

Lessons learned.

By J. L. Gordon.

Dam with a rip-rapped downstream slope.

George was undertaking a dam safety inspection, walking along a dyke crest towards the powerplant intake structure built into a rock abutment. On rounding a bend to the intake, he came across a puzzling sight. The downstream slope of the dyke, for about 30m. out from the concrete intake structure was covered with heavy rip-rap. Suspecting that perhaps waves overtopped the dyke in this area, he looked upstream and noted the short fetch, not sufficient to induce any large wave action. Turning to the plant manager who was walking beside him, he asked why there was rip-rap on the downstream slope. The answer was also puzzling “to take care of the burps”

Further questioning revealed that on several occasions the intake gate opening sequence had malfunctioned, resulting in large volumes of water spilling out of the intake onto the deck, and from there the water flowed over to the dyke and down each face. The worst discharge had severely eroded the downstream face, hence the rip-rap.

The high head powerplant had 4 intakes each connected to a 550m long penstock leading to 4 Francis turbines operating under about 300m. head. To save cost, there were no valves, hence on turbine shutdown, the penstock was de-watered to avoid wire drawing on the wicket gates. Turbines were taken off line quite often as the plant followed the load demand. Penstock watering-up and unit synchronizing was accomplished automatically by the plant operators. The operation called for the intake gate to be opened by 200mm. to slowly fill the penstock. A limit switch attached to the wire rope hoist drum above the intake gate, signaled the 200mm. open position, where the opening gate paused until a float switch indicated a full penstock..

The upstream sealing intake gate well was large, with ample area for the air vent. The hoists were located on steel beams spanning the air vent, located just below the intake deck, and just above reservoir flood level. Access to the hoists was through a manhole in the large concrete hatch cover over the air vent shaft. Between each pair of intakes, there was a horizontal passage, just below deck level, leading to a 3m. by 4m. concrete air vent tower which terminated in an inverted “U” about 5m. above deck level. A bird screen covered the vent outlet.

The “burps” occurred when the gate opening limit switch failed, allowing the gate to open fully. The rush of water down the penstock trapped an air bubble and this bubble–water mixture then rose up the penstock and the air vent. The worst burp caused the air/water mixture to push the 15 ton hatch cover aside and discharge a large volume of water onto the desk, and from there water was directed to the dyke by a small toe wall around the intake deck. All burps had occurred in winter, at temperatures well below zero.

George then examined the intake in more detail. There was a heater adjacent to the limit switch, but events indicated that it was not adequate. On looking up the air vent tower between the intakes, George was astonished to note that there was no swinging flap in a 1.5m. by 3m. steel framed rectangular opening at the top of the tower. The flap, usually a sheet of marine grade plywood cut to fit the opening, suspended on double

acting hinges and weighted with a steel angle on the bottom, is used to seal off the vent to allow heat retention in winter. Further questioning indicated that the flap had never been installed. No flap = large heat loss = frost on limit switch = malfunction.

Lesson learned.

The powerplant intakes had operated without an air vent flaps for about 25 years. The location of the air vent towers was such that there was no need to inspect the towers, and they were not near any equipment, hence the lack of a vent flap had not been noticed by either the commissioning engineers or the operators. From the outside, the bird screens concealed the flap location. A review indicated that the flap was shown on the construction drawings. Why they were not installed, was not determined. Bottom line – be certain that all components of the powerplant, however insignificant, are installed as shown on the drawings. Yes, vent flaps were installed.