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Rural Water Systems Automation and Telemetry: An Economic Advantage

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With the space age comes improved automation and telemetry equipment to assist rural water systems. Automation is the process or practice of utilizing a mechanical or electrical device to perform a simple, or series of simple, decision making or control functions. In many cases these functions have previously been performed manually, but not as efficiently as would be possible by automation.

Functions that can be automated in a rural water system include tank level recording, turning a pump on and off under preset conditions of pressure or water level, analyzing the chlorine residual in plant effluent, adjusting chlorine dosage to compensate for water quality changes, or actually operating a complete system from a distant location.

The most common reasons for automating control functions are as follows:

(1) To reduce manpower requirements.

(2) To reduce process costs by more precise control of operations.

(3) To initiate an alarm or other appropriate programmed action in case of a system malfunction.

(4) To have a continuous record of, and control over, a process regardless of time of day or weather conditions.

(5) To allow several remote but interdependent operations to be observed, and controlled from a central location.

(6) To analyze a situation against preset conditions and to react to system discrepancies in a faster, more precise, more accurate and more consistent manner.

Regardless of how well planned and controlled, an automated system is not failsafe. Automated devices do not think. They only respond to programmed instructions, or logic steps, put together by a person who like us cannot remember every detail or possible emergency. This one fact alone requires that any automated function be observed (or in shop talk, monitored) by operator personnel, so that if something

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goes wrong in the system and the control devices do not react, the service man can. This is done by dials, gauges, meters, and recorders. In a small rural water plant serving a number of widely spaced cluster wells it is fairly easy to group all the monitoring devices so that they can be observed by one man at a central location. Then, he can easily get to the controls if necessary and manually override the automatic system if it fails to perform the proper function.

Most rural water plants have their operations scattered over a wide area. Automating their control functions could eliminate the time and distance factors that consume available manpower to perform routine tasks. To do this it would be necessary to transmit information to a central location far removed from the actual operation. This process of transmission of information and control data over a distance is known as telemetry.

Design of the Telemetering Systems

General Fundamentals: "Telemetering" may be defined as "the electrical measuring of remote variables." Variables in rural water systems are flow, pressure, water level, residual chlorine, turbidity, temperature, radioactivity, among others.

The measured variable must be converted into an electrical signal. The American Institute of Electrical Engineers class types of telemetering as: (1) current or voltage, (2) frequency or tone, (3) position, (4) pulse.

Route Selection: The "telemetering route" is the way electrical pulses are carried. The most common route is a pair of wires with one wire and a ground return. For most small rural water systems, telemetering routes are usually confined to a single pair of wires. For telemetering single functions over short distances, either AC or DC circuits may be used. For distances in excess of a quarter of a mile, direct current only should be used.

For widely spaced systems, the usual approach is to lease transmission lines from the telephone company, thus avoiding considerable expense in installing and maintaining the wires. There are three types of telephone lines available: (1) voice channel, (2) teletype channel, and (3) telegraph channel. The voice channel used for normal, oral communication is the most expensive of the three. While costs will vary from one locality to another, a general rule of thumb is that voice channel (wide frequency) is one-third more expensive than the teletype (60-75 pulses per second) channel, and two-thirds more expensive than the telegraph (15 pulses per second) channel. The latter is fully capable of meeting the requirements of most rural telemetering applications of the types with which we will be concerned. It is easy to understand why it is the most popular.

Specific Applications

Tank Level Report-Back: This information is vital to any system, large or small. Not only is the level of water in the elevated tank important, but knowing the direction and rate of change is also helpful. A level transmitter hooked-up to a recorder (located in the tank itself) is a must for every rural water system. Normally, this setup requires a separate telephone pair for every tank.

If the recorders are located at a manned central office, they can be watched closely as a clue to system operation. If, however, the level receivers (recording or indicating) are located at remote pump stations, automatic controls for each pump can be included. These controls could turn one or more pumps off and on in any desired

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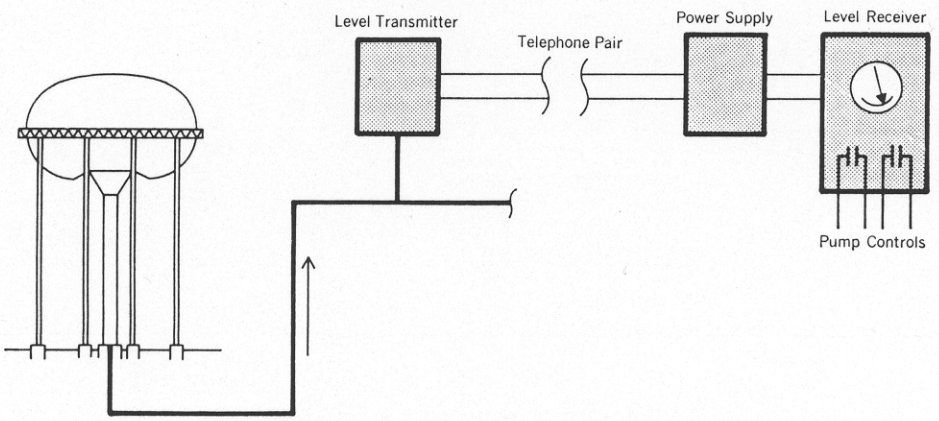
sequence with separately adjustable settings for each pump and for each condition.

