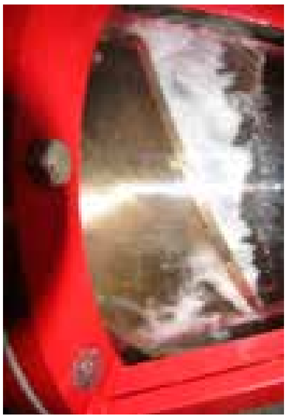
Characteristics confirmation by model testing

Model testing – a swift appraisal of the pump's characteristics according to various international standards in closed loop test rigs. The models are built using a variety of rapid prototyping technologies.
Note: the reaction time is short and it is possible to observe cavitation!

Double suction pump testing



Ejector cavitation testing



Cavitation observation

Step 6

Production of improved pump elements

Model and full scale impeller (welded) for NPP cooling water pump - refurbishment project.

Step 7

Verification of results achieved

Repeat site testing

Reference Cases:

Cooling water pump of pull-out design

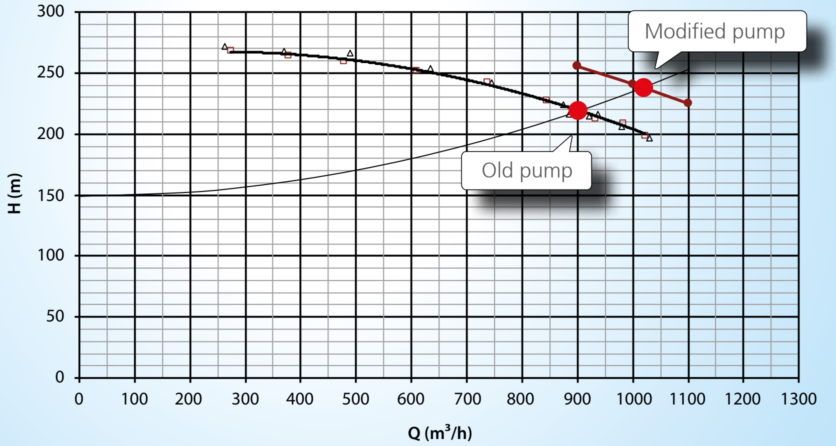
The delivery of new pumps for a coal-fired thermal power plant.

Goal: to adapt pump characteristics to the new operating point, increase efficiency, reduce energy costs and replace the old pumps

Action: newly developed, optimized and produced hydraulic parts (impeller, diffuser and casing), other pump parts were delivered by the consortium partner

Condenser extraction pumps

Coal fired thermal power plant – refurbishment project – to increase the flow rate and reduce cavitation erosion by replacing the impellers and diffusors.



Reactor cooling pumps

Application: additional safety cooling of the NPP reactor, safety class 2, extreme cavitational requirements

Action: hydraulic development (CFD, model testing), mechanical development and the production of 4 full scale ejectors

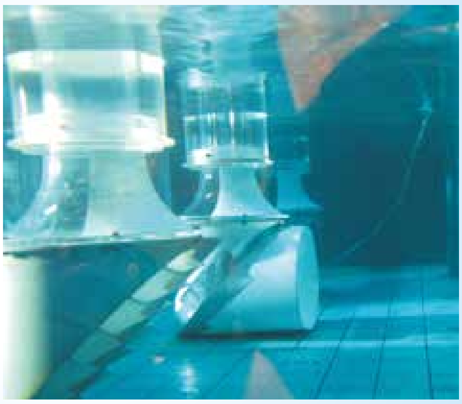
Vertical NPP auxiliary cooling water pumps

Left figure: Parts before delivery - 8 pumps in total
Right figure: Installation on a test rig at KTI and testing

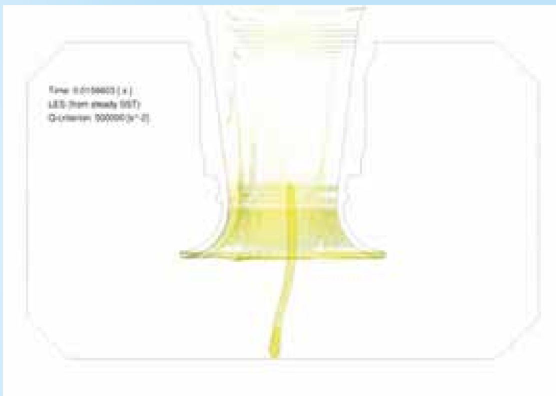
Pump intakes: physical model studies and CFD simulations

Cases: refurbishment projects and new investments (Nuclear PP, Thermal PP, others)
Goal: to ensure that the pumps operate smoothly
Issues: surface air vortices, subsurface dye core vortices, uneven velocity distribution and/or swirling flows at the impeller inlet
Best method: optimal combination of physical model testing and CFD simulations

Physical model



Surface vortex



CFD simulation of the subsurface vortex under the suction bell

Our goal is to extend pump lifetime, increase system availability, lower energy consumption, reduce maintenance costs and improve environmental efficiency!

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