Aspen Revisited

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ABSTRACT

Only ten years after installing a new turbine system at their Maroon Creek hydroelectric facility in 1986, the City of Aspen, Colorado was faced once again with deciding what is the best turbine selection, after the original unit failed to meet expectations. HTS INC was asked to make recommendations and concluded that replacement with a new OSSBERGER Cross-Flow Turbine would remedy the operational problems experienced at this site with a healthy dose of reliability. What follows should serve as a guide on how to avoid costly mistakes by selecting suitable equipment the first time around, based on performance and reputation, not price alone.

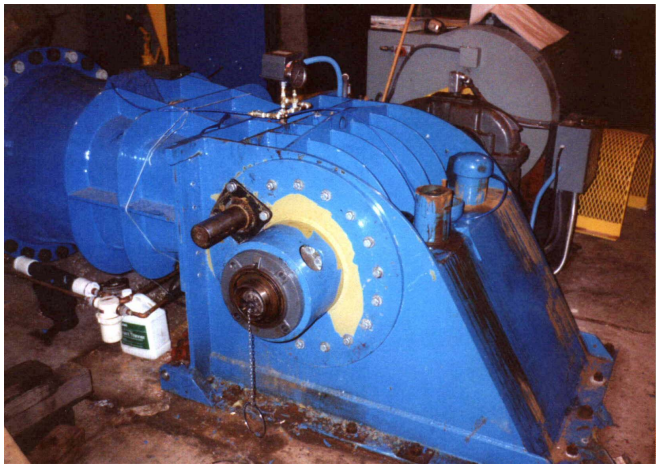

Figure 1: Turbine out of Commission again - this time a broken runner shaft - after ten years of intermittent operation - off to the scrap yard

The Background

The City of Aspen, Colorado investigated the feasibility of power generation at their existing water supply line and, in 1985, developed specifications for a Turbine/Generator package, including commissioning and start-up. After extensive information exchange between the consulting engineering firm and OSSBERGER TURBINES of Virginia, it was concluded, that a Cross-Flow Turbine was ideally suited for the variable flows that characterised this site. Flow to the Maroon Creek site is not only seasonably variable, but is also determined by the City's varying water consumption. Only water in excess of the demand for consumption could be diverted for power generation. Thus, with its high and flat efficiency curve the Ossberger Cross Flow design seemed a perfect match.

Unfortunately, when the project was sent out for bids in 1986, price was the determining factor in awarding the bid. Instead of Ossberger, the lowest bidder, a local manufacturer who was affiliated with the Consultant, was selected to build and install the turbine with associated equipment.

Figure 2: Space for the new Cross-Flow turbine is limited. The water intakeflange on the left side, the floor opening for the turbine discharge and thegenerator shaft in the background. Turbine and gearbox had to fit between.

For the next ten years, site operation was unreliable and, even when in operation, the equipment under-performed. Broken turbine runners and shafts were repaired, but the repairs or replacements were short lived. Perhaps more importantly, the shortfall in electric generation at full and partial flows, even when the unit was operational, ended up representing a significant economic loss which could no longer be overlooked. The City finally made the decision to remedy the situation or scrap the hydro scheme altogether and asked HTS INC. for suggestions. A field trip by the Author to the Maroon Creek hydro station (Aspen revisited - 10 years later) led to a proposal to replace the broken turbine with an OSSBERGER unit. This proposal was accepted at the City Council Meeting in November of 1997 and HTS began immediately to provide the necessary services and machinery.

The Challenge

The powerhouse is fairly small and located near several impressive residences, occupied by the celebrated rich and famous of Aspen. Therefore, it was constructed as a log cabin in order to blend with its rustic, wooded surroundings Besides budget limits, the biggest challenge was to use as much of the existing equipment as possible without sacrificing reliability and without making major changes to the powerhouse or civil structure. Complicating the challenge was the existence of a long penstock which carries flows at high velocities and pressures, and creates the possibility of extreme overspeed conditions during emergency shut-downs. The water supply line for the City of Aspen is buried beneath a site access road and consists of a two-mile long, 39 inch concrete pipe which bifurcates and is reduced to a 30 inch steel pipe that extends to the hydro plant.

