BKW Energie AG, Bern, Switzerland
Cassantec AG, Zurich, Switzerland

Condition-Based Malfunction Forecasts for Hydroelectric Power Stations

Deployment of a Prognostic Asset Management Solution at BKW in Switzerland

Background: BKW Energie AG is a major Swiss power generation and distribution utility engaged in hydroelectric, nuclear, solar, wind, and fossil fuel power production. In April 2014, BKW decided to deploy Cassantec's prognostic solution for its Bannwil hydropower station, seen in Figure 1. In April 2015, the deployment was extended to its Brügg and Kallnach hydropower stations. The Cassantec solution uses current and historical condition and process data recorded at these hydropower stations to forecast future availability and to compute remaining useful life (RUL) distributions for hydroturbines, generators, and transformers.

Figure 1: Bannwil Hydropower Station (Source: Onyx Energie Mittelland)

Objective: BKW is applying Cassantec's solution to prognosticate the condition of its hydropower stations and to calculate their RUL distributions, with the objective of optimizing maintenance planning and scope and minimizing operation and maintenance costs. In particular, BKW is targeting an adaptive asset operation strategy allowing optimal asset utilization over RUL. This extends to a suitable component procurement and replacement schedule. Furthermore, particular focus is being placed on preempting costly failure of one generator in critical condition at BKW's Bannwil station.

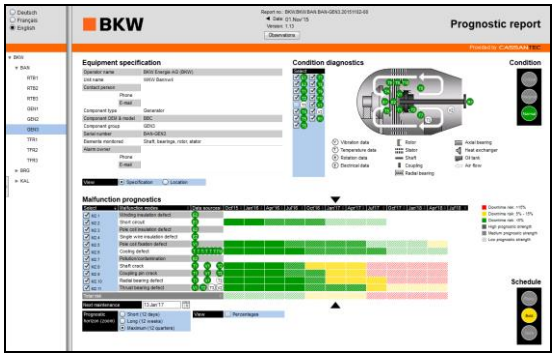

Figure 2: Example Prognostic Report for Bannwil

Approach: In a first step, current and historical vibration, temperature, pressure, flow, and electrical condition data from BKW's hydropower stations is used to forecast asset conditions over an explicit future time horizon. In a second step, these asset conditions are correlated to critical asset malfunction modes, formulated in close collaboration with BKW's engineers onsite. In a third and final step, future malfunction risk with respect to these malfunction modes is computed and converted to a prognostic report, as illustrated in Figure 2. This approach allows a fleet-wide learning process where malfunction risks and renewal planning are managed in a fleet context.

"Cassantec AG has improved our day-to-day plant management and long-term planning. They give us valuable insight on how our current operations decisions impact asset utilization down the line. With their findings, we can take steps today to limit costs and enhance reliability tomorrow."

Asset Manager, BKW Energie AG

During the solution configuration, trends in condition data of the critical generator at the Bannwil station were identified and analyzed. The analysis indicated a notable increase in vibration displacement of a generator bearing over time. An in-depth scenario analysis established a dependency between the bearing vibration gradient and the load level at which the generator was operated, bringing to light critical implications for optimal load balancing, machine lifetime, maintenance needs, and asset reliability.

Benefits: Based on the results of the prognostic solution so far, BKW has been able to adjust its operations and maintenance plan for the aforementioned hydropower stations to optimize asset utilization. In this context, three key benefits were identified:

- Appreciable extension of the RUL of BKW's hydropower assets
- Minimization of asset maintenance costs and scope, and relaxation of the maintenance schedule
- Informed and targeted asset procurement and replacement schedule

Next Steps: The prognostic solution is currently in use at the three aforementioned hydropower stations, with monthly update intervals and sporadic technical meetings for refinement of the configuration. The operator is considering the rollout of the solution to additional hydropower assets.

Contact: Please contact Dr. Frank Kirschnick (frank.kirschnick@cassantec.com, +49 160 9774 3600) for any technical questions or feedback.