Disregarded yellow warning light.

The single unit, medium head powerplant had been operating without a significant outage for over 30 years. However, freeze-thaw deterioration of the concrete dam at waterline had reached a level where repairs were needed. Plans were made to draw down the headpond by about three meters, or one meter beyond the maximum drawdown, in order to provide a dry surface for the repair contractor. The hydro plant included a concrete dam, a short earth canal which terminated at an intake and an abandoned log chute. (For many years, the river had been used to raft logs down to a paper mill, but this had been replaced with a truck and road transport system) After the intake, there was a long, almost horizontal wood stave pipe to the crest of a hill, where the pipe changed to steel. About one-third way down the hillside a large differential surge tank provided waterhammer control for the 50MW powerplant.

The headpond was drawn down and the contractor started the repair work. After a few days, a yellow warning light in the control room a few kilometers from the plant, started to flash on and off intermittently. The light was wired into the intake differential water pressure gauge, and was indicating that the pressure differential across the trashracks was in excess of about two meters. The new operator queried his supervisor about the light, and was instructed to disregard it, since it had a tendency to flash. A few days later, the light became continuously lit, indicating that intake trashrack differential pressure was now constantly in excess of two meters. A short time later, there was a minor surge on the system and a drop in turbine pressure followed by unit shutdown initiated by differential pressure across the trashracks exceeding 4 meters. An operator dispatched to the plant phoned in to report that the long, large woodstave pipe had collapsed and that the spilling water had severely eroded the access road to the powerhouse.

An investigation of the accident revealed that the pipeline hydraulic gradient was one pipe diameter (5.5 meters) above the woodstave line when operating at full load at full reservoir and this head dropped to only 3.5 meters when the headpond was lowered 2m. to low supply level. In order to keep a woodstave pipe round, internal pressure should be at least one half pipe diameter and preferably one pipe diameter above the pipe. The design just met this criterion. However, by drawing the headpond down by 3m., there was only 1.5m. of pressure on the pipe at full load. At the instant prior to the collapse, the plant was operating at about 90% load, and minimum pressure was just over 2m.

The flickering yellow light indicated that there was a head loss of 2m. at the trashracks, lowering the pressure further on the pipe to around zero. Any surge on the turbine would cause the pressure to fall

below the top of the pipe initiating a collapse, as happened. The large head loss at the trashracks was caused by "deadheads" - waterlogged timbers from the old logging work resting on the floor of the canal to the intake, picked up by the swifter current at the low drawdown and transported onto the trashracks. Fortunately, woodstave pipe is forgiving, and over 90% of the wood staves were reused in the rebuild, which required some four months.

Lessons Learned.

Warning lights should not be ignored. Also, in this case, the operators may not have been aware of the critical low pipe pressure at the three meter drawdown, where any head loss at the trashracks would compromise pipe safety. When operating outside designated drawdown limits, a review of pipe hydraulics should be undertaken.