Ask the Experts

"For those working with water distribution systems, water hammer is a very serious problem. What steps does your system take to prevent water hammer from occurring?"

Each issue, we will ask members of the *On Tap* Editorial Advisory Board to answer a drinking water-related question. We will print as many responses as space permits.

Editor's Note: Water hammer refers to pressure fluctuations caused by a sudden increase or decrease in flow velocity. These pressure fluctuations can be severe enough to rupture a water main. This topic will be covered in greater depth in an upcoming Tech Brief.

Bigger Systems Mean More Troubles

What we are seeing is the trend toward bigger and bigger water distribution systems. It's becoming easier to find a good source or treatment process and then pipe the water long distances, than to deal with multiple water treatment plants. However as these rural water systems grow, they tend to use more pipe and higher pressures in order to effectively reach the ends of their distribution grid. This definitely opens the door for water hammer problems.

One way to prevent (or lessen) water hammer is to start and stop high service pumps in such a manner that it does not become an issue. Either Variable Frequency Drives (VFDs) or "soft starts" allow the RPMs [revolutions per minute] of the motor to slowly increase (on start) and decrease (on stop). This prevents that rapid change in energy inside the distribution system, which results in water hammer. With the increased use of solid state circuitry and SCADA [supervisory control and data acquisition] systems, operators are becoming more familiar (comfortable) with this type of technology; thus opening the door for the increased use of VFDs. Another potential benefit of this technology may be the longer life of pump motors and reduced overall electrical costs.

Rodney L. Coker
Tribal Utility Consultant
Indian Health Service

Pressure Reducing Valves Are a Solution

To reduce the possibility of water hammer, the City of Auburn, New York, uses pressure reducing valves in the sections of the city's distribution system that typically experience pressures above 115 psi [pounds per square inch]. In the past, we've had problems with people using hydrants and shutting them down improperly. Now, the Fire Department receives training in the proper use and operation of hydrants. We have also established regulations that forbid the use of hydrants without permission. If permission is granted, the operator of the hydrants is given a brief lesson in the operation of the hydrant so as not to cause a "hammer" in the system. These regulations also allow us to have better control over backflow or cross-connection problems, as we do not allow the hydrant to be used without a backflow preventer and meter attachment.

Frank J. DeOrio
Director of Municipal Utilities
City of Auburn, New York

Got a Question?

Do you have a question you would like our experts to answer? If so, please contact Kathy Jesperson at *kjespers@wvu.edu* or Mark Kemp-Rye at *mkemp@wvu.edu*. You also may call (800) 624-8301 or (304) 293-4191.

Fire Hydrants Can Be a Problem

The city of Greeley, Colorado, is very fortunate in that the topography of our service area allows for the majority of the water to be fed by gravity. The system has two water treatment plants. The main plant at Bellvue runs year-round, and feeds the city some 37 miles away through three transmission lines—completely by gravity. These lines do have 25 two-way air relief valves that allow us to take the lines out of service and refill them, without any distribution system problems due to entrapped air. The second treatment plant at Boyd Lake is a peaking plant. This pumped line goes directly to a 15 million gallon storage reservoir that acts as its own surge-suppressor. There is also a surge-suppression tank located at the pump station. The pumps all have soft-start motors and discharge valves that open slowly through solenoid controls, to prevent hammering the pipeline when the pumps are called for. The biggest problem our system faces with water hammer is firefighters and contractors closing fire hydrant valves too quickly. Unfortunately, that you cannot protect against completely.

Nelson Yarlott
Chief Plant Operator
Greely, Colorado

Sudden Closure Is the Main Culprit

Sudden closure of a control valve or stopping of a pump produces excess pressure in a pipeline. Water hammer, or hydraulic transient, refers to pressure fluctuations caused by a sudden increase or decrease in flow velocity.

According to the *Washington State Water System Design Manual*, "There are a variety of ways to provide surge control. Methods include: open surge tanks, pressurized surge tanks, surge anticipator valves, vacuum relief valves, regulated air release valves, optimizing main size and alignment, electric soft start/stop and variable speed drives for pumps, electric interlocks to prevent more than one pump from starting at the same time, slow opening and closing valves, and increasing the polar moment inertia of the rotating pump/motor assembly. A combination of methods may be necessary and care must be taken in the design so that the addition of a protection device does not cause a secondary water hammer equal to or worse than the original design could cause."

Reliability of the surge protection facility is also important. Where appropriate, redundancy should be provided for essential equipment, such as vacuum relief valves. Adequate alarms should be provided on surge tanks and similar components to give operators early warnings. Consideration should be given to preventing the pumping system from operating if the surge protection facilities are not operable.

In Washington State, transmission mains designed to operate at velocities greater than 10 feet per second must include a hydraulic transient analysis in conjunction with a hydraulic analysis. Many of the computer programs designed to perform hydraulic analysis are capable of performing transient analyses.

The Peninsula Light Company owns and/or manages very small water systems. Most of these systems are groundwater wells with hydropneumatic (i.e., pressure) tanks that are not only sized to reduce the frequency of pumps cycling on and off, but act as surge protectors.

Surge control valves can also be installed between the pump discharge flange and the check valve. The surge control valve is fully open when the pump is started and passes sufficient flow in the fully open position. Once the pump is running at full speed, the surge control valve slowly closes while the hydraulic head slowly increases. Likewise, it slowly opens prior to the pump stopping. Any new pump that is installed with greater than 15 horse power is required to have a soft-start not only for control of water hammer, but less electrical load impact.

In a few of our systems that have storage tanks, the booster pumps are controlled by float switches rather than a surge suppressor. We also have a few systems with fire hydrants. Staff are trained in how to properly open and shut these valves. Unfortunately, we still have occasional "unauthorized" use of fire hydrants. We are placing signs on the hydrants in the hopes of deterring non-fire related use. Although, we've been mostly concerned about the potential of cross-connections.

Lisa Raysby
Water Department Manager
Peninsula [Washington] Light Company