Backflow Prevention:

The Last Line of Defense for Plumbing-System Safety

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In a piping system, water is intended to flow in one direction: from the supply to the point of delivery. Danger lurks when the pressure in a system exceeds the pressure of the supply. Anytime pressure in a system drops, even momentarily, the system is subject to backflow, back pressure, or back siphonage, opening the door to contamination. This can happen all too easily when a water main is shut off, a water main is broken, or water demand surges in a specific area.

Ultimately, rigorous backflow prevention and competent, thorough testing protect against cross-contamination. Avoiding cross-connections, however, has its challenges, especially considering the vastly more complicated connections to water at sites such as medical and diagnostic centers and research facilities.

Real-Life Consequences

How serious are the risks of contamination?

Several years ago, after a week in which a large number of employees of a plywood mill in Oregon missed work complaining of nausea and severe diarrhea, the county health department was called in to test the drinking-water supply. What it found were unusually high levels of fecal coliform.

Although the mill's drinking water came from the city supply and appeared to be clean and properly chlorinated, water for the fire system came from an adjacent river. Water from the city entered the mill at about 70 psi, while booster pumps maintained fire-system water pressure at about 125 psi.

The mill's maintenance staff examined the piping system for cross-connections, finding three (with open gate valves) between the potable-water and fire systems. The mill's recent use of water had been unusually low: 10 cu ft per month instead of the 7,000 to 9,000 cu ft used by comparable mills. Mill employees had been drinking untreated river water via the cross-connections.

A single check valve located at the mill's connection to the city was credited with preventing further contamination. Without it, the mill undoubtedly would have moved more contaminated water into the city's mains.

Caption needed.

And this, from the American Water Works Association:

For some time, nurses at a Michigan hospital had been complaining about rusty water coming from a drinking fountain. When maintenance workers finally looked into the matter, they discovered the rust actually was blood from an autopsy table that had backflowed into the hospital's potable-water system.

Hospital autopsy tables have a sump to collect blood and other fluids. They also have a spray unit. On an autopsy table at the Michigan hospital, there was no hook on which to hang the hose for the spray unit, so pathologists placed the hose in the sump when they were not using it. With no vacuum breaker in the line supplying water to the spray unit, blood and other fluids from the autopsy table were sucked into the hospital's potable-water system.

These stories illustrate a key point: The risks of contamination are very real and can be life-threatening.

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Caption needed.

Culprits

Bernie Clarke of Clarke Sales in Valencia, Calif., who for years has been recognized as one of Southern California's top backflow experts, says the weak links in the chain are:

- Inconsistent accountability to agencies of jurisdiction.
- Insufficient training of testing personnel.
- Loose requirements for testing procedures.
- Cross-connection-control policies permitting far too much flexibility.

"The key answer to these problems is for water companies to set a baseline for testing performance and verification and to enforce them," Clarke said.

Dave Yates, president of York, Pa.-based F.W. Behler Inc., a licensed backflow tester, added: "One challenge today is that there are so few standards for verifiable accountability of the testers. Very little is asked of the tester, and there are no 'witness stamps.' Nationally, most backflow test forms simply require a signature. There's room for improvement.

"There should be verification of my presence at the valve," Yates continued. "Also, OSHA (Occupational Safety & Health Administration) guidelines for confined-space entry are dangerously ignored by so many testers.

"I wish the protocol would be more rigorous, such as a policy or guidance document that verifies the tester's presence and establishes that all components are functioning properly," Yates concluded. "Also, a pressure reading, a main water-meter reading, and a facility representative's signature as witness if meter-reading requires confined-space entry and time of day."

What to Do and Where to Begin

Water pressure. Water pressure is an important factor and should be noted on test forms. Consider:

- In some areas, water pressure can be excessively high, stressing backflow devices and negating manufacturers' warranties.
- Customers should be informed whether pressure is regulated. The pressure regulator is a key component of water-piping-system safety.

Testers must come in contact with valves to get pressure readings and record data.

SELECTING A BACKFLOW PREVENTER

The first consideration in selecting a backflow assembly is the type of substance at risk of flowing into a clean water supply. A "pollutant" is a substance that would affect the color or odor of water, but not necessarily pose a health hazard. A health hazard exists when a substance, if ingested, could cause illness or death.

The second consideration in selecting a backflow assembly is system hydraulics. With back siphonage, reverse flow is caused by negative pressure, or vacuum, in supply piping. With back pressure, reverse flow is caused by downstream pressure being greater than supply pressure.

