23.0 INSTRUMENTATION

23.1 General

Instruments are employed to monitor the performance of the foundation and the structure during and after construction. In general, they are installed on major structures particularly where unfavourable phreatic conditions and/or foundation and structure movements can adversely affect the long-term performance of the facility.

The instruments must be consistent with those being employed by the Province, which have a proven record of accuracy, reliability, and longevity.

Proper installation requirements normally include location of instruments and leads by survey, calibration and testing, identification and marking of the leads, protection of the instrument and leads particularly during backfilling or encasement in concrete, and mounting the leads in a panel box (vandal proof).

In cases where the instruments may be damaged by construction equipment, the use of heavy duty fabricated steel or precast concrete barriers should be considered. Where the instrument leads are susceptible to damage during construction or backfilling, the use of rigid PVC or other conduits should be considered.

23.2 Geotechnical Instruments

Geotechnical instruments used to monitor the performance of the foundation typically include standpipe and pneumatic piezometers, extensometers, inclinometers, and thermistors. Other geotechnical instruments that have been used in specific projects include vibrating wire piezometers, rebound points, and various settlement measuring devices.

Standpipes are normally used to monitor groundwater conditions, and are used wherever practicable since they are easy to install and read. Pneumatic piezometers are normally used to monitor pore water pressures in foundations and embankments. Care is required to protect the pneumatic peizometer leads since they are prone to damage during installation. Vibrating wire piezometers are used for automated monitoring of pore water pressures.

Extensometers are usually used to monitor foundation movements directly beneath the structure such as settlement, heave, and lateral displacements.

Inclinometers are primarily used to monitor lateral movements in the foundation, particularly along weak seams between stratigraphic layers. Currently, inclinometer casing manufactured by Sinca is being used since it has provided the most satisfactory performance for deep, long-term installations. Careful consideration is required in ensuring that the diameter of the slope indicator casing is large enough to accommodate the long-term movements that may occur. The inclusion of collapsible couplings and settlement rings as part of the inclinometer installation should be considered where

settlement is anticipated.

Thermistors may be used to monitor ground temperatures below the structure.

Temperature monitoring is also a useful indicator of water migration.

In general, the use of rebound points to measure rebound has not been very successful because of the difficulties associated with obtaining a precise installation, taking readings within the level of accuracy required, and protecting them from damage during construction.

23.3 Structure Instruments

Structure instruments that have been used by the Province to monitor the performance of structures include the following:

- Survey markers to monitor displacements.
- Measurement pins to monitor displacements across expansion or contraction joints.
- Vibrating wire joint meters to monitor movements at expansion joints.
- Vibrating wire instrumented rebar to monitor stresses within the reinforcement.
- Vibrating wire strain gauges to monitor stresses within the concrete.

In general, survey markers should not be relied upon to provide an accurate measurement of structure displacements unless a sufficient number of reliable survey control monuments are located in close proximity to the markers.

Where survey markers are used for monitoring horizontal positioning, it is preferred that threaded studs that can readily be used to mount a total station or survey prism be provided at the control monuments and measuring points, respectively, in order to obtain more reliable data on a consistent basis.

In general, the use of measurement pins, joint meters, or strain gauges should be considered at expansion joints where long term movements may result in closing of the joint and the development of compressive forces that could damage the concrete (spalling) or affect the stability of the structure components. An example would be the expansion joint between the steep chute section and the stilling basin of a chute spillway.

23.4 Other Instruments

A measurement weir (e.g. galvanized steel weir plate) is commonly used to monitor seepage flow at a particular location. Proper location and installation of the measurement weirs are required to

exclude or minimize the influence of surface runoff due to rainfall or snowmelt.

In cases where seepage is collected by drainpipes that discharge into manholes or onto riprap, the outlet ends of the drain pipes should extend sufficiently past the wall of the manhole or riprap so that seepage flows through a specific drainpipe can be measured using a calibrated bucket and stop watch.