CONTROL EQUIPMENT

A state variable describes the current state of a particular system. The typical state components for a water distribution system include pumps, pressure regulating valves and control valves. A brief description of both the instrumentation and control equipment associated with each of these components is provided in the following sections.

Pump Stations

Figure 1 shows typical pump station controls and instrumentation. Field equipment usually consists of fixed speed pumps, pressure transmitter. Control equipment usually consists of a Motor Control Center (MCC), local control panel and control system Remote Terminal Unit (RTU).

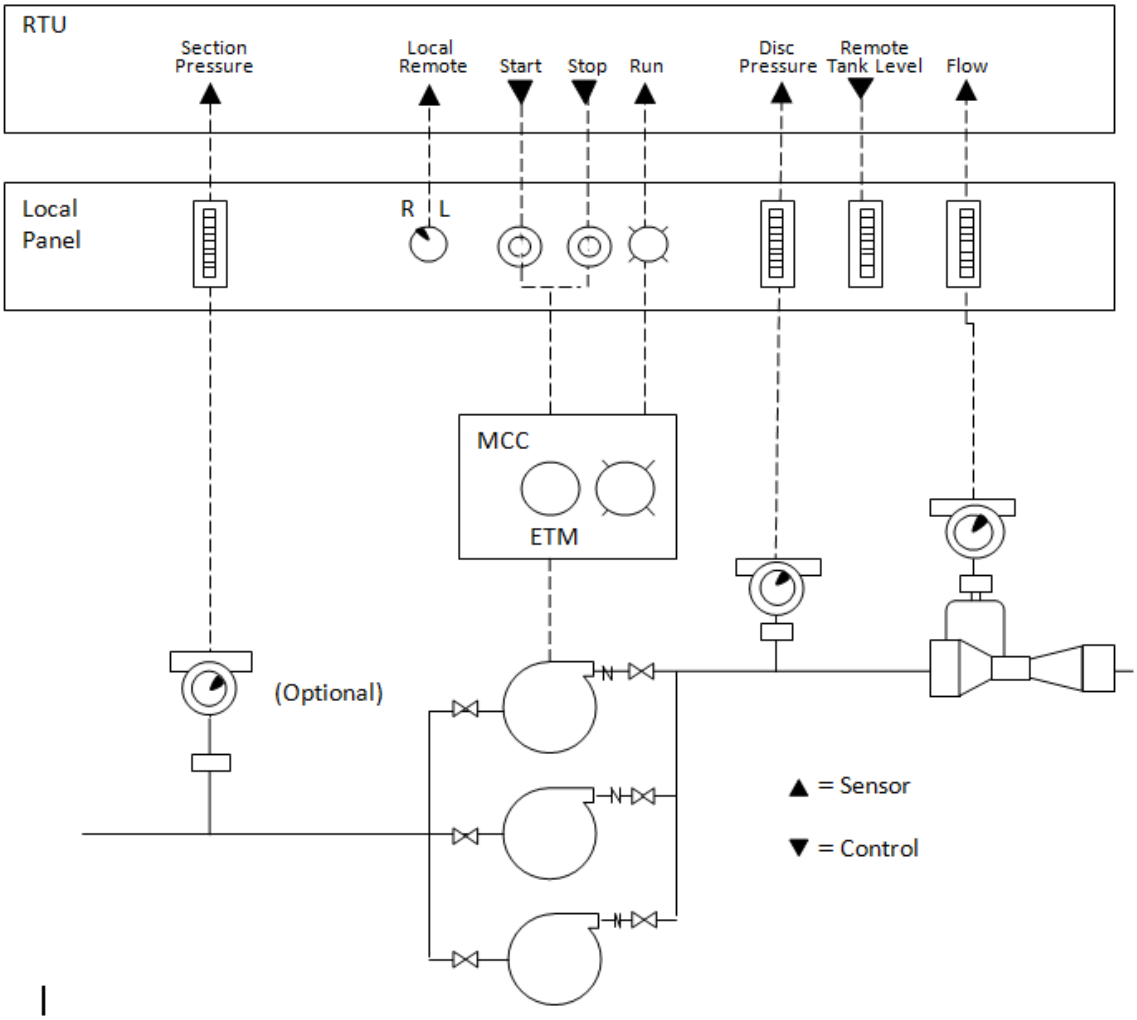

Figure 1. Typical pump station controls and instrumentation

Control Field Instrumentation for Pump Stations

Pump stations are normally equipped with pressure and flow transmitters. Some stations are also equipped with a suction pressure transmitter. Venturi flow tubes equipped with a differential pressure transducer and DC Magnetic flow elements are used for pump station flow transmitters. Both produce a 4-20 ma signal proportional to flow when coupled with the appropriate transmitter. Pressure transmitters produce a 4-20 ma signal proportional to measured pressure. Most pump stations are also equipped with additional building safety instrumentation including intrusion alarm, fire alarm low temperature (freezing) alarm, and building flood alarm.

