ENCLOSURE 3

1.0 Single Failure Evaluation of Common Instrument Sensing Lines for the RPS Overpower Trip Based upon Reactor Coolant Flow and Axial Power Imbalance

1.1 Reactor Coolant Flow Instrumentation

In each primary loop, reactor coolant flow is detected by measuring the ΔP developed across a flow tube that is an integral part of the outlet piping of the loop. As illustrated in Figure 1, each flow tube has a high pressure (HP) tap and a low pressure (LP) tap. As illustrated in Figure 2, connections to the taps are made with 1-inch lines. The 1-inch lines are terminated at root valves located inside the secondary shield wall. From the root valves, 1/2-inch tubing runs through the secondary shield wall to HP and LP headers. Four (4) ΔP transmitters are connected between the two headers. These transmitters provide flow information to: the reactor protective system, the operator with flow indication and alarms at the control console, and the ICS.

Each of the four (4) reactor protective system channels receives a ΔP signal from a different one of the four ΔP transmitters. In other words, one transmitter is exclusively assigned to one (1) protective channel. The identical arrangement and assignment of transmitters is used for each of the two (2) primary reactor coolant loops.

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Within each reactor protective system channel, the square roots of the ΔP signals from each loop are extracted to obtain loop flow signals. The loop flow signals are summed to obtain a total reactor coolant flow signal. The four (4) flow signals are displayed within the channel's cabinets and monitored by the plant computer.

The reactor operator can read the individual loop flows and total flow at the control console, within each reactor protective channel cabinet, and from the plant computer.

1.2 Failures Considered

The following failures are considered:

(a) Break in one of the 1-inch instrument lines.

(b) Break in one of the 1/2-inch instrument lines.

(c) A leak in one of the instrument lines.

(d) Plugging of instrument line between the flow annulus and flow transmitter.

1.2.1 Break in 1-inch Instrument Line

A break of a 1-inch instrument line will result in a reactor trip due to low RC pressure. If the break occurs in a HP line, the reactor will trip due to a high power/flow ratio if the power/flow limit is exceeded.

The operator will receive at least the following alarms and indications:

Alarms

(1) Break in 1" HP Instrument Line

(a) Low RC loop flow

(b) Letdown storage low level

(c) Pressurizer low level

(d) Low reactor coolant pressure

(e) Plant computer alarm and printout for low RC pressure

(2) Break in 1" LP Instrument Line

Identical alarms as listed for HP line break except RC flow is not alarmed on high value.

Indication

(1) Break in a 1" HP Instrument Line

(a) Control room indication of the reactor building atmosphere particulate and gas radioactivities increases.

(b) Loop flow indication on console falls to zero.

(c) Loop flow indication in each RPS channel falls to zero.

(d) Total flow indication on console falls to approximately 50%.

(e) Total flow indication in each RPS channel falls approximately 50%.

(f) Makeup flow goes higher than normal.

(g) RC pressure falls on console indicators and within each RPS channel.

(h) Reactor building pressure and temperature indication rises.

2. <u>Break in a 1" LP Instrument Line</u>

Identical indication as listed for HP line break except all loop flow indication goes full scale, total flow indication increases above normal.

1.2.2 Break in a 1/2-inch Instrument Line

A break of a 1/2-inch instrument line will result in a reactor trip due to low RC pressure. If the break occurs in a HP line, the reactor will trip due to a high power/flow ratio if the power flow limit is exceeded.

The operator will receive the same alarms and indications as described for the 1-inch instrument line break.

1.2.3 Leak in One of the Instrument Lines

If a leak occurs in either the HP or LP lines, the full RC pressure will rapidly increase the release rate to that of the break discussed above. In addition, if in the unlikely event that the leak rate did not progress to a break condition, the reactor building radiation monitors will readily detect activity levels resulting from leakage in excess of 1 gpm and result in leak evaluation, and subsequent action as required by Technical Specifications. In the unlikely event the radiation monitors did not detect this leak, the operator would observe a change in indicated flow when he performs a required flow indication comparison between expected and actual indication as required by Surveillance Procedure SP-300.

Depending on the size of the leak, alarms and indication described in Paragraph 1.2.1 may occur.

1.2.4 Plugging of Instrument Line Between Flow Annulus and Flow Transmitters

The probability of any mechanism which could completely block one of these lines is at least several orders of magnitude less than that of a break or leak. The reactor coolant system is a very clean system and is continuously filtered to assure that no significant particulate matter is circulated. The boric acid in the coolant is in concentrations about a factor or two below the boric acid solubility limit at 70° F. Therefore, no boron precipitation would occur within the reactor coolant system. The entire flow monitoring system is essentially stagnant because it is a pressure - sensitive device, and, as such, there is no free exchange of fluid between the reactor coolant system and the sensing lines to induce material into these lines to cause plugging.

