Reading and Maintenance Instructions for Hydrostatic Pressure Indicators

Hydrostatic Pressure Indicators were development concurrent with the Water Level Indicator (WLI) by the Bureau of Reclamation. The HPI (hydrostatic pressure indicator), a modification of the Goldbeck cell, was designed and installed in several dams. The instrument was designed to be installed in new embankment dam construction. It was planned to be installed as the embankment was being built so that construction pore water pressures could be obtained. Problems arose with the design and the instruments had to be installed in drill hole after most the dam was constructed. A typical example is the HPI installation is at Caballo Dam installed in1938 and 1939. Details of the pressure transmitting and recording elements of the instrument are shown on drawings 40-D-5642 and 40-D-5643. The contact element used in the indicator is a cylindrical brass shell with a thin gold-plated monel-metal diaphragm mounted in its base. This diaphragm is secured and protected by a locknut and filter stone placed in front or the end of tip that contacts the embankment and protects the diaphragm. This filter stone keeps out the embankment soil and permits the pore pressure to act on the diaphragm. The transmitting element consists of a copper tube through which an electrical lead wire has been threaded. This wire is soldered to a contact point in the top of the indicator in the terminal box. A similar contact point is fixed to the diaphragm.

The recording test set uses a combined pressure and electrical system. It consists of an air pressure tank, tire pump or a prefilled gas tank, Bourdon-tube gauge, battery, light, and valves and couplings. The recording apparatus or test set is coupled to each air hose tee located at the system in the terminal box on the crest of the dam. The electrical connection and battery are also attached to the wire terminal at the same indicator as the air hose. The light on the test set should light called the “make”. To read the HPI, air is pumped into the copper tubing which is embedded into the embankment. Air passes down the copper tube reaching the indicators tip where the pressure is applied against the diaphragm. When the light on the panel of the test set goes off, the air pressure in the system has reached or has become equal to the pore-water pressure at the indicators’ tip elevation. This is called the “break”. Successive “make” and “break” contacts determine the pressure at the indicator’s tip which is read directly from the test set’s Bourdon gauge in feet of water.

Several problems were found with the HPI instrumentation: It was not rugged enough to withstand normal long-term field operations. The thin metal diaphragm was easily warp or even ruptured when excessive air pressure was applied. Flushing procedures for de-watering the air removing water contained in the air being pumped into the system became rather complex. Galvanic cell reactions between the gold and the copper tubing and the brass shell and the lead solder could corrode and destroy the diaphragm. Moisture from the compressed air introduced into the system could condense above the diaphragm and invalidate the readings. The instrument was costly to manufacture because very accurate machining of the operating parts, particularly the diaphragm, was required. Each instrument had to be manufactured independently after ordering, thereby hampering availability. Measurement of pore-water pressures during construction could not be obtained in early USBR installations because the instruments needed to be installed in holes drilled into the embankment after the dams were completed.

Despite the problems encountered with the HPI, it was found to be very sensitive and has performed well. After 15 years of service, approximately 70 percent of the HPI's that had been installed were still operating, and with proper care in usage, a few of the installation are still in service today. Some site however, did not receive this necessary care and only a few sites remain in operation. Several accessory elements, such as the housing, have now been improved with the development of a weatherproof terminal box with drains, a terminal board for the tube ends, and steel covers. With careful redesigning, the HPI could have been developed into a more rugged, yet still accurate, instrument.

One system has a digital pressure gauge added to the test set it for taking readings. To take readings using this pressure gauge follow these instructions.

1. Push on button on the gauge, than push zero button wait for unit to zero.
2. Only zero gauge when there is not pressure applied to gauge.
3. Pressure up HPI as normal.
4. Take Break and Make readings as always.
5. When finished taking readings, push the on button which will turn off the pressure gauge.
6. If during a HPI reading cycle the pressure gauge turns off, push the on button again and it will turn. You don’t need to zero the gauge again during this process.
7. When finished taking readings turn off gauge to save battery.

c. **Maintenance** – There is little to no maintenance can be performed on the instruments installed within the structures. The only maintenance required is for the test set and at the external connections.

The test set should have its pressure system checked yearly for leaks and it pressure gauge calibrated every three years. All pipes, connections, and valves have been tested for tight seals and sprayed with lacquer to resist corrosion. Quick connects should be kept clean and free of dirt buildup.

Gauges should remain maintenance free. Keep the windows clean for ease of reading. The pressure gauges require being set in the horizontal position when readings are being taken or the zero of the gauge with change a little bit affecting your fail pore pressure readings.

Leaks are the most common problem in a HPI system. Once a leak is located, repairs can be completed or the faulty part replaced. To locate leaks, erratic gauge readings, rapid depletion of the gas supply, or unusual noises usually indicate the presence of a leak. Locating leaks may be done by using a liquid leak detector. We recommend Snoop Liquid Leak Detector, manufactured by NUPRO Company. Place the liquid leak detector on potential leak locations and look for bubbles. Most common places for leaks are at fitting junctions, connecting lines, valve stems, and quick connects seats. Repairing fittings, leaky fittings are repaired by retightening or replacement if cracked or broken. Use a pipe sealant or Teflon tape when retightening pipe fitting joints. Tube fittings can be sealed by tightening a quarter turn or until resealed. Do not over tighten tube fittings. Valves in the test set should be replace since most of these valves are very old the valve packing can’t be changed and replacement is the only option.

One maintenance item that will be required with the new digital pressure system is a battery replacement. The gauge is manufactured by Cole-Parmer which is 0-100 PSI, Battery Powered Gauge which

uses a 9-volt battery. To install a new battery, turn gauge face one half turn, remove top screw and battery cover, and install a new battery. Battery should last 100 hours on continuous readings.