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Lessons Learned

The Exploding Air Vent House

Nothing is more simple than an air vent at an intake. It's merely a passage to vent air behind an intake gate, with no mechanical systems. However, on occasion simplicity can be deceptive, as was found to be the case at a hydro plant several years ago.

This particular intake provided water to a steel pipeline over 5 meters in diameter and over 2 kilometers long down to the powerhouse. There was a surge tank along the pipeline about two-thirds of the way down to the powerhouse.

The pipeline had been dewatered for internal inspections, and the owner had taken this opportunity to carry out some maintenance on the intake headgate controls. When all the maintenance had been completed, the control technician, from the intake, telephoned the operations room in the powerhouse to advise that the pipeline was ready for filling. He then set off to walk down to the powerhouse.

After walking a few hundred meters, he heard a groaning noise coming from behind. He turned around just in time to see the aluminum siding of the air vent house collapsing inward. He started to run uphill back to the intake, but stopped when he saw the air vent housing explode with a large outrush of air and water from the intake concrete deck. When all was quiet, he walked up to the intake to find that everything else appeared normal, with the pipeline full of water.

Reconstruction of the event revealed that the technician had inadvertently left some bypass wires on the headgate controls, which rendered the stop at 10-centimeter gate open and the emergency gate stop inoperative. The normal gate opening sequence with the long empty pipeline is to open the gate by only 10 centimeters to allow a slow filling of the pipe. With this control ineffective, the headgate continued to open. The movement past the 10-centimeter open position was observed by the power plant control room operator, who then pushed the emergency stop button, but to no avail. The headgate continued to lift until it was fully open.

The effect on the pipeline was remarkable. The high velocity sheet of water emerging from below the opening gate entrained a large volume of air, causing the inward collapse of the air vent housing. As this water filled up the bottom of the pipeline it released the entrained air, which formed a large bubble, still trapped down the pipe by the incoming water. As the pipe filled, the trapped bubble and entrained air-water mixture started to travel up the pipeline, to emerge with explosive force through the air vent.

The lessons learned: First, it is preferable to fill a long empty pipeline using the manual controls at the intake, not the remote control. In this incident, the gate opening could have been stopped by opening the main electric power breaker switch, which would have resulted in the gate reversing direction and closing, since the wire rope hoist on the gate was designed to drop the gate on loss of power, with the closing speed controlled by a fan brake.

Second, some thought should be given to the intake design. There ware two types of headgates commonly used in an intake, which can be equipped with either upstream or downstream skinplates and rubber seals. An upstream sealing skinplate gate is installed in a large opening downstream of the gate headwall. This opening also forms the air vent. In such a design, the incident just described could result in the gate being lifted clear of the intake by the upward rushing mixture of air and water, and thrown on to the intake deck. Repairs could be expensive and the turbine could be out of service for several weeks. With a downstream sealing skinplate gate, the gate is installed in an opening upstream of the headwall. The air vent is a separate passage built downstream of the headwall. This is a safer layout because, in the event of an accident similar to the one described here, the uprushing air-water bubble will not have any effect on the gate. Fortunately, this was the intake layout used at the power plant, and the damage was limited to the air vent house. The air vent house was quickly rebuilt, and the turbine did not need to be removed from service for repairs to the gate.

Third, although obvious, remember to remove any temporary bypass wires on controls before returning the control to service.

—By James L. Gordon. Please send your stories of events, both serious and amusing, to HRW *so that we can all learn from — and hopefully avoid — accidents, errors, and omissions in future hydro-related work.*