The motor control center is the electrical switch gear that applies high voltage (480v) power to the pump motors. The switch gear is activated by low voltage (110v) control circuits in the local control panel, allowing the RTU or panel pushbuttons to operate the pumps. The motor gear is engaged. This contact is used to indicate run status to the RTU and operate panel run lights.

The local control panel provides a means of manually operating the pumps independent of the RTU. It is used for emergency or maintenance operations only. The local panel also provides a common wiring and termination point for the pump motor control circuits. The panel usually includes a remote/local switch, start pushbutton, stop push button and run light for each pump. When the remote/local switch is in remote, the panel controls are locked out and the RTU operates the pump. When the remote/ local switch is in local, the RTU is locked out and the local panel start and stop push buttons are operational. The local panel also provides a remote/local status contact and run status contact to the RTU. The local panel often includes panel indicators for flow and discharge pressure to assist the operators in running the station manually (when necessary). If the station is pumping to a remote tank, the panel may include an indicator for tank level.

The RTU provides normal automatic pump station control. It also transmits pump station monitoring information to the central control center. The RTU monitors station flow, discharge pressure, suction pressure (if used), remote/local status of each pump, and run status of each pump. The RTU outputs start and stop signals for each pump and outputs a 4-20 ma signal for remote tank level indication if needed.

Pressure Reducing Valves

Figure 2 shows typical PRV controls and instrumentation. Pressure reducing valves (PRVs) are hydraulically operated globe valves that automatically modulate to maintain downstream pressure at a setpoint. The downstream pressure setpoint is adjusted via a pilot valve by turning a screw to vary the pilot valve spring tension. Within the framework of a remotely controlled water distribution system, PRV pilot valve settings can be adjusted using a motor operated pilot valve assembly. Field equipment associated with the PRV may include a motorized pilot valve, high and low side pressure transmitters and a flow transmitter. Control equipment consists of a small local control panel and RTU.

