

Breathing penstock

Surges in penstocks are a common occurrence due to load variations on the turbine. Where there is the right combination of circumstances, breathing can become severe and impose a limitation on plant operation.

In this case, two long concrete saddle supported, riveted steel almost horizontal pipelines to surge tanks exhibited severe breathing, to such an extent that the steel had cracked at the top of several saddles near the middle of the pipelines. Repairs had been made by welding steel plates over the cracks, but these lasted only a few years before cracking. Next, steel saddles covering 180 degrees were installed beside the 120 degree concrete saddles, but even these, while lasting longer than the plate repairs, still failed to prevent further cracking. Movement at the top of the pipes sometimes exceeded 20cm. and regularly exceeded 10cm on a pipe of just over 4.5m diameter. The motion was slow, taking 40 to 60 seconds for a full up-down movement, hence the term "breathing". It was quite an experience to stand on top of the breathing pipe and see the surrounding area apparently move up and down as you stood still!. As time passed, maintenance costs became excessive and other means of stopping the cracking were discussed, such as building ring girder supports. Eventually, it was realized that the pipes, being over 80 years old, had reached the end of their service life, and a decision was made to replace the two penstocks with a canal and new intakes.

Lessons Learned.

Penstock breathing can be avoided by having at least two diameters of pressure head, at minimum surge level, above the penstock. Also, a check should be made to see that sound wave return times in the pipeline upstream of a surge tank and in the penstock between turbine and tank are not a simple multiple of the draft tube time, which is speed in rpm divided by about 3.6.