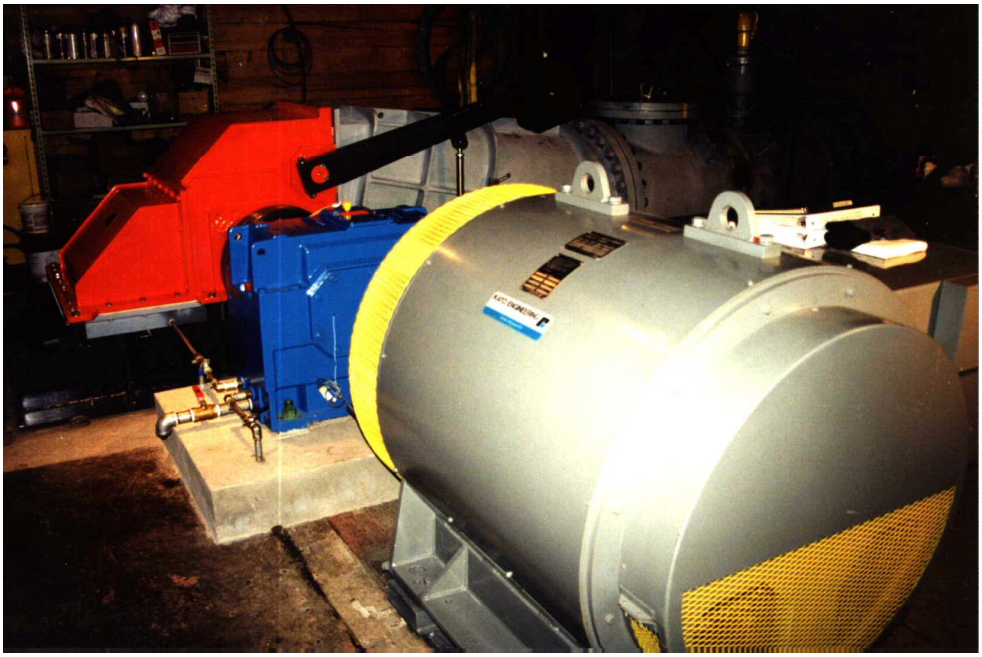

Figure 3: Installation completed with the 450 kW induction generator in front

HTS INC supplied an Ossberger Cross Flow turbine with a maximum flow rating identical to the original specification (43 cfs or 1220 lit/sec at 156 ft. or 47.5 m of head), but we made use of the existing 450 kW induction generator. The existing switchgear, head level controller and hydraulic power unit, and the pressurised pipe with by-pass line and pressure reducing valve were all left in place and reused. However, the existing butterfly/shut-off valve had to be replaced by a new gate valve designed to maintain a uniform flow pattern. Likewise, a new speed increaser with flexible couplings was needed to step-up the turbine speed to match the 1200 rpm generator speed. In order to fit the new turbine and discharge tube in the existing floor opening, it was also necessary to design and install a transition piece to connect the existing round pipe flange with the rectangular turbine intake flange.

The Execution

After the equipment was delivered to the site in the fall of 1998, installation was carried out by the City's Water Department under the supervision of HTS INC. The butterfly valve was replaced with a knife type valve, to fit inside the powerhouse. The Ossberger Cross Flow turbine design, which is remarkable for its efficient use of widely varying flows is equipped with two individual guide vanes, which permit effective utilisation of flows varying between 16 and 100 % of rated flow. Regulation of these guide vanes is accomplished by two hydraulic cylinders with counterweights mounted onto each guide vane arm to effect fail-safe shutdown in case of load rejection or emergency shutdown. In addition, the parallel shaft, single stage gearbox is equipped with a water-cooling coil embedded in the sump.

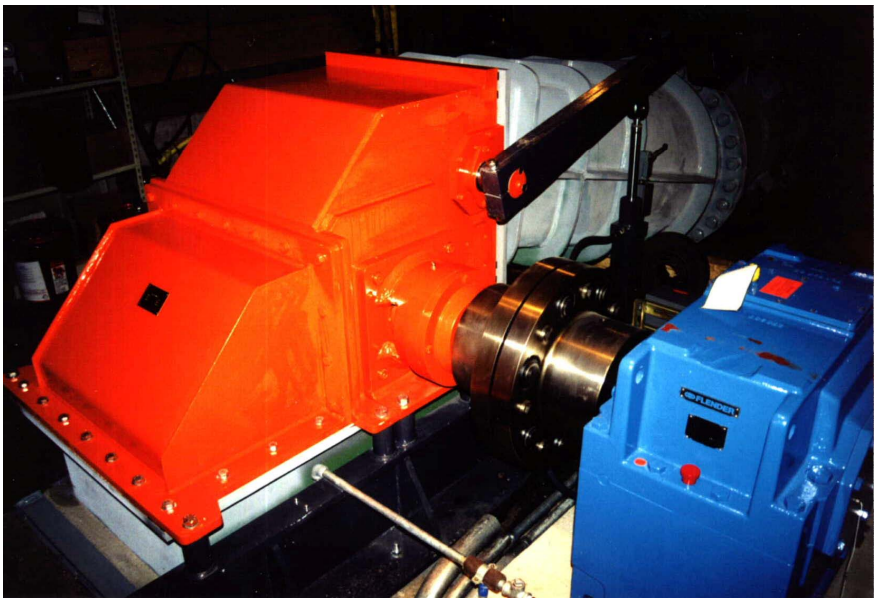

Figure 4 The new OSSBERGER Cross-Flow Turbine with FLENDERGearbox and flexible coupling installed at Maroon Creek Hydro offeran ideal combination to guarantee reliability and performance.

