

## Lessons Learned

### *Suffering the Consequences of Untrained Operators*

Although the need for adequately trained hydro plant operators may be obvious, it is surprising how many operators lack sufficient training to perform their jobs competently and safely. The following incidents exemplify the problems that can come about due to lack of operator training:

- A utility suggested that its future hydro plants be designed with "fail-safe blow-off draft tube gates" after an operator tried to start the turbine against a closed draft tube gate. (Fortunately, there was no damage since the gate was able to withstand the reverse pressure of 19 meters of head.)

The utility went as far as designing a retrofit that featured a break in the draft tube concrete reinforcing immediately upstream of the gate guides. The retrofit was never carried out because the repair cost would have exceeded the cost of a new gate.

- In another situation, a very large, slow speed, 26-meter-head, vertical axis turbine-generator unit was in the final stages of being commissioned. In order to measure the clearances at the runner blades, the operators decided to use water pressure to rotate the unit. They reasoned that, by cracking open the head gate and opening the wicket gates, the generator could be slowly inched around to the desired position. The procedure was started with men still standing inside the generator rotor.

The head gate was opened to the 7.5-centimeter stop position, and then the wicket gates were opened. The generator started to rapidly accelerate, owing to the low friction within the pressurized thrust bearing. One man managed to jump out, two others clung desperately to stanchions near the shaft, and another was severely injured when thrown against the coils.

In the subsequent investigation, it was found that the procedure was not approved and was undertaken in the absence of any supervisory staff. It might have worked if the wicket gates had been opened first and the head gate opened by only 1 or 2 centimeters — a difficult operation since there is no fine lift control on the head gate. Instead, by first opening the head gate, the spiral casing filled, as did the short penstock, so that the wicket gates were opened under almost full reservoir head, causing the turbine to rapidly accelerate.

The attempt to rotate the generator should never have been made with men standing inside the rotor.

- In a third incident, an underground powerhouse contained three small high-head Francis units, in the final stages of being commissioned. The consultant had meticulously trained the local staff in the watering-up and start-up sequence of events. On this particular day, the chief operator insisted that his staff was now fully competent and

capable of watering-up and bringing the unit to the speed-no-load position, which they proceeded to do while the consultant's and manufacturer's engineers were having breakfast. As the engineers were completing their meal, the bus scheduled to pick them up for transport to the powerhouse came roaring up the hill and screeched to a stop. Several operators jumped out; ran into the camp service trailer; grabbed every mop, pail, and bucket in sight; and boarded the bus, which went speeding back to the powerhouse — all without explanation. The consultants were later advised that commissioning was being delayed due to "technical difficulties."

Two months later, the plant owner called the consultant, ready to complete commissioning. Eventually, the reason for the delay emerged. The high-head Francis units were each equipped with rotary shut-off valves. During the watering-up procedure, the bypass valve around the rotary valve is opened, and the 5-centimeter air vent valve on the top of the turbine spiral casing is watched closely. As soon as water starts to spout out, the valve is closed, indicating a full casing. Apparently, the operator assigned to close the air vent valve had not slowly closed it during filling and was suddenly faced with a 5-centimeter jet of water, under about 220 meters of head, streaming out of the valve.

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