

Water meters not only generate revenue for a utility, but they also record flow and help identify leaks.

Understanding Water Service Entries

Part 1: Water Meters

O*ne-size-fits-all is not in the vocabulary of most water utilities when it comes to water service entry lines. The water service entry into a building can be simple or complex depending on the building and what it contains. Even water services for residential homes can be points of controversy under the right conditions. Sound confusing? It really should not be if the local municipality/utility has a set of regulations in place that clearly spells out how the water service is to be installed and what components are placed in the water service line as well as by whom and at what cost.*

There are three important components that must be considered for a water service entry line—the water meter, a local/remote reading device and a backflow prevention device. Usually, backflow preventers are considered only for commercial/industrial applications, but they also should be placed on residential service lines when the residence is used as a commercial establishment (e.g., hair salon, dog grooming, photo processing, etc.). Under the right conditions, these dwellings can be a source of contamination. However, finding these home businesses might be difficult, as they often do not hang a sign advertising their presence.

This series of articles will describe each of the separate functions or components of the entry line as individual items and will detail how each can be used or placed. Additional information within each article will describe the operating characteristics of each device as well as some tips on

maintenance and service. The articles will not cover water shutoff valves or devices.

Water Meters

Water meters are always the most interesting to discuss because everyone knows their importance in generating revenue for the utility. (At least the author hopes your meters are generating revenue.) However, water meters also provide such important information as recording the flow, providing production versus consumption usage, helping identify leaks at the property and identifying illegal water usage. The latter occurs when the property owner uses water from other than the potable water connection.

Water meters are manufactured by a number of different companies and in a number of different styles. The one point to remember is that most water meters are made in accordance with standards that were developed within the industry. Meters manufactured for use in the United States are made in accordance with American Water Works Association (AWWA) standards (Table 1). This means that the physical construction has uniform dimensions and that the internal parts of each type also have some similar characteristics although they are neither alike nor interchangeable.

Meter selection always is based on the utility's preference and experience. Most utilities use two or three different types from one or more manufacturers. The type selected should be based on the maximum cold water flow through the service line to the building. Residential meters usually are sized for 3/4" (or slightly smaller) and are connected to a 1" service line. The smaller size meter is acceptable because the residential water flow seldom exceeds 25 gpm (the nominal flow for the meter). In cases where flow is greater, a 1" meter can be installed, but this often reduces the meter's ability to accurately record leaks or very small flows (1/2 gpm or less). However, most 3/4" meters at 25 gpm can handle two water hoses and a flushing toilet without any adverse effect on the water flow and pressure.

Multi-family commercial and industrial water meters should be sized for the maximum anticipated flow and not the size of the service line entering the build-

ing. There are published tables that can assist the utility in determining the proper size for different properties and applications based on the number of fixtures and the approximate use.

Water services that require meters greater than 2" in diameter need a compound meter. Compound meters are constructed with a small meter (3/4" to 1") for low flows and a larger meter for the higher flows. This arrangement permits the utility to capture all of the low flow usage that occurs when a single faucet is turned on for brief periods of time.

Buildings that are constructed with fire sprinkling systems also should be equipped with a water meter on the fire protection system. In some cases, the fire line is separate from the potable water service connection, while in others only one large service line is connected to the building, providing both demands.

Buildings that have separate fire protection systems should have a detector check meter that records the fire line flow. Additionally, the meter should be constructed with a small meter to record any small flow that is used. Another option is the use of a compound and fire flow meter combination.

Small Meter Construction

Water meters come in four basic types of construction: positive displacement, multi-jet, single jet and turbine (Figure 1). Additionally, there are some electronic meters, but their use is not as widespread. The designations refer to the flow of the water through the meter and the manner in which the flow is measured and recorded.

The meter case can be made of bronze, brass or plastic and usually is available in the different materials from

any given manufacturer. The internal measuring chamber is made of a thermoplastic compound and is replaceable as a unit. The register or recording component is mounted outside of the case and often is magnetically driven. There still might be some very old mechanical drive meters in use, but those are rare.

Operation of the meter-measuring chamber varies with the different meter construction types. **Positive displacement type meters** generally are constructed with a nutating disc or oscillating piston in the measuring chamber. Water enters the chamber through a port in the side and flows across and through the disc or piston, discharging through another side opening.

There is a different action that takes place within each device that measures the water flow. Oscillating piston meters transfer their motion to a spindle mounted in the top of the case that is fitted with a magnet. Water flowing across the piston rotates the magnet that then drives the recording mechanism.

