



Opflow

Improve Accuracy With Proper Water Meter Installation

Installation manuals are often ignored or discarded. When it comes to water meters, however, ignoring manufacturer recommendations and AWWA standards may adversely affect meter accuracy and useful life.

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METER INACCURACY decreases water and sewer revenues and increases apparent water losses. A meter's useful life may be significantly shortened if measuring components are exposed to stresses for which they weren't designed. Installing a non-fire-rated meter in an application that requires a fire-rated meter may contribute to loss of property and life in the event of a fire.

Although there are only minimal standards for meter settings, certain principles should be observed. Specific problems and questions related to meter installation can best be addressed by consulting meter manufacturers and the AWWA Manual of Water Supply Practices M6: *Water Meters—Selection, Installation, Testing, and Maintenance*. As shown in the accompanying photographs, a lack of knowledge by those tasked with selecting and installing water meters can cause many unanticipated problems.

POSITIVE-DISPLACEMENT AND VOLUMETRIC METERS

For positive-displacement meters, orientation has only a marginal effect on accuracy because of the measuring chamber's

mechanics. Independent research confirms that error curves for positive-displacement meters remain virtually constant regardless of meter orientation. However, depending on set orientation and the type of positive-displacement meter used, a meter's life span may be reduced. Oscillating piston meters are probably least affected by meter orientation, but the plastic thrust roller on a nutating disk-type meter mounted in a nonhorizontal position may be loaded eccentrically, causing uneven wear and premature aging.

Photograph 1 illustrates how improperly setting a positive-displacement water meter can cause premature wear and eventually affect meter accuracy, especially at low-flow rates. In this example, the meter consists of a 2-in. oscillating-piston positive-displacement meter installed in the vertical plane. The water meter served a small motel, an application in which low-

flow accuracy is important. The registered usage at the time the meter was removed from service and tested in August 2009 was 268,450 ft³ (2,008,145.5 gal). According to the serial number, the meter was manufactured in 1984. After the meter was removed from service, testing in the horizontal and vertical planes revealed a 5 percent degradation in meter accuracy at low-flow rates. This meter setting was





2 Access problems can make it difficult to manually read meter registers.



3 An encoder register for a 2-in. meter was installed on a 5/8-in. meter, resulting in high water bills.

completely replumbed, and a new 2-in. positive-displacement meter was installed in the horizontal plane.

Register accessibility is another concern in meter installation. Photograph 2 shows two 1-in. nutating-disk positive-displacement meters. As installed, it's difficult or impossible to manually read these meter registers. Each meter should have been installed using an appropriate setter, yoke, or horn. A meter box or tile that

read the meter via a mobile AMR system on three occasions—instead of physically inspecting the meter—and reported the meter was functioning properly. In reality, the customer was being billed for 10 gal of water for every gal actually used.

INFERENCEAL OR VELOCITY-TYPE METERS

Proper installation is also critical to accuracy and life span for inferential or velocity meters, including multijet and

would accommodate two meters, two curb stops, and automated meter reading (AMR) radio transmitters should also have been installed.

Similarly, in the installation shown in Photograph 3, no one noticed that an encoder register for a 2-in. meter was installed on a 5/8-in. meter. When the customer complained about exceptionally high water bills, the utility merely

singlejet water meters. To accurately measure usage at low-flow rates, the bottom end of the impeller shaft for most multi-jet meter models and some singlejet models rests on a jeweled bearing. As flow rate increases, a slight twist in the impeller vanes generates a lifting force, causing the impeller to achieve neutral buoyancy (float) in the center of the measuring chamber. This lifting force eliminates wear on measuring chamber components.

If such a meter is installed in a non-level, nonhorizontal position, the impeller shaft no longer rests on the jeweled bearing surface and rubs against the walls of the impeller shaft guide. This increases the amount of friction the impeller must overcome to register flow, which in turn greatly affects accuracy at low-flow rates. Friction forces also accelerate wear inside the impeller shaft guide, further decreasing meter accuracy throughout all flow ranges and shortening meter life.