If the assumption is made that a sensing line became blocked, the following indications, alarms, and surveillance procedures would enable the operator to detect such a failure in the flow instrumentation.

Indication and Alarms

The reactor coolant loop flow indication with a plugged sensing line are sensitive to reactor coolant system pressure fluctuations. The pressurizer heater control loop has a design control band which produces a reactor coolant system pressure cycle of about 35 psi with a period of approximately 10 minutes during steady state operation. This pressure cycle has no effect on the reactor coolant flow indications when imposed equally upon the high and low pressure sides of the flow transmitters. However, in the event that the high or low pressure sensing line becomes plugged, the pressure cycle (35 psi) is imposed on only one side of the Δp flow transmitters and the resulting flow indication will shift approximately 1.4×10^6 lbs/hr for every lb. of reactor coolant system pressure change. This shift in flow indication will provide the operator with identical flow related indication and alarms as that listed for the case of a line break (see Section 1.2.1).

Plant Surveillance.

(1) In accordance with Plant Technical Specifications & Surveillance Procedure SP-300, the Operating Daily Surveillance Log must be completed each shift and daily while the unit is operating in Modes 1, 2, 3 or 4. As part of the surveillance required by the daily log, the operator must record the indicated reactor coolant system flow and compare it against the required flow corresponding to the number of R.C. pumps in operation and also compare it against readings taken at earlier shifts to determine deviations.

(2) Following each calibration of the RPS Reactor Coolant Flow sensors during refueling, the response time of the reactor coolant flow protection channel must be verified. This response time testing of the reactor coolant flow system would provide additional indication of pluggage within sensing lines, as pluggage would alter the response time measured.

1.3 Conclusion

The conclusion of this analysis is that the operator has adequate indication and alarm facilities to quickly recognize a common mode failure in the flow instrumentation for the reactor protection system. Corrective action would therefore be positive and prompt, in order to preclude reactor operation outside of acceptable limits described in the Plant Technical Specifications. For these reasons, modifications to the pressure sensing lines to the reactor coolant system flow differential pressure transmitters is not required at this time.