Nutating disc measuring devices wobble within the chamber and do not rotate. However, the wobble motion is restrained in a lower ball and socket and only the small spindle on the top has a circular motion. This circular motion is transmitted by a connecting link into rotary motion that drives a spindle-mounted magnet outside of the chamber. This magnet actuates a secondary device in the recording mechanism.

Multi-jet meters also are made with a removable thermoplastic measuring chamber. However, in these meters water enters the bottom of the chamber and flows upward past an impeller (or rotor) that looks like a series of vanes extending from a hub that is mounted on support shafts. Water flowing past the vanes causes them to rotate on their axes. The upper

Table 1: AWWA Water Meter Standards

C700-02	Cold-Water Meters—Displacement Type, Bronze Case
C701-02	Cold-Water Meters—Turbine Type, for Customer Service
C702-01	Cold-Water Meters—Compound Type
C703-96	Cold-Water Meters—Fire Service Type
C708-96	Cold-Water Meters—Multijet Type
C710-02	Cold-Water Meters—Displacement Type, Plastic Main Case

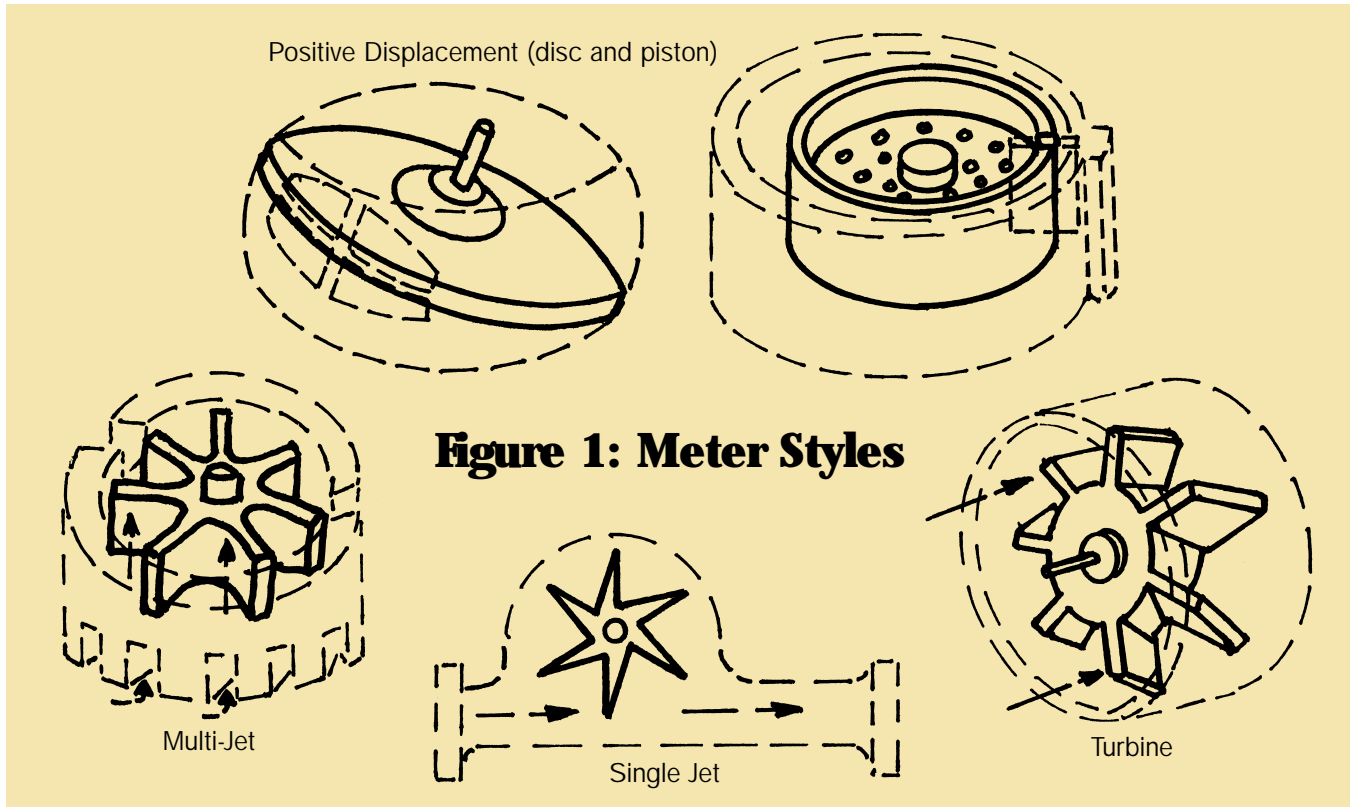


Figure 1: Meter Styles

shaft has a magnet located on its end and transfers the rotary motion of the impeller to another device in the recording head.