Independent research for singlejet meters shows that a new, horizontally installed meter may not achieve an error rate of less than 5 percent until it reaches a minimum flow rate of 0.14 gpm. If the same new singlejet meter is installed at a 45° angle, an error rate of less than 5 percent isn't realized until the flow rate reaches 0.19 gpm. If installed at a 90° angle, the error rate of less than 5 percent isn't realized until the flow rate reaches

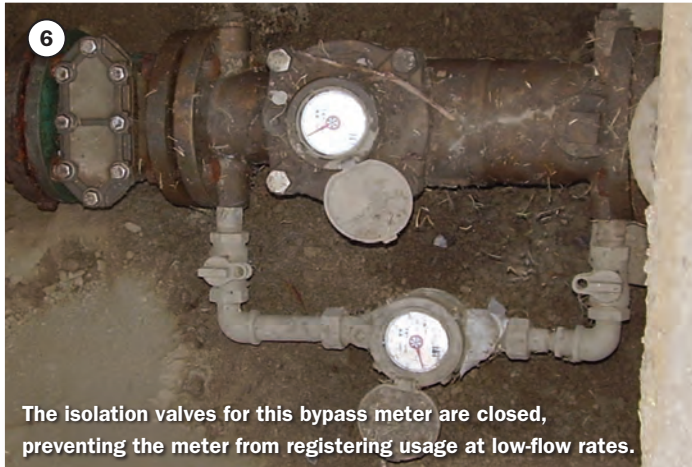


4 A 2-in. multijet meter should have been installed in the horizontal plane.



5 A 3-in. horizontal turbine meter set may have low disturbances in the flow profile.

System Operations



The isolation valves for this bypass meter are closed, preventing the meter from registering usage at low-flow rates.



The strainer installed on the downstream side of this meter doesn't protect the measuring chambers from being damaged by debris.

0.22 gpm.

Photograph 4 shows a 2-in. multijet meter installed at a 12° angle in the vertical plane that serves an apartment complex located on a hilltop; the service line followed the terrain. The installer should have purchased a meter setter or plumbed this set so the meter could be installed in the horizontal plane.

WOLTMANN OR TURBINE-TYPE METERS

Woltmann or turbine-type water meters are among the most reliable, robust, and accurate measuring devices available, but installation will affect their accuracy. The measuring chamber of a Woltmann water meter consists of an impeller that faces in an axial direction. To provide accurate measurements, all turbine meters need an ideal, turbulent velocity profile at the impeller, which provides a near-uniform vector representation of the axial speed of a fluid, except for those areas near the pipe wall.

If flow is disturbed immediately before reaching the measuring chamber, however, the velocity profile may be altered, and the water may pass through the impeller in an unbalanced manner, commonly referred to as jetting. These disturbances are usually categorized as low, medium, or high.

For low disturbances, the velocity profile is skewed toward one side of the pipe, but there's little or no radial velocity or swirl present. Low-disturbance profiles

are usually caused by installing fittings such as elbows, tees, and eccentric reducers without sufficient lengths of straight pipe; flow conditioners; or strainers to settle the flow. Misaligned flanges or gaskets may also be a source of low-disturbance profiles. Research indicates that a low-disturbance profile will affect meter accuracy by ± 1.5 percent. In addition, measuring chamber components will suffer increased wear, shortening meter life.

It's important to note that a meter will overregister or underregister usage. Overregistration often leads to angry customers; underregistration causes apparent losses and lost revenue. An inaccuracy of 1.5 percent doesn't seem excessive when compared with the additional cost of providing and installing straight pipe or flow conditioners and enlarging the vault, but it may prove costly during the life of the meter and the set.

For example, assume the following typical conditions for a 3- or 4-in. meter service are met:

- ✘ The annual billable usage is 40,000 kgal/year, and the usage pattern remains constant over time.
- ✘ The combined volume rate for water and sewer is \$7.75/kgal, and these rates will remain constant for the life of the set.
- ✘ The meter will last 20 years, and the meter set will last 50 years.

For this illustration, assume the meter's

accuracy won't degrade over time. A 1.5 percent underregistration caused by a low-disturbance profile means the meter won't register 600 kgal of water/year, and the utility won't receive \$4,650 in revenue. During the meter's 20-year life, 12,000 kgal of water will pass through the measuring chamber without being registered, and the utility won't bill \$93,000 in revenue. Over the set's 50-year life, 30,000 kgal of water won't be registered, and the utility won't receive \$232,500 in revenue.

Photograph 5 shows a 3-in. horizontal turbine meter set that probably has low disturbances in the flow profile caused by a reducing elbow located immediately upstream of the meter inlet. The vault is undersized for this setting; there's insufficient room to install a 3-in. plate strainer with its 6-in. lay length at the meter inlet; and the vault can't accommodate five equivalent diameters (15 in.) of straight pipe upstream of the meter inlet.

