

Hydro-Clone

**Innovative Real-Time Simulation
Monitoring System for Hydro
Power Plant Transient Survey**



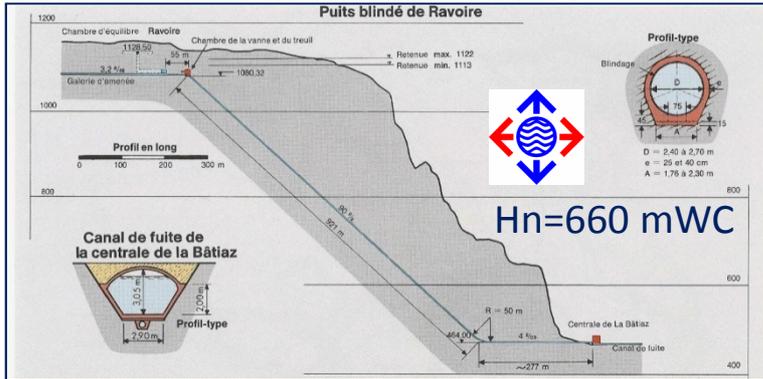
**Water Hammer / Surge Tank Survey
Real-Time Simulation Monitoring (RTSM)
Ahead of Time Simulation Monitoring (ATSM)
Detection of Hydraulic / Electrical Anomalies
Estimation of Non-Measurable Quantities
Anticipation Power Plant Damage**



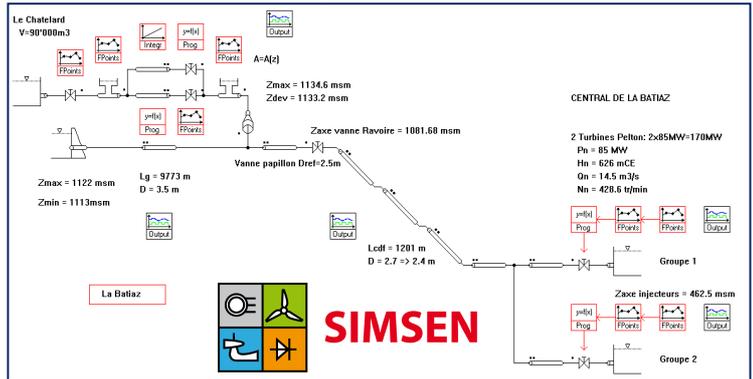
Hydro-Clone

Case Study EMOSSON SA: 2x85 MW La Bâtiaz Power Plant

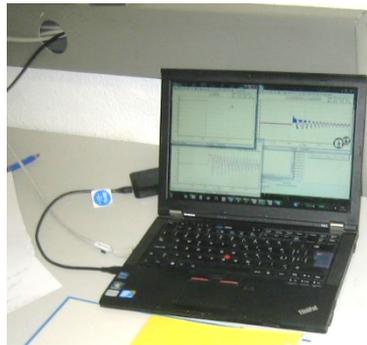
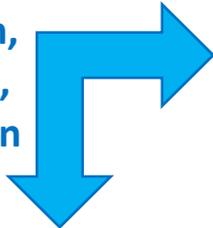
Input data



SIMSEN modeling and validation

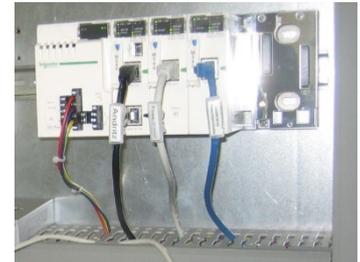


On-Site installation of
Hydro-Clone
Acquisition,
Simulation,
Comparison

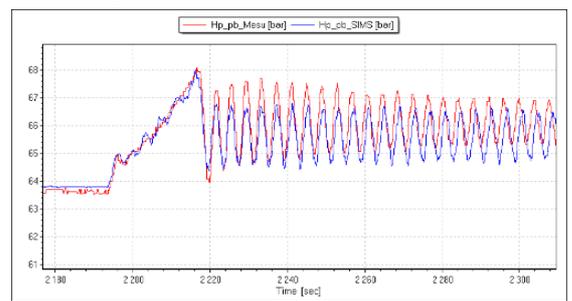
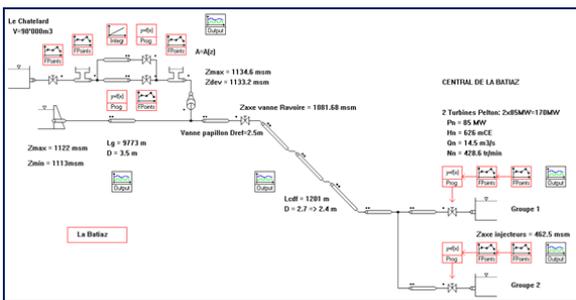


