HPP YBBS-PERSENBEUG
ELECTRO-MECHANICAL EFFICIENCY ENHANCEMENT AND REFURBISHMENT

SHF - Enhancing Hydropower plants Grenoble, April 9-11, 2014
Location at Danube River

Power Plant Ybbs - Persenbeug
Original View of Erection Site

- Power House South
- Portal Cranes
- Power House North
- Weirs
- Ship Locks
Refurbishment Project

Main driver
- HPP Ybbs-Persenbeug in full operation since 1959
- Commissioning of an additional bulb turbine in 1996
- End of life time of electro-mechanical equipment reached

Project goal
- Preserve high availability of HPP
- Increase efficiency and production of renewable energy for economical and ecological reasons
- New functionality → primary control

Basic conditions
- Refurbishment during full operation of remaining machines
- Avoid loss of generation due to spilling water over the weirs
- 144 Mio € total volume
Refurbishment Project II

Climatic conditions Danube
- Low flow conditions of Danube in winter time
- Catchment area northern alps of Austria
- Melt water in case of warm weather in Christmas period
- Prevent flooding of power house

Schedule
- One unit per year
- Just in time delivery of main components
- Installation
  - 6 months period during winter

Pre manufacturing of crucial parts
- Runner blades + 1
- Generator stator and poles
- Spare transformer
**Turbine – Generator Cross Section**

**Kaplan Turbine**
- Renewal of runner blades, hub and guide bearing
- 5 blades Voith Unit 1,2,3,4,6
- 6 blades Ansaldo Unit 5
- Runner Diameter 7,4m

**Generator**
- Renewal of stator and poles
- Umbrella type
- Bore diameter 10,2 m
- S = 45 MVA
- n = 68,2 rpm

**Low Voltage Generator**
- Remains original
- Auxiliary supply for each machine
New Design
- New hydraulic contour → Increase of efficiency
- Reduced hub ratio 42 % → 39 %
  Increase of discharge capacity
  2650 m³/s → 3100 m³/s
- Designed for higher mechanical stress to deliver ancillary service
- Oil lubricated guide bearing

Benefits
- Increase of annual production of 60 GWh
- Capability to deliver new products
  Frequency Sensitive Mode (primary control)
Frequency Sensitive Mode (FSM)

Situation in Austria
- Primary Control market based procurement by APG
- Market volume 71 MW
- Delivery period 1 week with 100 % availability
- Increase of active power with falling frequency up to 10% $P_{\text{max}}$ of a turbine within 30s

Requirement for Turbines
- Permanent operation in partial load
- Very frequent, fast load changes
- Best delivered by run of river power plant

Basic conditions for Danube HPPs
- Danube is navigable for tourist and cargo ships
- Varying plant discharge by FSM would change water levels in an unpredictable way
- Only a small number of turbines in FSM at a time
- But 10 HPPs at Danube river in operation

from ENTSO-E Network Code RfG for CE
Renewal of Electrical Equipment

- 91MVA Generator G7
- 45MVA Step up Transformer G2
- 220kV Cable
- 220kV Switchyard
- Auxiliary Supply
- Circuit Breaker
- Excitation
- Generator 45MVA
Generator

New design
- New poles and stator
- Reduced losses
- Reuse of rotor sheet chains
- Only flameproof material
  Dismantling of CO₂ fire extinguisher system

Stator manufacturing on site in powerhouse south in progress
- Delivery of housing in 4 pieces
- Screwing of stator housing
- Stacking of stator core
- Installation of winding
- Lifting of entire stator through roof by portal crane
to generator pit

Apparent power 45 MVA
Power factor 0.9
Voltage 10.3 kV
Voltage range -5/+8%
Rotational speed 68.2 rpm
Poles 88
Stator weight 145
Stator diameter 10.2 m
Excitation System, Generator Bus Duct

Excitation System
• Rotor DC current changes significantly
• Renewal of entire excitation system, incl. thyristor bridge
• Supply from generator bus duct or external source
• External voltage to adjust generator output voltage starting from 0 V
  → start up of HV equipment e.g. overhead lines or transformers within APG network

Generator Bus Duct
• Renewal of pressure air driven circuit breakers by electrical driven ones
• Removal of existing Bütow Transformer
• Installation of new stator earth fault protection system
Transformers

Original design
• mirror symmetrical transformers North – South
• not interchangeable
• oil cable connection via bushing, separate oil room,

New design
• 5 identical transformers with two star point positions
• Detailed isolation coordination study for placement of surge arresters performed
• No surge arresters at transformer connection point necessary
• VPE cable connection by 220 kV Pfisterer Plug system
• On load tap changer for reduced generator voltage range
220 kV Cable Connection

Common high voltage (HV) cable tunnel
Cable length power house
• 600 m North / 300 m South

Works performed each year
• dismantling of one cable system incl. cable tray
• mounting of new cable trays and cables

Main challenges
• Ordering of short cable length
• 1 km necessary to adjust cable machine
• Storage of prefabricated cable for 6 years
• all works performed under full operation of other HV systems
Conclusion

Starting Point
• After 55 years of operation of HPP Ybbs-Persenbeug start of project Ybbs 2020
• Refurbishment covers all electro-mechanical components
• Overall project volume 144 Mio €
• All works performed under full operation of the HPP
• New turbine design
• Generator manufacturing performed on site

Project Goal
• To make HPP Ybbs-Persenbeug fit for another 50 years of operation
• To increase annual production of 60 GWh
• To deliver ancillary services