For medium disturbances, the velocity profile is skewed, and there's a noticeable, measurable radial component of more than 2 percent of the swirl. Most medium disturbance profiles occur when several items that individually cause low disturbances are placed close together so the effects are combined and multiplied, such as when two elbows are bolted together in different planes. Research indicates that a medium disturbance profile will affect meter accuracy by ± 2.5 percent, and the

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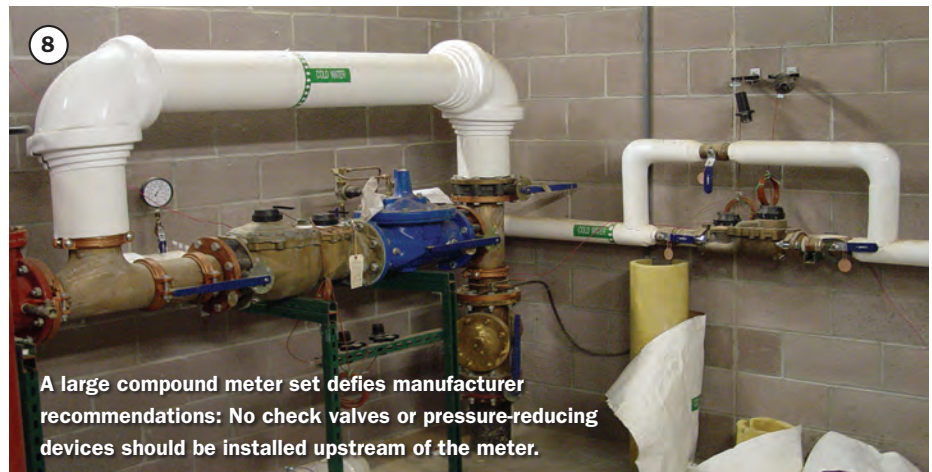
When high disturbances occur, there's some combination of a skewed velocity profile, a measurable radial component somewhat above 3 percent of the swirl, and possible cavitation of entrained air. Common causes of high disturbance profiles include partially opened valves and certain types of pumps installed close to the meter. Valves, backflow prevention devices, and pumps placed immediately upstream or downstream of the meter can also cause high disturbance profiles. Research indicates that a high disturbance profile will affect meter accuracy by ± 3 –5 percent, and the measuring chamber components will suffer increased wear, shortening meter life.

Floating-ball technology meters aren't as sensitive to flow disturbances and can be installed in a wide range of orientations without affecting meter accuracy. Regardless of type, however, all water meters should be installed level, horizontal, and according to manufacturer recommendations.

COMPOUND METERS

Although the design of compound meters makes them less susceptible to flow disturbances than large turbine or single-jet meters, it's still important to follow manufacturer installation guidelines. In addition, every large meter should have a strainer to protect the meter from damage by debris in the water.

Dual-body compound meters should be inspected periodically, and billed usage for an account should be reviewed regularly to ensure isolation valves for the bypass meter haven't been engaged. As shown in Photograph 6, the isolation valves for the bypass meter are closed. Water can't flow through the bypass



meter, which means the meter can't register usage at low-flow rates and is functioning as a large turbine meter.

Likewise, all large-meter sets with a bypass should be inspected regularly, and the billed usage for the account should be reviewed each billing cycle to ensure the bypass valves haven't been opened. Wherever possible, a utility should install a locking mechanism to prevent bypass valves from being opened.

In Photograph 7, the strainer was installed on the downstream side of the meter, which doesn't protect the measuring chambers from being damaged by debris. The pressure-reducing valve (PRV) serving each of these meter sets has been installed downstream of the meter, but a minimum of five equivalent pipe diameters between the meter and PRV are recommended by AWWA and the manufacturer when the PRV is installed downstream of the meter.

Photograph 8 illustrates how a large compound meter shouldn't be installed. A PRV is mounted to the inlet side of the meter, and a butterfly valve is mounted to the meter inlet flange. The manufacturer recommends against install-

ing check valves or pressure-reducing devices upstream of the meter. In addition, valves immediately upstream of the meter should be fully open gate valves only. Butterfly valves are acceptable if they're five pipe diameters or more upstream from the meter. Downstream, fully open gate or butterfly valves can be used.

It's also important to note that a 2-in. compound meter was installed downstream of the 6-in. compound meter. Because the 2-in. service supplies an irrigation system, there will be no usage at low- or intermediate-flow rates; therefore, a compound meter isn't recommended for this application. A 2-in. horizontal turbine meter with a plate strainer, a 2-in. vertical turbine meter with a plate strainer, or a 2-in. floating-ball technology meter are better suited for this situation. Unless the 2-in. compound meter serves as a sewer deduct meter, this customer is paying twice for irrigation water—once through the 6-in. compound meter and again through the 2-in. compound meter.

