United States Environmental Protection Agency

Distribution System Water Quality

Protecting Water Quality Through Distribution System Pressure Management

Pressure management involves maintaining pressure within an optimal range throughout a distribution system, which may have varying topography and water demand. Effective pressure management can help sustain high water quality, reduce main breaks and water losses, and improve energy efficiency. This fact sheet is part of EPA's Distribution System Toolbox developed to summarize best management practices that public water systems (PWSs), particularly small systems, can use to maintain distribution system water quality and protect public health.

Examples of Utility Actions

A PWS in the southern United States (U.S.) serving 6,000 people observed that approximately 30% of their total water produced went to apparent and real losses. Such high losses could indicate vulnerability of the system to contamination in the case of low or negative pressure. The PWS implemented a pressure management program to reduce water losses by reducing operating pressure and minimizing pressure fluctuations. By installing pressure monitoring instruments and a pressure regulating device in the distribution system, the PWS reduced water losses by almost 27% (i.e., from 30% to 22% of total water produced).

After three water main breaks on the same PVC line threatened the water quality and safety of its distribution system, a PWS in the southwestern U.S. serving 1.3 million people decided to install a computer-controlled pressure monitoring system. Monitoring data showed pressures in the range of <0 to 323 psi, with 15 distinct pressure fluctuations occurring per day. These pressure fluctuations were triggered by valve operations. The PWS was able to reduce the maximum observed pressure from 323 psi to 160 psi by modifying its valve operation procedures.

Water Quality and Pressure Management

- Pressure management and monitoring are important elements of water quality maintenance in distribution systems.
- Chronic low and high pressures can be a result of design practices (e.g., location of storage tanks, lack of pressure reducing valves) or operating practices (e.g., tank operating levels or pump setpoints). Changes in water demand, location of new customers, and pipe condition (i.e., frictional losses) can also affect system pressure.
- Depending on the cause, a change in pressure may last for only a few seconds or it could last for hours or longer.
- During drops in pressure, microbial and other contaminants can enter a distribution system through cracks and holes or via cross-connections.
- Short-term pressure surges, also known as "water hammer," can have a variety of causes, including opening or closing valves too quickly or power failure. Surges have alternating very high and very low pressures and can cause main breaks and leakage as they travel through the piping. They can lead to compromised water quality via contaminant intrusion.

Maintenance of Operating Pressure Range

- Keeping the operating pressure within an optimal range protects public health, minimizes main breaks and repairs, and lowers operating costs.
- Many states have numerical requirements for operating pressure. A majority of states specify 20 psi (pounds per square inch) as a lower limit on pressure, to ensure that firefighters have access to water of sufficient pressure. While not all states have a maximum pressure limit, states that have implemented limits typically set them between 60 and 150 psi. Site-specific considerations may set other bounds on pressure requirements.

Pressure Monitoring

- Placing pressure monitors at the highest and lowest elevations in each pressure zone, and at any other locations prone to low pressure, will help identify high- and low-pressure incidents quickly and efficiently.
- Pressure monitoring frequency can be set to seconds, logging minimum, maximum, and average values over each recording interval.
- Establishing low-pressure alarms and trigger levels can help PWSs react more quickly to low pressure events, and issue boil water advisories and public notifications as required by the state.

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Preventative Measures

- **Valve and hydrant operation**: Fast operation of valves and hydrants is a common cause of negative hydraulic fluctuations. Training firefighters and water distribution operators to operate valves and hydrants slowly can help protect distribution systems.
- **Pump controls**: Pumps, by their nature, can change the flow of water quickly. Starting and stopping pumps using pump control valves, soft starts, or variable frequency drives can help limit pressure fluctuations and extend the life of distribution system materials.
- **Pressure Managed Areas**: Establishing District Metered Areas (subdivisions of the distribution system that can be isolated and separately metered) can simplify decision-making, providing a framework to address multiple demand scenarios and allowing for pressure and water supply optimization, especially when coupled with real-time system control.
- **Flow velocity**: Installation of specialty valves can help to minimize sudden changes in velocity that trigger pressure surges. For example, spring-operated check valves will not slam closed due to flow reversals, and the spring will cause it to close slowly.
- **Surge tanks**: To limit the effect of pressure surges, surge tanks can be placed close to the sources of pressure fluctuations.
- **Air-and-vacuum relief valves**: These valves are installed at high points in pipelines to remove air that accumulates. If not removed, these air pockets will restrict flow and increase pumping costs. The valves also allow air back into the pipelines if a vacuum occurs and prevent pipe collapse.
- **Surge control valves**: These valves can reduce pressure surges by preventing sudden velocity changes. They include anticipator valves, pump bypass valves, pressure-relief valves, and automatic control valves.

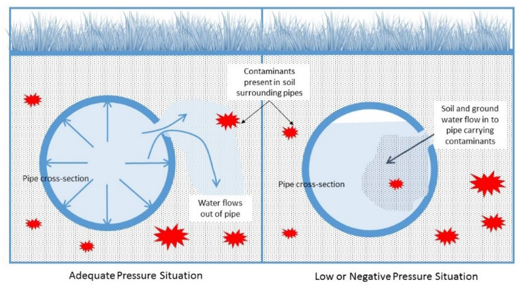

Table 1: Resources and Guidelines for Pressure Management

Resource Title and URL	**Relevance to Pressure Management**
ASDWA. 2020. State Drinking Water Distribution System Survey. http://www.asdwa.org/	Presents information on state policies and regulations related to pressure management and associated requirements for boil water advisories.
AWWA. 2017. M68 Manual of Water Supply Practices. Water Quality in Distribution Systems. https://www.awwa.org/	Summarizes pressure management principles and provides program recommendations for preventing pressure-related incidents.
GLUMRB. 2018. Recommended Standards for Water Works (aka Ten States Standards). https://www.mngovpublications.com/	Includes recommended design standards for storage facilities and distribution systems such as minimum and maximum pressure, allowable pressure variation, and use of pressure reducing valves.
Partnership for Safe Water. 2011. Partnership for Safe Water Distribution Program. https://www.awwa.org/	Recommends pressure performance goals and implementation of pre-approved procedures in cases of emergency conditions.

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