LOSS LESSONS

VOLUME 1

ALLIANZ GLOBAL CORPORATE & SPECIALTY®

MACHINERY BREAKDOWN ON A WATER TURBINE

REPORT PUBLISHED BY

ALLIANZ RISK CONSULTING

Occupancy:
Hydropower Station

Property Damages:
€ 100,000

Business Interruption:
2 Months

Main Technical Data:
Type: FRANCIS turbine
Power: 1,500 kW
Total head: 11 m
Flow: 60,000 m^3/h
Speed: 157 rpm
Wheel diameter: 2 m
Bearing: Water lubricated journal bearinge

CIRCUMSTANCES

The power station is operated with a remote control system, without local human attendance. During a routine remote checking, the operator noted that the generator was not delivering any power but was running in motor mode. After isolation and water drainage, the inspection of the internal parts showed that the wheel was on free rotation on the shaft and had jammed in the inlet guide vanes and the exhaust bushing.

EXTENT OF THE DAMAGE

- Rupture of connecting bolts between the wheel and the shaft
- Metal rubbing on rotating parts
- Metal rubbing on stationary parts
- Journal bearing damage

CAUSE OF THE LOSS

Water pressure applied an axial load on the shaft line that is partially balanced by holes drilled into the hub of the wheel. These holes also allow the drainage of the bearing lubricating water. Loss was caused by a faulty design of the balancing holes. The flushing of the bearing was not correct (too low flow), the bearing overheated and clearance increased out of margins. Consequently, high vibrations and dynamic loads were developed by the turbine, bolts were over strained and broken, then the wheel dropped inside the stator.

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WHAT HAS WORSENED THE LOSS

The water turbine unit was not fitted with on line vibration and temperature monitoring. Overheating and abnormal vibrations were not detected by the remote control system.

WHAT HAS LIMITED THE LOSS

There was no overspeed because the wheel dropped and was stucked in the exhaust bushing. Vertical installation of the shaft line with the wheel at the bottom limited the damages to the lower part without propagation to the upper parts (generator, coupling, gearbox). Temporary repair of the wheel limited the loss period to 2 months and permitted to run at reduced load during 1 year, which is the replacement time of the wheel.

COMMENTS AND LEARNINGS

This type of water turbine is traditionally assembled on site without prior shop test. Commissioning and provisional acceptance were delivered without any mechanical running tests. The operating conditions for the mechanical parameters were not checked and not logged (bearing temperature, bearing water pressure, vibration level, bearing water flow). Tuning and adjustments (clearances, sizing of wheel balance holes) could not be carried out due to unexisting test results. Basic loss prevention methods and protective devices would possibly have avoided or reduced the damages.

PREVENTION MEASURES

Commissioning and start up phases would possibly be formalized with a certificate of completion. Tests and controls should be included in the acceptance procedure and these tests could be carried out in presence of all the parties involved in the works (client, engineering, contractor, manufacturer). It is a common interest to detect during erection abnormal operating conditions and it is easier to carry out changes before the end of works.

PROTECTION MEASURES

On line supervision of turbine with temperature and vibration monitors would allow the setting of a preventive maintenance and a reduction of the consequences of any failures or breakdown (cost and duration). Temperature and vibration are reliable indicators of mechanical condition for rotating equipment.

QUESTIONS OR COMMENTS?

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