Some new styles of the multi-jet meter are made with a special exterior case placed at right angles to the threaded service line connections. This setup permits water to enter on the side of the case and then flow upward through the impeller. The advantage is that the meter service line does not have to be horizontal while still metering the water flow as if it were on a horizontal plane.

Single jet meters consist of a bronze, brass or alloy case that houses a measuring impeller and a chamber placed slightly off-center from the water flow connections. Water entering the case is directed through a single orifice into the impeller chamber. Water flowing tangentially past the impeller causes it to rotate on its supporting axis. This rotation drives the magnetic coupling on the recording head.

Turbine meters usually are made of bronze or brass materials, although some other alloys might be used. The measuring chamber is made of a thermoplastic material and is removable from the main case. The impeller (rotor) is mounted horizontally within the measuring chamber

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on a set of support spindles/shafts. The measuring chamber often is fitted with a series of straightening vanes that control the direction of the water that enters the impeller chamber.

Water passing through the chamber causes the impeller to rotate. Since this rotation is parallel to the water flow, a set of worm or bevel gears is needed to change the motion direction so it is perpendicular to the water flow. This change in direction allows a magnet located on the end of the shaft to be magnetically coupled to the recording device on top of the case.

A variation of the turbine meter is the **propeller meter**. This type of meter uses a tapered and curved impeller placed in an open pipe to register the flow of water. These meters are used as production (wells and plant discharge) or fire hydrant meters and not as consumption meters, because of their inability to register low flows.

Large Meter Construction

There are several different styles of large meters used for commercial, multi-family and industrial applications. However, these meters do not have special or different methods of measuring the flow of water. Instead, they use a combination of one or more of those types of meters (positive displacement, turbine, etc.) previously discussed.

Some meters (1½" and 2") used in four- to six-unit multi-family buildings still may be a single unit meter much like those previously described. The only difference is in their physical size, the maximum flow capacity (120–170 gpm) and a loss of low flow accuracy. However, if the building has other occupancy or has a higher flow, then generally a compound meter is used.

The advantage of a compound meter over a single meter is in its ability to capture low flows more accurately, while still accommodating the same high flow and fitting into the same general space. For example, one 2" disc meter has a flow range from 1½ gpm to 170 gpm, with a continuous rating of 100 gpm. A 2" compound meter from the same manufacturer has a flow range from ¼ gpm to 170 gpm continuous flow. If this were a six-unit apartment, about 15 to 20 percent of the water used would be less than 1½ gpm.

Compound meters usually are manufactured in sizes from 2" to 6" and have different flow ranges for each size. Generally, the low flow measuring range is somewhere between ¼ gpm and ½ gpm, with the high flows extending to approximately 1,500 gpm. Some manufacturers also make 8" compound meters that range from 1 to 2,000 gpm.

Compound meters (Figure 2) generally consist of a small meter that can measure up to 25 gpm and a turbine meter that handles the remainder of the flow. Most manufacturers place them in a single cast bronze or brass housing that is made with flanged connections. Since all are manufactured in accordance with AWWA standards, the external dimensions usually are



**Figure 2:
Compound
Meters**

the same, with some physical differences. Additionally, some manufacturers make compound meters with other than a single body so they can accommodate their individual meter styles.

Those meters that share a common body usually have some sort of a diverting plate or valve device located within the main body of the meter. The purpose of the diverting device is to direct the flow of water to the proper section of the meter. Therefore, when the flow becomes greater than the upper limit of the small meter, the gate opens and the water is

directed to the high flow turbine or recording device. In some instances, the compound meter has individual recording heads for the separate measuring devices, while in others a single recording device is supplied.

Fire line meters are another large style meter that usually are found in industrial, commercial and multi-family (apartment or condo) buildings that have fire suppression systems. However, these meters are made in a variety of types (Figure 3). The one selected for any given application will depend on the utility serving the

property and the regulations that they follow. Not all have the same requirements.

For example, some utilities are not concerned with how much water is used within a building's sprinkling system. For these applications, a simple detector check with a small bypass meter will only record the small amount of water that is used for testing or flushing and almost no water if the system is activated. Other utilities want an accurate record of all water used and require fire line meters that are fitted with compound and main line meters. These usually are 6" to 12" meters.