Data
(Modbus)
 $f_{\text{sample}} = 10\text{Hz}$

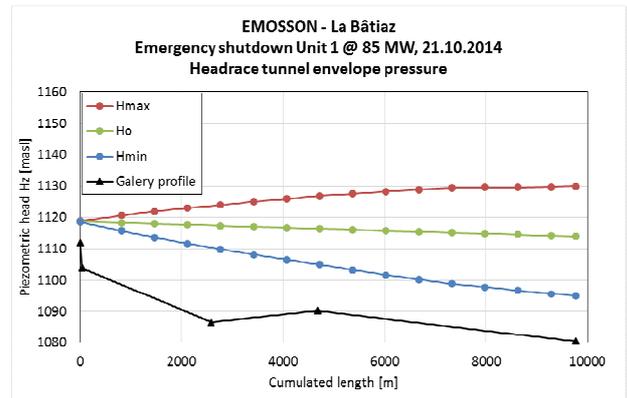
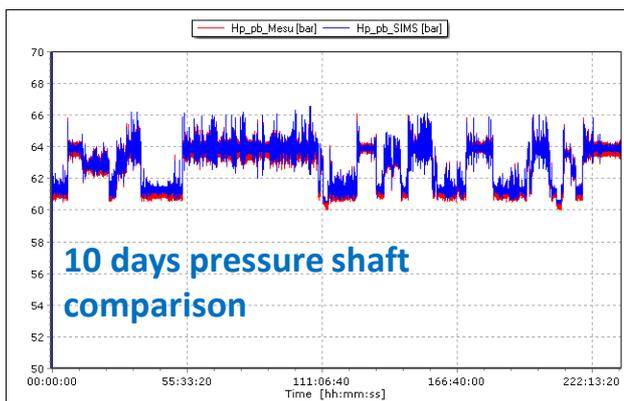
SCADA



Comparison Simulation-Meas.