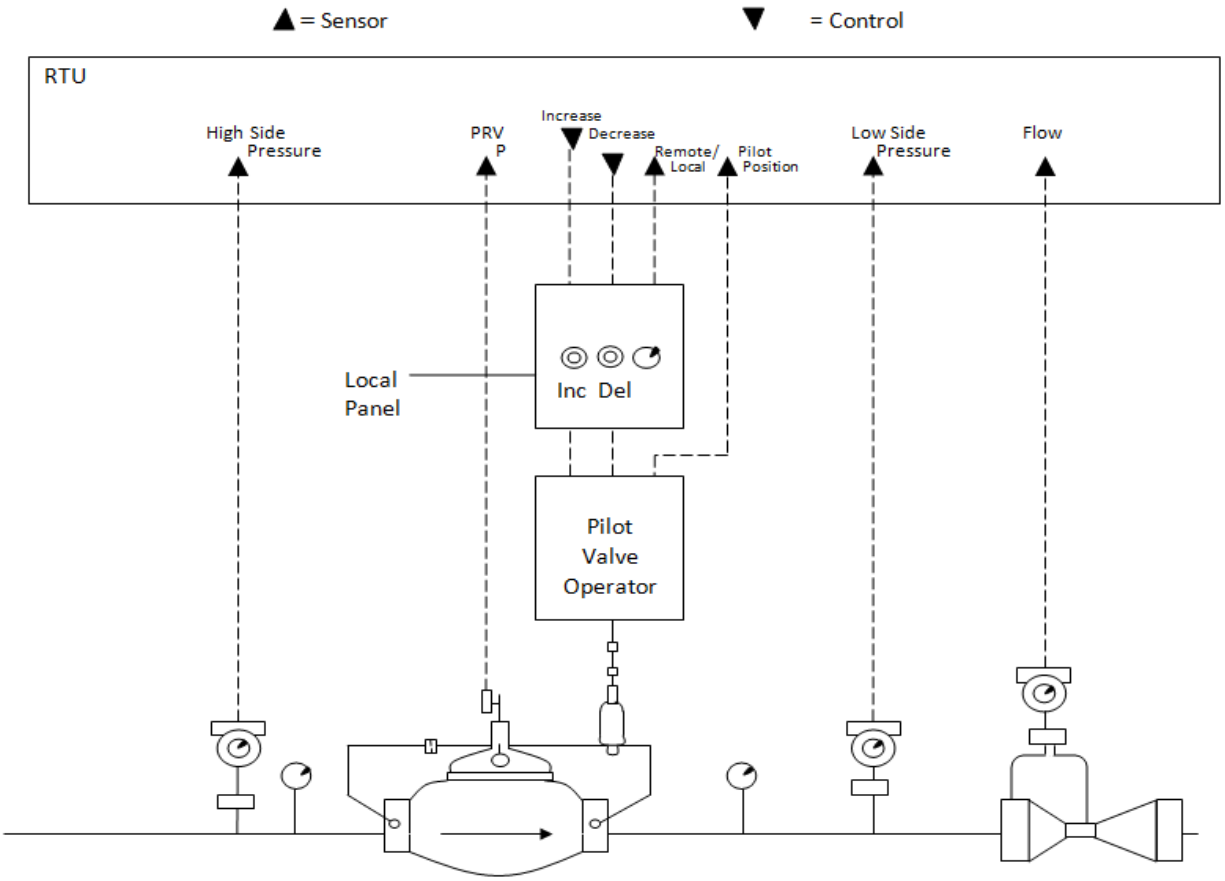

Figure 2. Typical PRV controls and instrumentation

PRV Field Instrumentation

PRV sites are always equipped with upstream (high side) and downstream (low side) pressure transmitters. The PRVs are also usually equipped with mechanical gauges for upstream and downstream pressure. PRV sites often include a flow transmitter to measure zone to zone water transfers, allowing water utilities to calculate consumption on a zone by zone basis. Venturi flow tubes are used almost exclusively in this application. The PRV is usually equipped with a valve stem position transmitter to aid the operators in verifying proper PRV operation. Site safety instrumentation; including power fail alarm, intrusion alarm, low temperature alarm and flooding alarm; is usually provided.

PRV Control Equipment

The pilot valve operator is a simple reversing motor and gear assembly identical to the operators used for small control valves. It usually includes a pilot valve position transmitter to aid the operators in verifying proper pilot valve operation.
PRV sites are equipped with a small local control panel for maintenance and emergency

operation. The panel includes a remote local/switch, increase pushbutton and decrease pushbutton. When the remote/local switch is in local, the RTU is locked out. The pilot valve motor will increase the pressure setpoint as long as the increase pushbutton is being pushed and vice versa for the decrease pushbutton. When the remote/local switch is in remote, the local push buttons are locked out and the RTU operates the pilot valve motor.

The RTU monitors high and low side pressure, flow, PRV position, pilot valve position and pilot valve remote/local status. The RTU operates the pilot valve using increase/decrease contact modulation outputs. The RTU has increase/decrease contacts which are equivalent to the increase/decrease pushbuttons in the local panel. The operator enters a desired pressure increase in psi and the RTU activates the increase contact for the correct amount of time based on the pilot valve adjustment range and the valve operator travel time. For example, a typical motorized pilot valve has a 30-300 psi adjustment range and is geared for 270 seconds full travel. This equates to 1 psi of adjustment per second of operation. If the operator desires a 5 psi increase, the RTU would activate the increase contact for 5 seconds. The increase/decrease contact interface provides fail safe operation by insuring the pilot valve will hold its last position if the RTU or communication fails.

Control Valves

Figure 3 shows a typical control valve installation with controls and instrumentation. Control valves are used occasionally in place of PRVs in gravity feed systems with large diameter mains. Control valves are usually standard motor operated butterfly valves. Field equipment includes the control valve, valve operator, high and low side pressure transmitters and a flow transmitter. Control equipment consists of a small local panel and RTU.

Control valves use standard valve operators which include a reversing motor and gearing valve operators typically include full open and full closed limit switches and a valve position transmitter. In this application, the valve operators are usually geared to provide a very slow travel time, sometimes as much as ten minutes for full (0-100%) travel. The slow travel time is used to minimize pressure transients in the network.