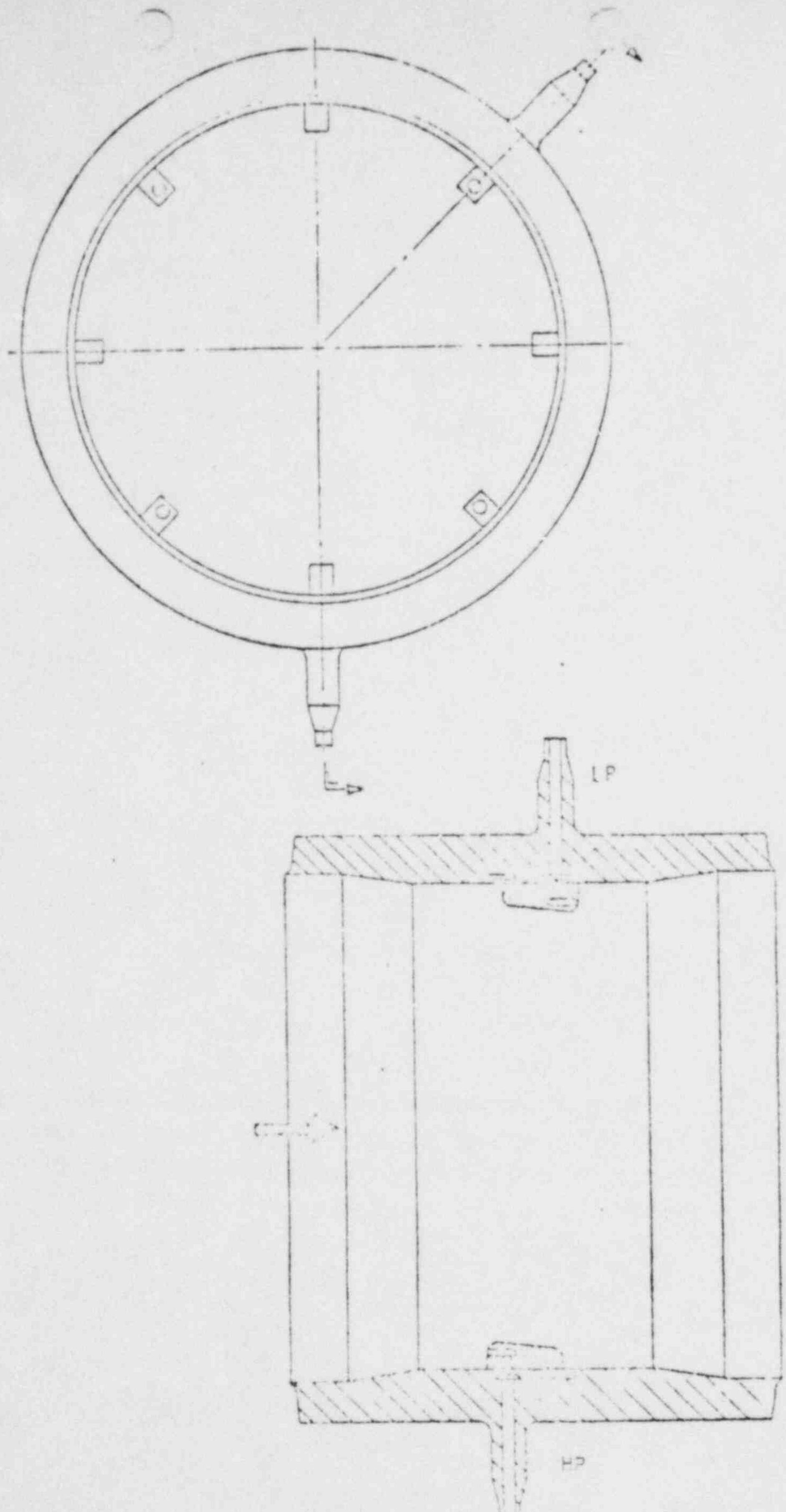

Figure 1

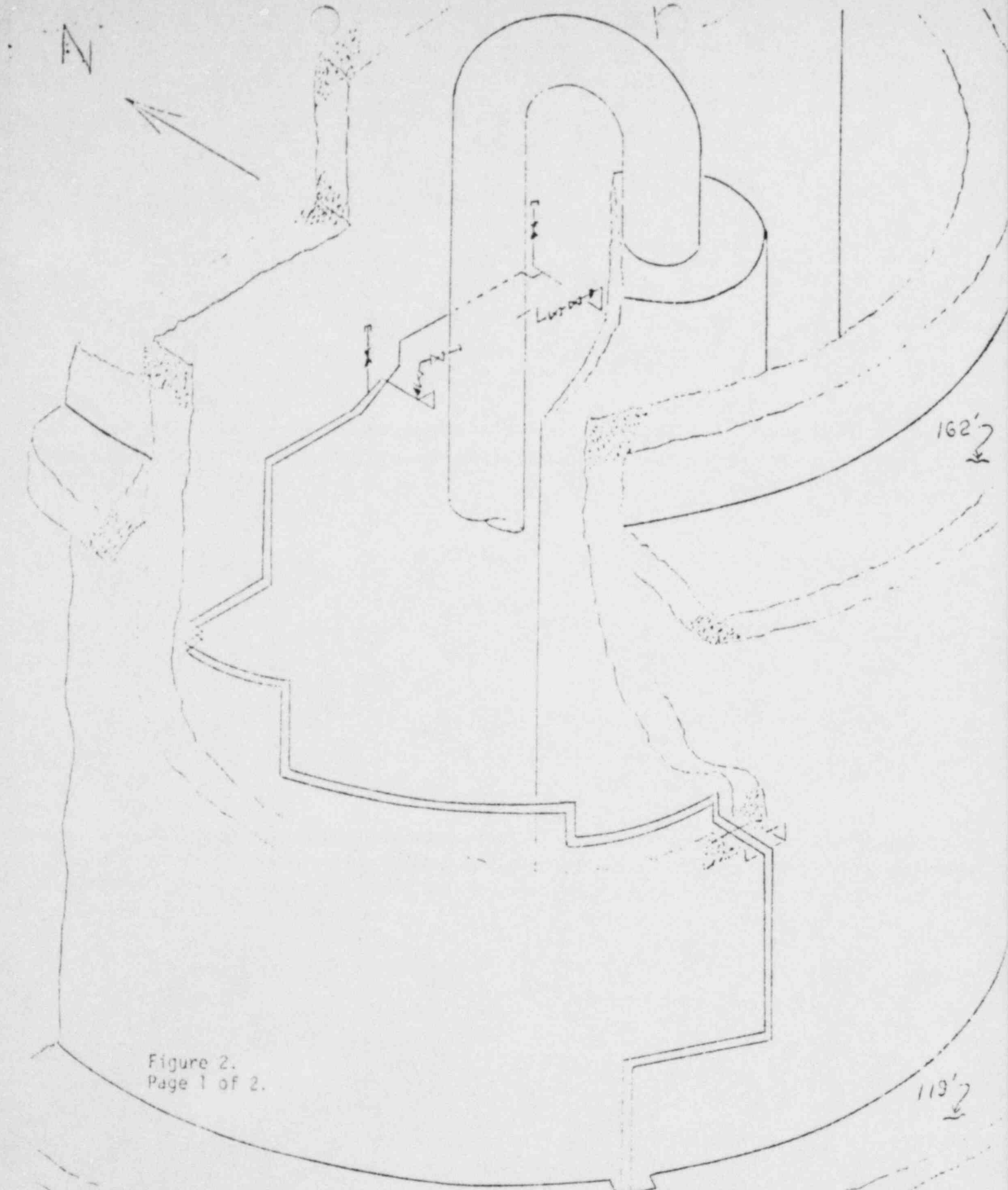

Figure 2.
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