Backflow assemblies can be categorized as follows:

- Air-gap assemblies, which separate drinking water and a potential source of contamination via air space. Approved for severe risk, these are considered by many to be the best backflow systems, but are not practical for modern plumbing systems.
- Double-check-valve assemblies, which consist of two independent check valves used under continuous pressure. Approved for moderate risk, they protect against back siphonage or back pressure. Typical uses include lawn sprinklers, non-toxic fire-sprinkler systems, and commercial swimming pools. A related device, the double-check detector valve, is applied to prevent reverse flow of fire-protection substances.
- Reduced-pressure zone backflow preventers, which can be used on all direct connections subject to back siphonage and/or back pressure and on systems operating under continuous pressure. They are approved for severe risk. Typical installations include main supply lines, boiler feed lines, and medical aspirators.
- Pressure vacuum breakers (PVBs), which protect against back siphonage in non-potable systems. They can be used under continuous pressure and for low- or high-risk connections. They are approved for severe risk when a reduced-pressure zone backflow preventer is installed upstream. Typical applications include irrigation and laboratory equipment.
- Atmospheric vacuum breakers (AVBs), which are used on cross-connections to protect against back siphonage. An air-inlet valve closes when water flows in the anticipated direction. As water ceases to flow, the air-inlet valve opens, introducing air into downstream piping. AVBs must be installed at least 6 in. above downstream piping and outlets. They cannot be used under continuous pressure. Like PVBs, they are approved for severe risk when a reduced-pressure zone backflow preventer is installed upstream.
- Specialty backflow preventers for point-of-use applications, which are approved for moderate risk.

Sizing of backflow preventers is determined by system requirements. In most cases, backflow preventers are line-sized.

Water-meter reading. Requiring water-meter readings forces intelligent contact with backflow assemblies. A tester must verify which water meter he or she is shutting off prior to a test. A water-meter reading should include the date and time a unit was tested.

Unauthorized connections. Specify what you want a tester to look for and document. With a stipulation that unauthorized connections be looked for, the problems that can be avoided is rather amazing.

Gauge calibration. Gauge calibration should be part of any policy. Accurate calibration of gauges leaves technique, test procedure, and recording as the only sources of inaccuracy.

Verification of forms and data. Verification of forms and data helps to focus a tester on getting the job done. It also tells the water company when the form was ready to be released to the tester. Other advantages include:

- Dates provide a tracking record and let testers know when they must complete a test and return a form to the water company.
- Owners/agents cannot say they never received a form because they would need to sign and date it, confirming receipt and review.
- The water company receives a validated test form.

Plumbing, irrigation, and fire systems. Noting plumbing-, irrigation-, and fire-system specifics adds valuable context for testing. Before water service is turned off, the tester acknowledges what the backflow assembly is attached to and considers the impact of his or her immediate actions.

Customer identification. Alphanumeric identification (e.g., "APR007-DEC121-F") can be a sensible way to sort forms, with easy combinations of information of value to you.

Flooded With Risk

At a medical facility in Southern California, a plumbing contractor turned off the water main for a short time. Unbeknownst to him, nurses had partially closed the supply valve to a vacuum breaker, starving flow to the backflow assembly. The unit leaked undetected for days, flooding three floors and effectively closing six doctors' offices for six months. Needless to say, a substantial lawsuit followed.

"Why are we shutting down water service, especially to buildings where water service is critical, such as restaurants, hospitals, schools, and clinical facilities?" Clarke asked. "It's not necessary. Designers and engineers need to know there's now a better way. The regulator doesn't need to go into the building; put it with the backflow preventer. This lets the water customer have uniform pressure at the needed flow rate."

A dual backflow assembly, regulator, and other components combined into one fully redundant valve station eliminates:

• The need to designate a room for components.

• A main line with 24 hr of high pressure on it going to various buildings containing their own set of regulators. Pressure at the backflow assembly and, in turn, pressure in the main line throughout the facility are reduced.

The use of an automatic control valve (ACV) is the best way to optimize pressure range. The ACV has a higher range of pressure and can hold design operation pressure when flow is increased.

• The use of several direct-acting regulators in parallel to get optimal flow range. One ACV will hold design pressure when higher flow is needed. A direct-acting regulator will lower pressure when more water is called for.

• The need for a regulator in an irrigation system. Pressure generally is adequate because of the absence of flow pressure drop.

• The need for a backflow tester to interrupt water flow to a building. Additionally, Clarke said, "The backflow tester can ... have the time to (do) quality repairs and, if necessary, change station components with no interruption in service or regulated pressure."

DISCHARGE

A common problem with reduced-pressure-style backflow preventers is discharge of water. More often than not, improper flushing of a system during installation is the cause of discharge.

"This serves to illustrate the importance of having certified installers," backflow expert Bernie Clarke of Clarke Sales of Valencia, Calif., said.

If discharge occurs during installation, the valve simply needs to be cleaned and put back into service.

When a valve discharges, fouling nearly always is on the first check. If dirt has damaged the check, then the elastomer needs to be replaced. Adequate floor-drain capacity needs to be provided to accommodate discharge water from the relief valve of a reduced-pressure zone backflow preventer.

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