Control valve sites are equipped with a small local panel for maintenance and emergency operation. The panel includes a remote/local switch, open pushbutton and close pushbutton. When the remote/local switch is in remote, the pushbuttons are locked out and the RTU operates the valve.

The RTU monitors high and low side pressure, valve position, full open limit switch, full closed limit switch, and remote/local status. The RTU operates the valve using open/close contact modulation outputs. The operator enters a desired percent increase in valve position and the RTU activates the open contact for the correct amount of the time based on the valve operator travel time. This interface provides fail safe operation by insuring the valve will hold its' last position if the RTU communication fails.

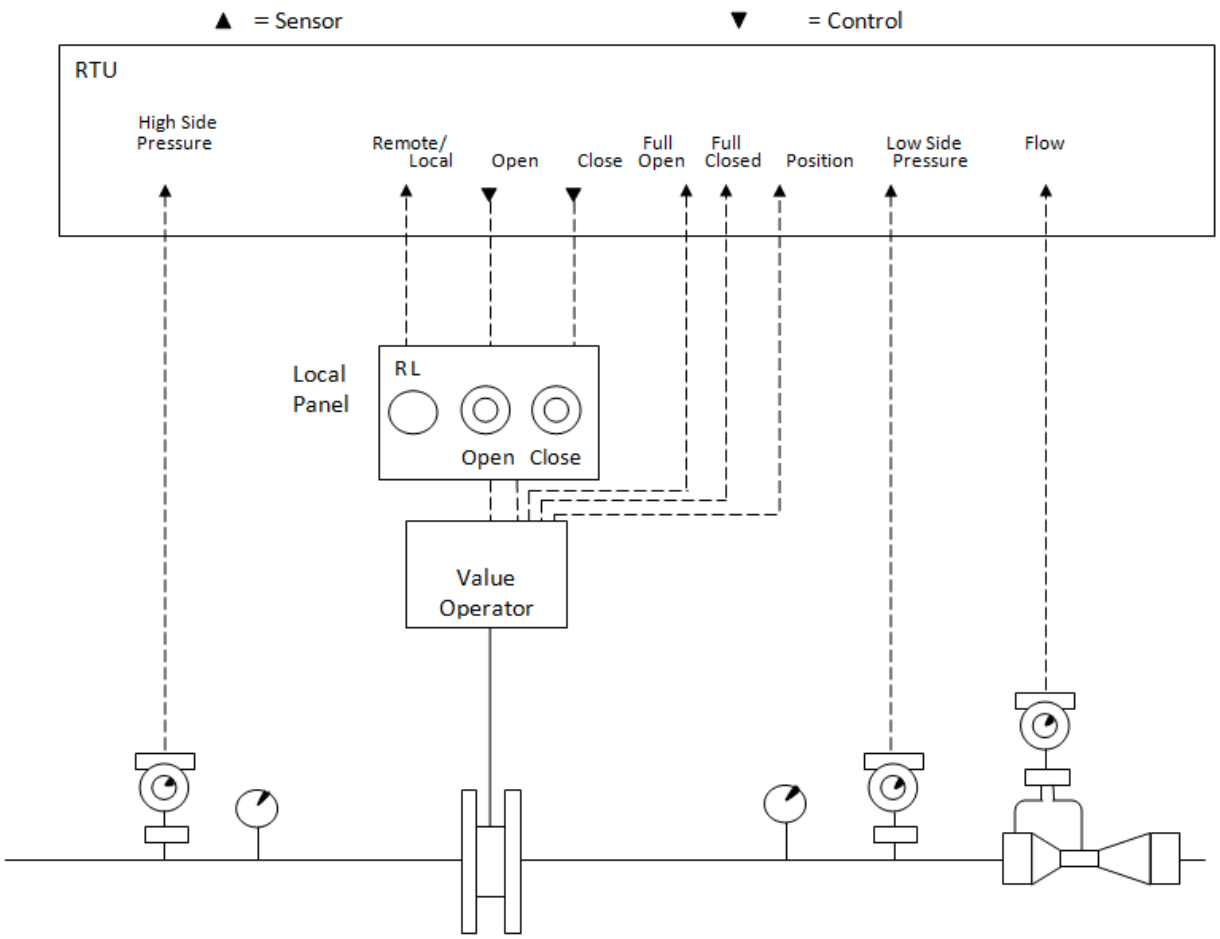

Figure 3. Typical Control Valve controls and instrumentation