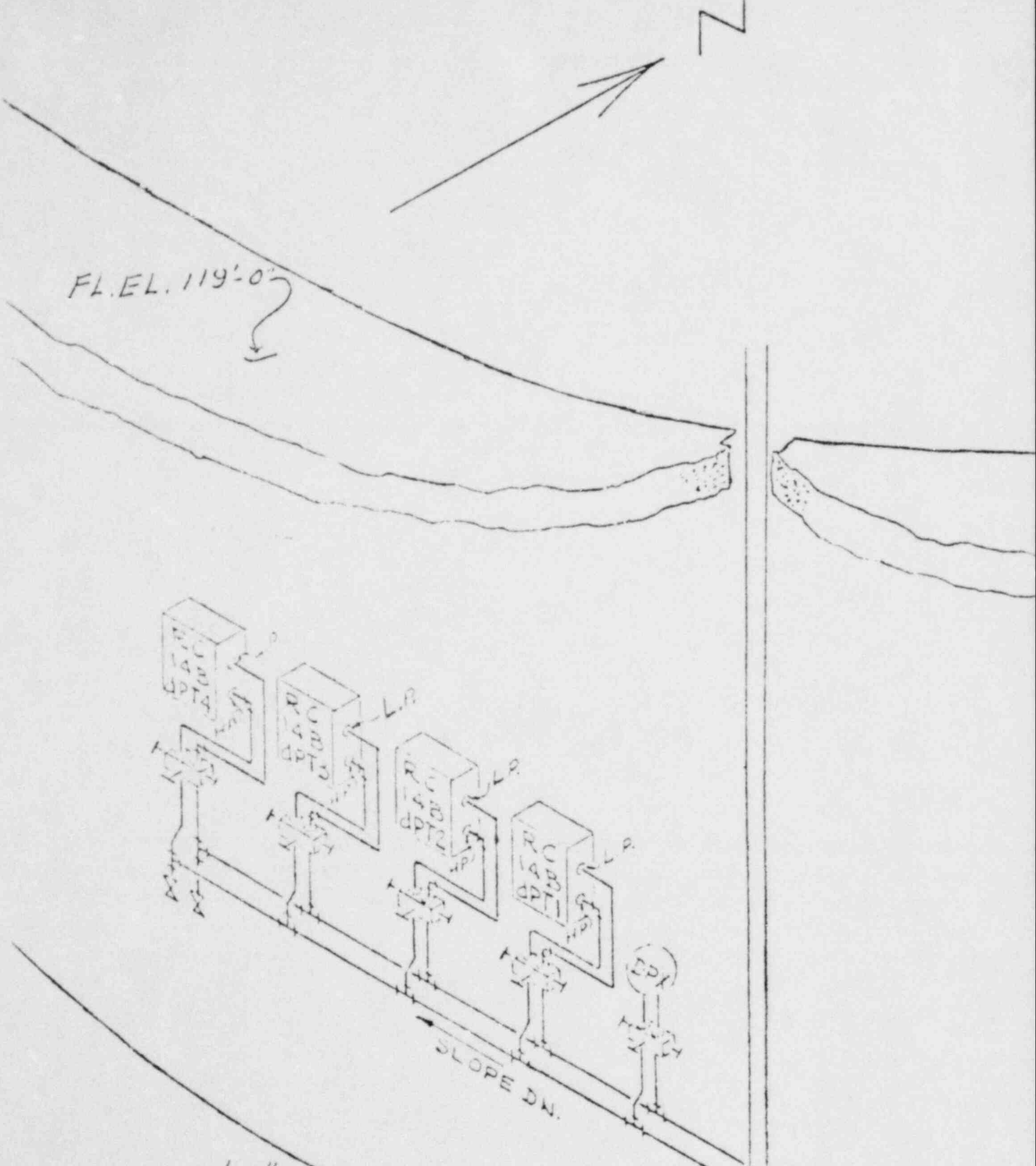

Figure 2.
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South "X" Station

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