As shown in Figure 1, all that is needed are one level transmitter, one recording receiver, one telephone pair, and a power supply to place the proper electrical signal on the wires.

Figure 1



Tank-Level Report Back with Pump Controls

A level transmitter with recording receiver and power supply can be obtained for approximately $750 (1971 price). Controls for each pump are available for approximately $100 extra.

Well-Pump Interlocks: Where well pumps discharge directly into the system, it is usually desirable to interlock chlorinators, chlorine booster pumps, and other associated chemical feeders into the pump starter circuit. This interlock provides reasonable assurance that pump operation will always include proper treatment.

Manual Pump Control: Many small rural water companies have scattered, unattended sources of water. This procedure usually requires the daily visit of an operator to each well site to start selected pumps in the morning and a second visit to stop them at night. An unusual change in weather or other conditions might so alter the normal pattern of consumption that additional visits during the day would be required.

This constant running back and forth can be quite time demanding for a small staff. Either overtime is required for an operator, or the manager may start at 6:00 or 7:00 a.m. and not finish until 8:00 or 10:00. All of this inconvenience can be eliminated if each pump (or at least one at each station) could be started and stopped manually from a central location.

As shown in Figure 2, a simple switch, a telephone pair, and a telemetering power supply would provide this function for a total of less than $150. In addition, it is always desirable to know if a pump is actually running. Manual pump control plus operation report back can be handled over one pair of telephone wires as shown in Figure 3. A start-stop selector switch, a pressure switch for pump report back, lights, and a function mixer-function separator for each end of the circuit can be supplied for each pump for less than $400.

Security: The subject of security is becoming more important every day. Unattended facilities seem to be a magnet for vandals. They either want to get inside to play with equipment, or they want to break the windows, doors, or locks just for "fun." Several methods can be used to determine abnormal conditions; each one should create a relay contact.

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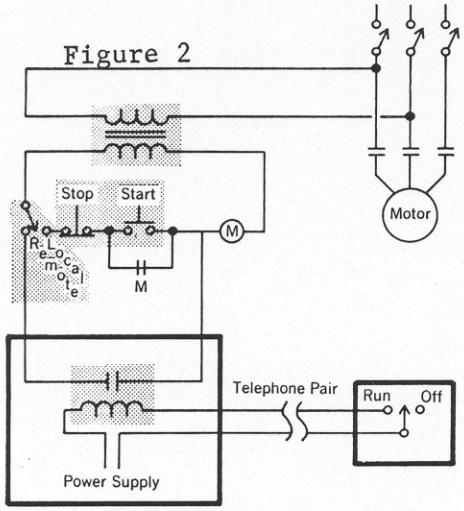
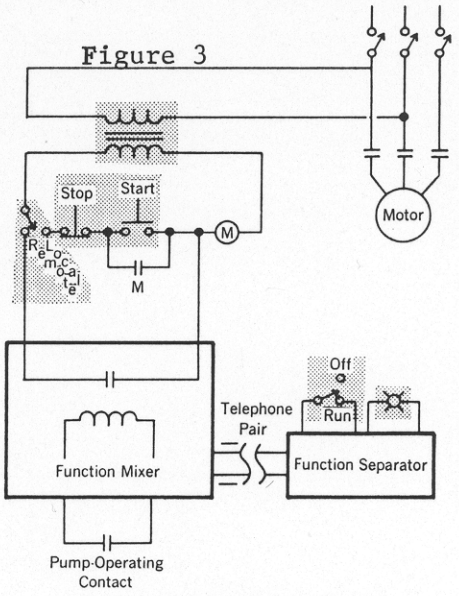
Figure 2



Remote Pump Control—No Report Back

Figure 3



Remote Pump Control with Report Back

(1) Photo-cells react when someone or something breaks a path of light between the bulb and the detector. This method has obvious advantages and disadvantages.

(2) Microwave detectors will pick up any movement, even the blowing of papers to the floor. However, their sensitivity can be adjusted so that they will react within reasonable limits.

(3) If the facility has no windows, a simple door switch will work wonders. Any time the door is opened, the alarm is activated.

If the common alarm is the only signal required, the total material cost can be less than $150, including a door switch. If other signals also need to be transmitted, the cost will vary according to the method used.

Management Benefits: Table 1 depicts four of the principal management functions that are accomplished through telemetry, along with an indication of the advantages of the

Table 1

Management Advantages Currently in Use

Function	Man-power	Opera-tional	System Perform-ance	Preventa-tive Main-tenance	Customer Needs
Centralizing data	X	X	X		
Remote pump operation	X				X
Alarm monitoring		X	X	X	X
Data reduction for future system operation	X				X

Table 2

Emerging Advantages

Function	Man-power	Opera-tional	System Perform-ance	Preventa-tive Main-tenance	Customer Needs
Production forecastings		X	X		X
System pressure analysis		X	X	X	X
Intelligent remotes	X	X	X	X	X

function from the management point of view. Most of these functions are well known and presently in common use in many rural water systems; however, advantages have been categorized under broad headings, and it would be quite easy in some cases to argue that other advantages not shown for the particular function could be claimed. For example, under remote pump operation, better system performance could result, although given sufficient manpower a system can be operated just as effectively manually as by remote control. Table 2 lists three additional functions that are now emerging as useful tools from a management point of view.

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