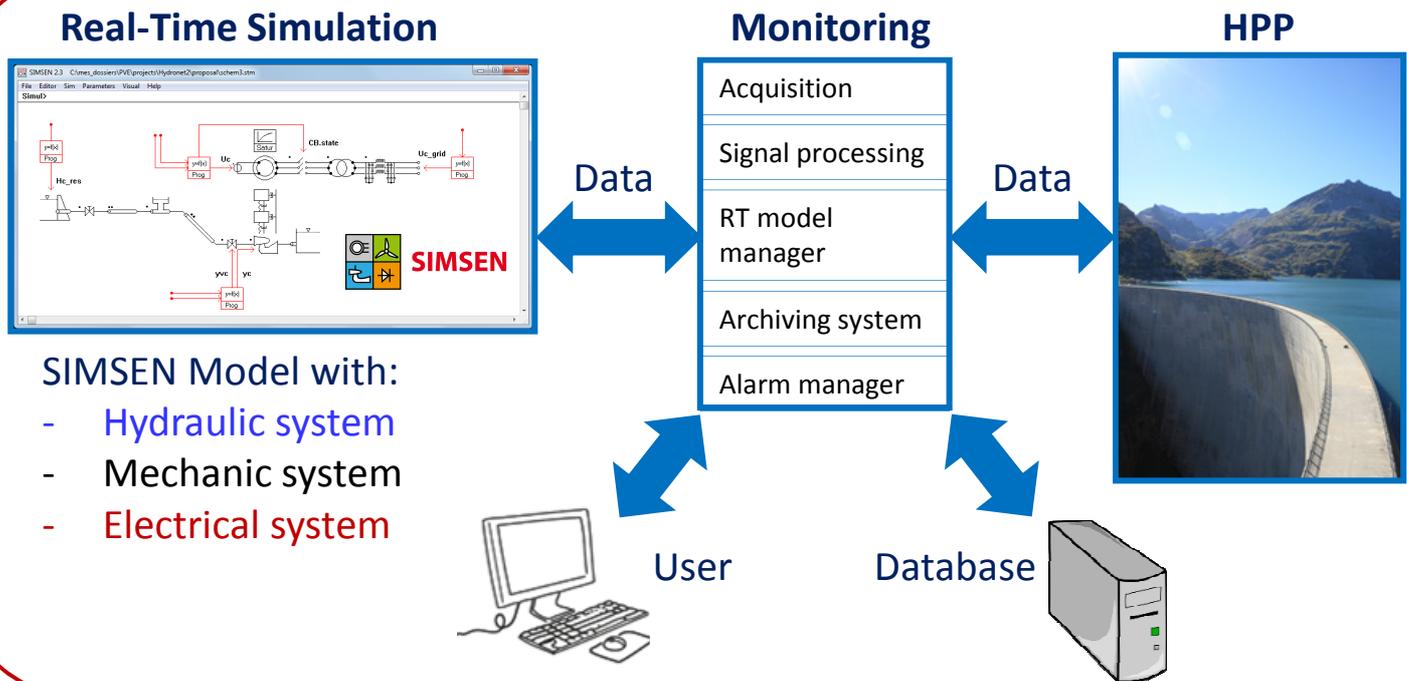


Long term
transient
survey and
analysis



Innovative Real-Time Simulation Monitoring System for Hydro Power Plant Transient Survey

Hydro-Clone – Real Time Simulation Monitoring System



Features

- A calibrated SIMSEN model of the HPP, operated in Real-Time and using *in-situ* measured boundary conditions including:
 - hydraulic circuit: galleries, surge tanks, valves, pressure shaft, **pumps and turbines (Pelton, Francis, Pump-Turbine, Kaplan)**
 - mechanical inertia and coupling shaft
 - electrical system: motor-generator, transformer, circuit breakers, transmission lines
- A real-time monitoring system performing the following tasks:
 - Real-Time acquisition and transfer of *in-situ* measured **boundary conditions** and quantities to SIMSEN model
 - data processing and diagnosis of the power plant health
 - provide pre-defined appropriate alarms based on both real-time (RTSM) and ahead-of-time (ATSM) analysis
 - communication with archival storage system
- A tailor-made archival storage and related database system enabling:
 - to archive simulated and measured quantities
 - to display and analyse previous results
 - to contingency alarms
 - to update and enhance the clone functioning

Purposes

- Identification of hydraulic or electrical anomalies:
 - unexpected gate or valve closures
 - unexpected air admission from air-valves
 - flow obstruction by external body
 - head loss increase
 - water column separation
 - conduit breakdown
 - surge tank sediment deposit
- Monitoring of non-measurable quantities:
 - minimum or maximum pressure throughout the penstock or the headrace/tailrace tunnels
 - discharge throughout the system
 - extreme torque in the coupling shaft
 - extreme current or voltage
- Ahead-of-time projections of the state of the system (what-if), to identify possible risks related to pre-defined scenarios such as emergency shutdown, unit loading, or unexpected valve closure
- Post processing based on specific modules for:
 - Fatigue evaluation (cumulating of damage along a conduit)
 - Buckling risk of conduit
 - Discharge and water volume balance

HYDRO-CLONE Services

Fitness Check (included in the license)

- Annual Report: summary of, alerts, remarkable facts, recommendations for future HPP operation
- Maintenance of HydroClone (hardware + software)

Specific Check (On Demand)

- Analysis of selected specific events and search for solutions/adaptations
- Definition of possible framework of agreement

Full Health Check (On Demand)

- Analysis and evolution of HPP model (corrections, upgrades)
- Definition of possible framework of agreement

Add-ons (On Demand)

- Specific modules (fatigue, buckling risk, ahead-of-time)

Training (On Demand)

Simulation of a hydro plant by ‘cloning’ makes it possible to detect undesirable phenomena, such as penstock or gallery overpressures, head loss increases, decreases in efficiency, surge tank limits, start-up and shut-down issues, unexpected cavitation and possible water column separations, air intake, and unwanted valve closures. Furthermore, a clone is able to minimize the risk of potential imminent harmful behaviour of the plant, by generating so-called ‘**ahead of-time simulation monitoring’ (ATSM) alarms**, based on a series of instantaneous simulations of any potential near-future behaviour of the plant. By combining RTSM and ATSM in real-time, it is believed that the newly developed system, known as Hydro-Clone, can be a valuable numerical asset for hydro plant owners to improve powerplant safety.



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