Lessons learned

by

J. L. Gordon.

"The Stuck Turbine"

George was puzzled, he had just initiated the auto start-up procedure at the local control board, but the turbine refused to rotate. Over the previous three weeks, George and Jack had been installing a new SCADA and remote control system onto the 25MW single unit Francis-turbined generator. The 50 year old, 40m head powerplant had a vertical unit with a steel spiral casing set well above tailwater. With some storage available in the headpond, the work was being undertaken during the low flow season in the middle of winter, so that no water was wasted over the spillway.

Leakage through the intake headgate was larger than through the wicket gates, hence the water had been retained on the wicket gates, and the penstock remained pressurized during the retrofit work. The ambient temperature was unseasonably cold, at about 30 to 40 degrees Celsius below zero throughout the retrofit work.

With the turbine refusing to rotate, George started to check all controls. Jack went down to the turbine headcover and checked the wicket gate servomotor, governor and oil piping. All seemed to be in order, with pressure on the servomotor, wicket gates closed, and water pressure in the penstock. After a discussion, they decided to try again, with Jack standing below the generator to observe the wicket gate opening. On startup, the wicket gates opened as usual, but the turbine still remained at a standstill.

By this time, both George and Jack were thoroughly confused. After another discussion, it was decided to open the draft tube door, and have a look at the turbine. With the spiral casing well above tailwater, there was no need to drop the draft tube gates, since the draft tube door sill was just above tailwater. After lunch, they went down to the draft tube door, where a sight glass adjacent to the door, indicated no water in the draft tube. The draft tube had an outward-opening door, and after removing the 24 large nuts retaining the door, they tried to open it, to no avail. They tried a crow-bar with no success. Next, they attached a small chain hoist to the door handle, and succeeded in prying the door open, to be greeted with a large sucking sound, and then the door opened easily.

On looking in and up at the turbine with a flashlight, Jack noticed that the runner buckets were all frosted, and made way for George to have a look. George noted

the frost, but also was astonished to see that the spaces between the buckets were filled with ice! Suddenly George realized that while the wicket gates were closed, that the full penstock pressure of the water in the turbine was being retained by the ice – and he didn't know how long the ice would remain in place. Shouting to Jack to "close it, close it" they managed to close the draft tube door in record time.

Now the reason for the non-rotation of the turbine was apparent – it was frozen in place. Normally, the powerhouse was operated for several hours every day throughout the winter, and relied on the re-circulation of hot air from the generator for heating the building. Generator cooling air was drawn in through the turbine headcover access passage, and circulated up through the generator. A large louvered opening through an outside wall at turbine floor, was used during the summer to ventilate the powerhouse. It was closed in winter, but the aluminum louvers were not insulated, and added to the heat loss at turbine level. With exposed un-insulated concrete walls on three sides, and no auxiliary heaters at floor levels below the generator, the three weeks of shut-down had allowed the frost to penetrate well into the runner. George arranged for propane heaters, and to retain the heat in the lower part of the powerhouse, all openings in the generator floor were covered with tarpaulins.

About 4 days of heating was needed for the runner to be completely free of ice, as observed from the draft tube door, which was opened a few days after the heating started. The SCADA and control system was checked again, and the unit started without incident.

Lesson learned.

Whenever there is an unusual event that cannot be readily explained, take time to think and do not rush into an investigation. In this case, George and Jack were fortunate that the ice did not break while the draft tube door was open, since there was sufficient water in the upper portion of the runner to fill the draft tube above tailwater level, and perhaps injure anyone in the vicinity of the draft tube door.