As a rule, the measuring chamber of the fire line meter is a proportional type meter and is not made with an individual housing or chamber. Instead, the measuring section is similar to a multi-jet chamber that is placed in the top of the case. The placement of the measuring section permits a clear path for the fire suppression system water to flow through the meter. It also prevents damage to the measuring section in case a contractor left something large in the pipe. However, many new installations require a strainer placed ahead of the meter to prevent such damage from occurring. These strainers are sized and manufactured so that there is no restriction to the water flow.

Meter Size and Selection

Selecting a water meter for a building usually is based on previous experience or existing criteria. If there are no previous data available, selection should be based on the demand or anticipated consumption of the building using some existing device flow formulas. This meter should never be based on the size of the water service line, unless the building has fire protection.

Developing a water demand for an application is not difficult, but it does require a set of building plans or an on-site inspection. Since an on-site inspection can be done only with the building nearly complete (a little late to be selecting a meter), the plans usually are necessary. The best time for the plan review is during the permit application and before any construction begins.


Most meter manufacturers, as well as the AWWA, have tables giving the consumption rates of different building fix-

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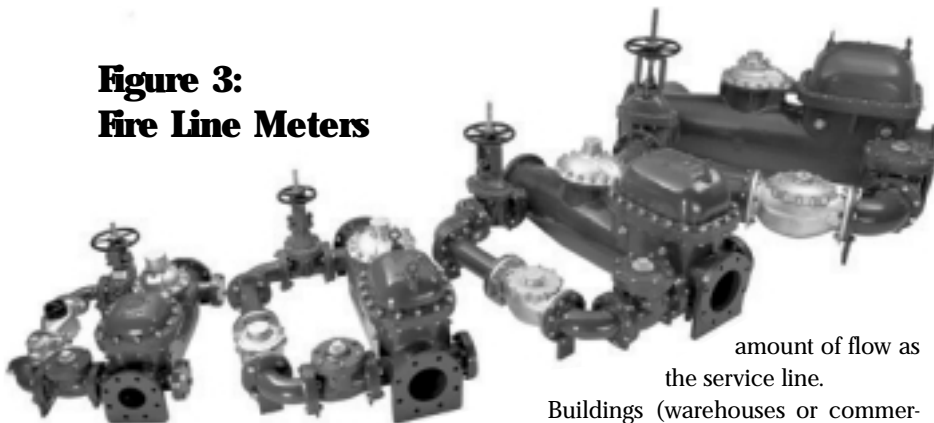
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**Figure 3:
Fire Line Meters**



amount of flow as the service line.

Buildings (warehouses or commercial) that have fire protection systems, but only a small water demand require a different method of selecting the water meter. For these applications the potable water for the building often is tapped off of the main line and does not require a full-size meter. To be most efficient, the fire protection system should be fitted with a detector check meter (including a strainer) and the small line should have a meter that meets the required demand of the fixtures.

Meter Installation

All water meters should be installed in accordance with the manufacturer's instructions. They should be located in an accessible location that is protected and has ample room in which to work. If the meter is a compound or larger type, then consideration must be given to the size or style of test equipment that will be used. It must factor in the ability to discharge test water safely without causing any water damage to the building.

Since many electricians ground the electrical system to the water pipes, some consideration must be given to providing protection to the meter and anyone working on the system from stray electrical currents. Usually, this is accomplished by installing a jumper wire across the meter, as well as grounding the electrical line to the incoming side of the service line. Much new construction, because of changes in the electrical codes, requires a separate grounding rod for the electrical

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tures. Using these tables and counting the number of fixtures will provide a maximum building demand. This amount then can be modified to an actual demand by estimating the number of fixtures that will be used at any given time.

For example, if the building was a four unit multi-family, the water demand could be based on three of the four units using similar fixtures at the same time—such as showers in the morning combined with a couple of water closets (toilets) and lavatories (wash basins). This projected maximum flow in gallons per minute then can be checked against the meter manufacturers capacity for a given meter size. If the projected flow was 50 gpm, then a meter having a standard flow capacity above this would be required.

Most meters have an excess capacity over the normal operating range. However, this excess should *never* be used as the basis for meter selection. It only provides a cushion for peak flows that do not have a long duration. Again, remember to ascertain the low flow rating on the meter. Capturing the leakage flow that occurs in older buildings not only provides revenue but also can assist the utility in alerting the building owner of a problem and save water.

Full size meters can be used for industrial applications that have large service lines. Even if a building does not currently have the domestic demand for an 8" line, it is easier to install an 8" fire line or compound meter than to try and calculate what the building consumption will become in future years. When the service line (16" to 24") is greater than a meter size, the service can be manifolded to accommodate two or more small size meters that would provide an equal

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service located outside of the building. In some cases, this is required because the new plastic service lines being installed do not provide a grounding capability.

