Bankrupt village.

By

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George was flabbergasted at what he was inspecting. He had been asked to look at a new small hydro facility by the Municipal Commission – a government department set up to manage bankrupt municipalities. In this case, a remote village had built a 1.2MW hydroplant to supplement their expensive diesel power. After a year trying to commission the plant, the village had declared bankruptcy after defaulting on bonds issued to build the plant.

At a nearby river, a low concrete weir had been built, diverting the flow into a short canal, bypassing some rapids, to a concrete powerhouse containing a single vertical axis propeller turbine, in an open flume setting, operating at about 6m head. The civil work was fine, but the equipment was a disaster. The village had engaged the services of Joss, an elderly retired engineer, with instructions to keep costs to a minimum. Joss had found used equipment from a recently renovated plant, and had installed the mid-1920's turbine, generator, Woodward HR governor and open switchgear panels in the new powerplant. Unfortunately, Joss passed away just before commissioning started. A local electrician and car mechanic had attempted to complete the work.

In early winter, George had arrived at the village, and stayed at the local inn. The landlady, on learning that George was going to look at the "hydro" asked him to look at her freezer, where he found a burnt-out motor. He asked the landlady if the lights had been unusually bright before the freezer stopped, and she answered in the affirmative, mentioning that this was her second freezer, the first also failed, but was replaced under guarantee. George now knew that the plant had frequency and voltage control problems.

The next day, after a quick inspection of the site and equipment, George asked the operator to start the unit. This was accomplished by manually opening the wicket gates at the governor servomotor wheel. When the unit reached near-synchronous speed, as indicated by the rpm dial gauge, the operator closed a large switch, and promptly attached a 20kg weight to the handle. George asked why, and was informed that without the weight, the switch would fly open. The operator then opened the wicket gates to about 50%, and the powerhouse lights came on. George thought that the plant was now supplying power to the village, but the operator said that the power was all being used to light and heat the powerhouse! Connection to the village system, which required shutting down the diesel, was prohibited, since the last two attempts had resulted in burning out all the lights!

George noted that the operator continually made small adjustments to the wicket gate opening, while keeping an eye on the rpm gauge, and realized that the governor was not operational, hence the frequency deviations. An inspection indicated that the kW meter was also not functioning.

George asked the operator to shut down the unit, and open the concrete casing, so that he could inspect the turbine. This was accomplished by closing the wicket gates, lifting the weight off the switch, and placing a 20cm square, 5m long timber in the generator pit, with one end wedged against an air vent. A come-along on the opposite end was then used to force the timber against the generator shaft to act as a brake! The two timber headgates were closed with the rack and pinion gears, and a manhole in the powerhouse floor was opened. The operator descended with a long forked shaft, and after some probing, located a valve handwheel, and opened the turbine casing drain.

After checking that there was no pressure in the governor, George entered the casing and looked at the 4-blade runner, found that it was loose on the shaft, and discovered a 2cm gap between runner blades and throat ring. The conical draft tube had been fabricated locally, and was slightly oversized, hence the gap. George had seen enough, and asked the operator to close up. This was done, and George noted the alacrity with which the operator ascended the ladder out of the casing, a necessity due to the rapidly rising water level from gate leakage.

The old turbine nameplate was still attached to the generator casing, and indicated a design based on 30ft (9.15m) net head, a speed of 150rpm, and a runner diameter of 100 inches (2.54m). Turbine horsepower was 3,500 (2.6MW). From this, George estimated the old design flow at about 33m3/s. Down-rating to 6m head should have produced an output of around 1MW at the generator. However, losses around the runner and operation at off-design head indicated that power was less than anticipated, confirmed by the low power output at 50% gate.

In his report, George recommended that the generating equipment be removed and replaced with a modern Kaplan powered turbine with a gear-driven high-speed generator and electronic controls. However, it was found that it would be more economical to build a transmission line from the nearest utility substation.

Lessons learned.

This case is disastrous. A village had taken the initiative to construct a small hydro plant, but unfortunately had received poor advice. An adequate feasibility study had not been undertaken, and the consultant had little hydro experience. Always look for an experienced consultant, and as added security, ask engineers with extensive hydro experience to review the feasibility report.

Try to avoid using old equipment, and avoid equipment older than about 50 years. If suitable old equipment is used, install modern switchgear and controls – old switchgear cannot pass modern safety codes, and old controls cannot maintain the steady frequency now required by electronic equipment.

Never use a single propeller turbine on an isolated system – the turbine would be difficult to control, and very inefficient at part load.