Installation was quite simple, only requiring field welding of the transition piece counter flange; and the generator had to be moved a few inches back to fit. Start-up and commissioning procedures went according to plan, except for required modifications to the existing hydraulic power unit, including larger hoses and control valves to achieve the oil flow necessary for faster turbine shutdown. Due to the two-mile length of the water supply line and the high flow velocities experienced during the high flow season, it took some time to adjust the pressure release by-pass valve settings, in order to limit penstock pressure rise and generator run-away speeds during load rejection tests.

The Results

The refurbished Maroon Creek Hydro station has now been in continuous operation for over a year. The new installation has been very reliable and output has increased as maintenance requirements have declined. Even a famous neighbor by the name of Jack Nicholson, whose home is near the powerhouse, appears to be pleased, since he has had no more complaints about excessive noise levels after the new turbine went on line.

The following table shows the dramatic increase in output and proves, that it is wiser not to select equipment by price only To have a successful hydro project it is necessary also to pay attention to product quality and the reputation of the manufacturer.

Flow in cfs	*before(kW)*	*after (kW)*	*Increase (%)*
43	*370*	***465***	***25***
21.5	*150*	***300***	***100***
11.3	*50*	***150***	***200***

Table 1: Summary of Generator Output Increase at various flows

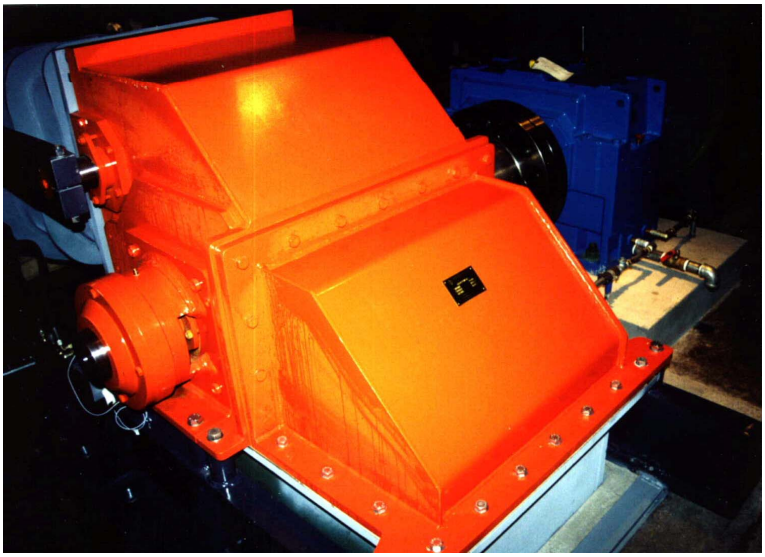

Figure 5: OSSBERGER Cross-Flow Turbine Type G6.039/12g

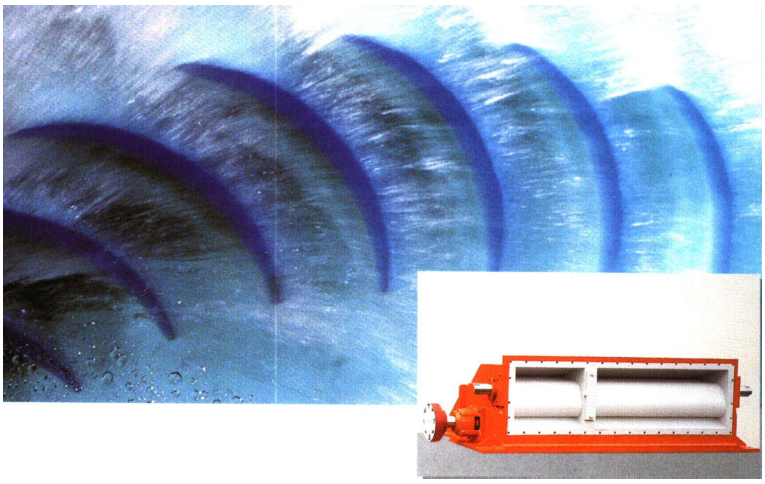

Figure 6: OSSBERGER Patented Cross-Flow Turbine
View of flow intake side with guide vanes split at a 1:2 ratio
Drive shaft with coupling half visible on left hand side

OSSBERGER

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