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

Input data

Hn=660 mWC

SIMSEN modeling and validation

On-Site installation of Hydro-Clone

Acquisition, Simulation, Comparison

Data (Modbus)

f_{sample}=10Hz

Comparison Simulation-Meas.

Long term transient survey and analysis

10 days pressure shaft comparison
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Hydro-Clone – Real Time Simulation Monitoring System

SIMSEN Model with:
- Hydraulic system
- Mechanic system
- Electrical system

Features

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

Purposes

• Identification of hydraulic or electrical anomalies:
  o unexpected gate or valve closures
  o unexpected air admission from air-valves
  o flow obstruction by external body
  o head loss increase
  o water column separation
  o conduit breakdown
  o surge tank sediment deposit
• Monitoring of non-measurable quantities:
  o minimum or maximum pressure throughout the penstock or the headrace/tailrace tunnels
  o discharge throughout the system
  o extreme torque in the coupling shaft
  o 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:
  o Fatigue evaluation (cumulating of damage along a conduit)
  o Buckling risk of conduit
  o Discharge and water volume balance

European Patent application EP 2 801 879 A1, “Hydroelectric power plant real-time monitoring system and method”
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.

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)**

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