SENSOR EQUIPMENT

All water distribution systems must be instrumented so that the state variables may be monitored and the state components may be controlled. The instrumentation required for such a task can be broadly grouped into two categories: sensor equipment and control equipment. Sensor equipment will include level, pressure and flowrate transmitters while control equipment will include such things as motors and electrical switches. Both the sensor equipment and the control equipment may be monitored and controlled directly from the water treatment plant or auxiliary pumping stations via a direct communication link. Alternatively this equipment may be monitored and controlled by several remote control stations out in the field (Christie, 1989). Remote control units can in turn communicate with the central plant.

Sensors and control units can be further classified on the type of signal they monitor or emit. The first type is referred to as *discrete*, or also called *digital*. A *discrete* sensor is a sensor that only senses two positions; "on" or "off". It cannot sense anything in between these two positions. Some consultants will refer to *discrete* sensors as *digital* sensors, because in the world of *digital* devices, either a "I" or "O" is used, which is why some people still refer to these devices as "I/O devices". The second type of sensor is an *analog* sensor. *Analog* sensors can sense and report back specific values in any given range of values. For example, if we wanted to sense temperature. A discrete sensor could tell the user if the temperature is freezing (32˚F) or if the temperature is boiling (212˚F). In the same example, an analog temperature sensor can report back any temperature in a broad range, say any temperature between 32˚F to 212˚F. Another example is a simple motor. A discrete sensor could tell the user if the motor was on or off, while an analog sensor could tell the user not only if it was on or off, but even how fast it was running. Discrete is simply "on" or "off", "open" or "closed", and so on, while analog can report back specific "how much" values in a pre-programmed range.

Most field monitoring instrumentation uses an AC current signal with a 4-20 ma output range for use in characterizing the low/high range of the measured parameter. Tank level transmitters and pressure are the most common type of field instrumentation used in monitoring applications. Tank level transmitters are usually very similar to pressure transmitters. The only difference is that tank level transmitters allow the calibration zero point to be raised so that the 4-20 ma output corresponds to 0-40 ft. equal to (for example) 100-400 ft. elevation above the transmitter. Pressure monitoring sites use the same pressure transmitters as pump stations, pressure reducing valves (PRVs), or control valve sites.

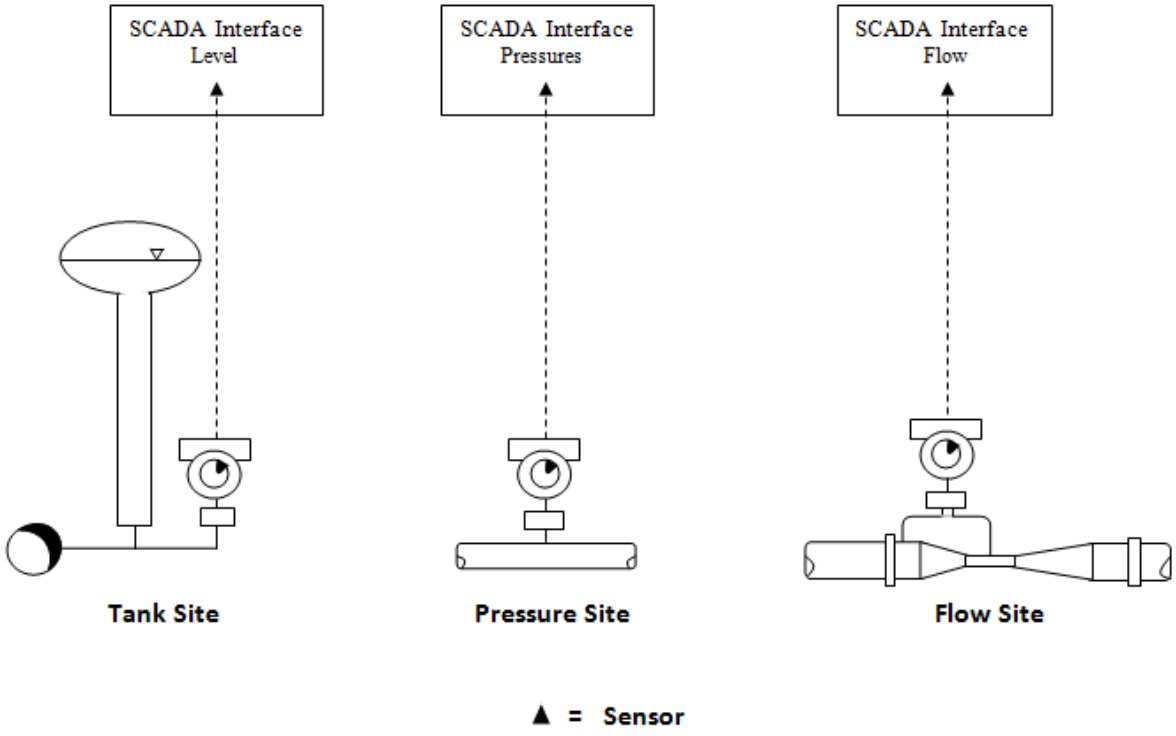
Flow monitoring sites typically use venturi flow tubes with a differential pressure transmitter and square root extractor to provide a 4-20 ma signal proportional to flow. Sometimes a turbine type meter is used which provides a pulse train output with each pulse corresponding to a fixed number of gallons. Usually tank, pressure and flow monitoring sites will have site safety instrumentation including intrusion alarm, flooding alarm, low temperature (freezing) alarm and power fail alarm.