Meter Testing

Meter testing often is a controversial subject. For starters, it requires money. It also is an inconvenience to the property owner, as well as a disruption to normal daily routines. However, in almost all cases, the cost of meter testing and replacement (if necessary) is more than offset by an increase in revenue during the life of the meter. This is especially true for areas that have average or higher water rates. A thorough and well-thought-out plan is the best approach.

The frequency of meter testing depends on several factors: meter size, quality of water, usage, service calls and application being the most common. Manufacturers and other associations (AWWA) have recommended standard times for meter test cycles that have proven satisfactory over the years. Many utilities also have established programs that they gladly will share with interested parties.

As a rule of thumb, most residential meters should be checked at a 10- or 15-year interval. A test sample of a few meters within a given area will help you determine the present meter accuracy. This can be accomplished using a portable test meter any time there is a service call to check a low registering meter or a complaint of a high water bill (presuming there are no leaks).

If the meters are relatively accurate (95 percent) then a total testing program can be delayed. Lower accuracies are a catalyst for a total test program. If the utility experiences a lot of service calls for stopped

meters, then a testing program should be started. Further, if many of the meters show large inaccuracies, then a changeout and repair program should be initiated without going through a testing program.

Large meters should be tested more frequently, especially if the building uses a great amount of water. The rationale is that the low flow meter sizes often fall behind in their registration, causing the utility to have an increased amount of unaccounted for water and resulting in a loss of revenue. In some cases, the cost of testing and subsequent repairs may be more than the gain from lost revenue, but the testing program frequency should not change.

Testing larger meters at two- to three-year intervals might seem excessive to some, but it should be cost effective in most cases. This is especially true for multi-family buildings (or apartments/condos) where there is a lot of low flow usage (e.g., toilet flushing and wash basins/sinks). If there is any concern about the cost benefit, a record of the test costs versus revenue gain can be used as a basis for the testing program. The test time also will provide the utility a chance to make a vital inspection of the meter to check for tampering or other problems.

A water meter is tested in a variety of ways. For residential meters, it is easier to do a change out and bench test the meter than trying to test within the house. However, there are portable test meters that can be used within the house that give

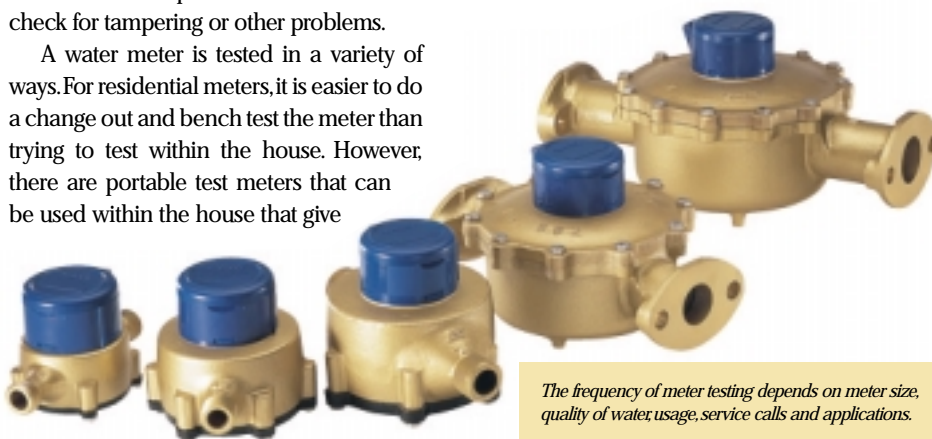
accurate results. Larger meters usually can be tested only in place, which means having to shut off the water or provide some other means to supply water while the test is going on. Having a locked bypass line around the meter will allow the building to have water while the test is being done.

In other cases, the building might be served by two or more lines (common in hospitals), thus permitting one to be shut down at a time. If there is no other way of providing water while the meter is being tested, then arrangements have to be made for the test to be done at other-than-normal working hours. Usually this involves a lot of coordination and overtime pay. Still, this testing must not be ignored or put off. After all, it is revenue and unaccounted-for water that is at stake.

Photos courtesy of Hersey Meters, Cleveland, N.C.

About the Author:

Don Renner is a former plant operator and author of the book *Hands-On Water/Wastewater Equipment Maintenance*. He also is a member of *Water Engineering & Management's* Editorial Advisory Board.



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