Cracked generator rotor bracket.

George was worried. He was working with an Owner's small design team on a medium sized hydro plant, and was reviewing the water to wire contractor's second design for a 40MW vertical axis Francis turbine-generator. Comments on the first design had been accepted by the contractor, and appropriate revisions made, except for one comment on the generator rotor, where a flat steel disc was still proposed as the connection between the generator shaft and the rotor poles.

The design team had questioned the selection of a disc to support the rotor poles in the first design, based on a lack of precedent, and a suspicion that there would be severe vibration problems arising from the lack of rigidity between shaft and rotor poles. Vibrations in the disc could be induced by turbulent flow through the runner at part gate openings, perhaps enhanced by harmonic interaction with vibrations emanating from the space between the runner and turbine headcover. It the vibrations were within the range of hearing, noise would be a severe problem for the operators. The design team had no mathematical means to support their suspicions, so all they could do was ask the contractor to provide a precedent for the design.

The contractor had provided several precedents, but all were for horizontal axis units, falling into two categories. One was for high-speed generators of less than about 10MW capacity connected to diesel units. The other category was more appropriate, being for several large slow-speed horizontal axis bulb units. All the generators had disc connections between the shaft and the circular section holding the rotor poles. The steel discs had a thickness ranging from a few centimeters to about 8cm. According to the contractor, the generators had been in operation without incident for several years.

This data appeared to provide adequate precedent, but George was still hesitant to approve the design concept, pointing out that there was a vast difference in the forces acting on the disc in a horizontal and vertical generator. However, in a water to wire contract, the final design decision is entirely within the jurisdiction of the contractor, and George was reluctant to reject the design, since it would provide an open invitation to the contractor to submit a claim for an extra.

A few weeks later, George was attending an international hydro conference, and met Peter, an engineer from New Zealand. Over a convivial repast, George mentioned his problem with the generator design, omitting details which could identify the project. Much to George's surprise, Peter immediately mentioned his experience with a similar design. The 60MW vertical axis Francis unit had originally been provided with a generator with a disc-supported rotor. After about 2 years operation, the rotor disc was examined in detail, and hairline fatigue cracks were discovered around the periphery, at the junction with the rotor pole

support section. The cracks were gouged out and repaired by welding. A year later, another inspection revealed further cracking requiring more repairs. Eventually the rotor disc was replaced with a standard very stiff “spider” section fabricated from large wide-flange (WF) steel sections.

George was quite incredulous when Peter proceeded to open his wallet and extract a small piece of paper on which Peter had listed in minute handwriting, all the pertinent details about the projects on which he had worked. The data included name, head, capacity, unit speed, dam type, spill capacity and so forth. Data on the project was given to George, and on his return to his office, he passed the data on to the contractor. George also pointed out that the generator had been manufactured by a company recently purchased by the contractor, and therefore all data on the unit and the repairs must be in the subsidiaries files.

About a month later, a new generator design was submitted by the contractor, with a standard spider design based on the use of WF steel sections. George asked the contractor why, with the negative experience with disc rotors by the subsidiary, had the contractor insisted that the disc design was acceptable. The reply was to the effect that the subsidiaries file retrieval system was manual and not compatible with the contractor’s data-base, and hence the experience was not readily available to the designers.

Lesson learned.

Without George’s data, fortuitously provided by Peter, it is likely that a rotor with a disc design would have been installed, failed in fatigue, and eventually replaced with a standard WF spider design. The cost in lost generation would have been large.

Currently, all design work, including drafting is undertaken on computers. Recent prior designs are stored in memory, and retrieval is simple. This is not the case for designs made only a few years ago, where all drafting was undertaken by hand on mylar paper. These designs are usually stored on microfilm, retrieval is difficult, and viewing takes time to organize – hence reference to older designs is neglected.

George’s networking at the conference had paid off handsomely, and illustrates one of the prime advantages of attending conferences. In these days of cut-backs, downsizing and budget reductions, one of the first cost cutting measures usually introduced is a reduction in conference attendance. The value of networking is often overlooked, and never taken into account – to the detriment of the utility or consulting engineer.