At the time of this report, the top ten SCADA sensors currently in use, based on sales, are:

1. Temperature Sensors - The most basic way to monitor temperature is a discrete threshold sensor. This is very similar to a simple home thermostat. You set a high-point threshold or a low-point threshold (one per sensor). When these presets are exceeded, you get a contact closure alarm, which translates to a basic high or low temperature alarm. The downside to this type of alarm is that if your threshold was set to 80°F, you could be at 81°F or 181°F - and you would not be able to tell the difference. More advanced temperature sensors output analog values. Analog monitoring allows you to monitor fluctuating sensor levels at remote sites. With the right SCADA system, analog readings can be used to send alarms based on configurable thresholds. There can be different thresholds for low, critically low, high, and critically high.
2. Humidity Sensors - Often, humidity monitoring is overlooked, but it is one of the key environmental conditions to monitor in every unmanned remote site. Looking at both internal and external humidity ranges, it's very important to monitor what conditions your equipment is operating in. If your environmental control unit failed and you didn't have adequate monitoring of the humidity at your site, you would be completely unaware of the damage and would be too late in preventing equipment failure. Humidity can be monitored with both discrete and analog sensors, much like temperature. Some sensors monitor both temperature and humidity.
3. Motion Sensors -The most critical element of physical site security is being able to detect intruders and receive an immediate alert. Motion sensors provide instant information to react to an intruder before real damage is done. Discrete motion sensors can even turn on a light and send an immediate intrusion notification when movement is detected in its field of vision. It is very important to consider placement when installing motion sensors. Windows and other possible intrusion points should be protected by motion sensors.
4. Water (or any liquid) Level Sensors - Water level sensors can be used to monitor water towers, ground storage tanks and clearwells. This makes them especially useful for alarm circuits that may tell a motor when to turn on in order to keep a tower full. With a discrete liquid level sensor, you can configure the sensor to latch a contact closure when liquid level has fallen below a critical line. This allows a notification when water tanks are low. Analog sensors can be set up to measure any water level in the tank, rather than just the high and low levels.
5. Water Flow Sensors - Water flow sensors give an accurate picture of water flow rates *and* direction. Most flow sensors can monitor water with an internal flow meter or a flow data logging device. At a water treatment plant, water flow is one item on a long list of data that must be collected during the treatment process. It is important to find a reliable water flow sensor that produces accurate flow results and allows quick decisions based on that data. Water flow direction is also very important to water system managers to determine if "water racing" is occurring. Water racing is a phenomenon where water in a distribution system "races" around in circles. If this occurs, it is a huge waste of energy.
6. Smoke Sensors - Smoke sensors are critical safety devices needed in every remote facility site. There are many possible reasons a fire could break out at a site: overheated equipment, electrical short, wildfire, etc. Fires can cause irreparable damage and smoke sensors are a good first line of defense.

7. Door and Window Sensors - Unmanned sites are vulnerable. While you might expect this type of criminal activity from strangers, an alarming amount of damage is done by employees, ex-employees, and outside contractors. Door and window sensors keep equipment secure. You will know the moment someone tries to gain unauthorized access to one of your remote sites, or if an employee enters when they are not supposed to. Without the protection of a door sensor, an unknowing technician could walk into a dangerous situation. Door and window sensors provide a warning, "Hey, nobody's supposed to be there at 3 a.m.!"
8. Power Failure Sensors - The primary damage caused by a power outage is obvious: If commercial power fails and you don't have a reliable backup power supply, that site will eventually go dark. Dark sites mean network downtime, frustrated customers, and lost revenue. A power failure sensor will send an alarm when power is disrupted. This is a discrete sensor that outputs a contact closure when power is not detected for a user-defined amount of time. Most users want to receive a critical alarm after any failure lasting more than a few seconds.
9. Current Sensors - You must always know whether your battery chargers, backup generators, and other power sources are outputting power. Analog current sensors tell you way more than, "They're outputting power". You also need to know the current draw. Measuring AC/DC currents, current sensors isolate the sensor output from the conductor. These types of sensors are highly useful for motor drives, UPS systems, and battery supplies.
10. Propane Tank Sensors – Monitoring propane tanks can avoid running out of fuel or indicate theft. Some propane sensors send an audible alert when they are running low. At sites where propane is the only fuel source, you may need advanced sensors that track gas usage rates and report back to an on-site RTU with the exact amount left. These types of analog sensors allow you to order more propane for your tank - before it runs empty.

The typical types of data monitored from a water distribution system include: tank levels, flowrates, and pressures. Tank level, pressure and flow monitoring sites each consists of a single transmitter at an isolated location. Level monitoring should be required at all storage tanks. Pressure monitoring is required at key locations within the distribution system to make sure adequate service pressure is maintained everywhere. Stand-alone flow monitors are typically used to measure flow into or out of the distribution system from water plants or at transfer points with another water utility. The figure below shows typical instrumentation at tank, pressure and flow monitoring sites.



Typical instrumentation for level, pressures and flow monitoring sensors

Additional Information:

Hydraulic Sensors

Water Quality Sensors