Water Meters— Selection, Installation, Testing, and Maintenance

AWWA MANUAL M6

Fifth Edition





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Chapter **Z**

Selecting Meter Types

INTRODUCTION

Selecting water meters for installations serving various types of customers usually presents a problem only when considering commercial or industrial accounts. However, apartment buildings, schools, other large establishments, and the combination of private fire service and general use through a single line (when permitted) also require consideration for satisfactory meter installation.

Selection involves both size and type of meter. Too often, size is chosen merely to match the pipe size; but oversized pipe is often installed to allow for possible future increases in water use or to reduce pressure loss in a long length of pipe. Chapter 3 discusses the method of calculating total friction loss, although the example covers only small services. Based on this principle, plus customer demand information, and pressure-loss data from meter manufacturers' catalogs, the meter size is selected. For example, if a 3-in. (80-mm) meter in a 4-in. (100-mm) line is appropriate, use of a 4-in. (100-mm) meter is inadvisable. It would be unnecessarily expensive, heavy to handle, and less accurate under overall usage conditions. However, it is advisable to provide a suitable transition and extra space in the pipeline and in the meter pit so that a larger meter can be installed later if usage increases.

Undoubtedly, the past tendency to install oversize meters resulted from the desire to use a meter large enough to meet the customer's maximum demands and not to incur additional expense, if a small meter became inadequate. However, with careful study of expected demand, the correct meter size can be determined in advance. A larger meter can be installed later, if necessary, if space is provided at the time of the original installation.

The type of meter to use is determined by the anticipated range of flow rates, plus allowable pressure loss and possible safety requirements (such as fire-service regulations). Several types are available, as shown in Table 2-1. This manual describes only the more common types; information on other meters can be obtained from the respective manufacturers. When calculating flow demand, it is important to consider meter type and suitability for use as a revenue-collecting metering device or a flow-monitoring device.

		Usual Rang	Usual Range of Sizes	
Type		in.	mm	
I. Displacement				
A.	Nutating disc	1/2-2	13 - 50	
B.	Oscillating piston	1/2-2	13 - 50	
II. Nondisplacement				
A.	Velocity			
	Multijet	⁵ /8–2	15 - 50	
	Singlejet	⁵ /8–6	15 - 150	
	Fluidic oscillator	1/2-2	13 - 50	
	Magnetic-pickup turbine	1/4-12	6-300	
	Turbine	3⁄4-20	20 - 500	
	Propeller	2 - 72	50 - 1,800	
	Proportional	3 - 12	80-300	
B.	Differential pressure			
	Fixed opening, variable differential			
	Orifice	2 - 24	50-600	
	Venturi, flow nozzle, flow tube	2-84	50 - 2,100	
	Pitot tube	Unlimited		
	Variable opening, fixed differential rotameter	1/4-4	6-100	
C.	Electronic velocity			
	Electromagnetic	1/10-72	2 - 1,800	
	Ultrasonic	$\frac{1}{2}-72$	13 - 1,800	
D.	Level measurement			
	Weir, Parshall flume, etc.	Unlimited		
III. Compound				
A.	Standard compound	2-8	50 - 200	
B.	Fire service	3-12	80-300	

 Table 2-1
 Types of meters for water measurement

SMALL FLOWS

In the United States and Canada, the standard meter in 2-in. (50-mm) and smaller sizes has been the displacement meter, of which there are two variations, the nutating piston (disc) and the oscillating piston. Essentially equal in performance, these meters have proven by experience to be unrivaled for their combination of accuracy, long life, simple design, moderate cost, and easy maintenance. Tens of millions of these meters are in use. Since the 1960s, multijet meters have been successfully used in the same applications. Multijet meters are covered in ANSI/AWWA C708, Standard for Cold-Water Meters—Multijet Type.

In the 1990s, singlejet technology was introduced from Europe. Singlejet meters have since been in use for small-meter applications. These meters are covered in ANSI/AWWA C712, Standard for Cold-Water Meters—Singlejet Type, the first edition of which was approved in 2002.

In addition, major advancements have been made in the area of small electronic meters designed primarily for residential service. These include the fluidic-oscillator, ultrasonic, and electromagnetic meters.

The standard for fluidic-oscillator meters is ANSI/AWWA C713, Standard for Cold-Water Meters—Fluidic-Oscillator Type. ANSI/AWWA C750, Standard for Transit-Time Flowmeters in Full Closed Conduits, addresses transit-time ultrasonic

flowmeters used in a variety of applications as flow-monitoring devices (rate measurement); it does not apply to revenue-collecting metering devices specifically. As of 2012, AWWA does not have a standard for electromagnetic meters.

Most residential services are metered with the 5%-in. (15-mm) size having 34-in. (20-mm) connections. For information on capacity in relation to pressure loss, see chapter 3. Note that normal flows should not be more than approximately one-half of the maximum capacity if long life is the objective.

Today, small magnetic-drive meters have very low pressure loss and a much longer life than older models.

MEDIUM FLOWS

For services that can be metered with $1\frac{1}{2}$ -in. (40-mm) meters, the displacement, multijet, or singlejet meter can be used. The low-flow accuracy of modern $1\frac{1}{2}$ -in. (40-mm) meters is excellent, and compound meters are not usually manufactured in sizes less than 2 in. (50 mm). Where low-flow accuracy is not important, as in services used only for filling tanks at rapid flow, the $1\frac{1}{2}$ -in. (40-mm) turbine meter may be operated safely at a higher average rate than the displacement meter.

The 2-in. (50-mm) displacement, multijet, turbine, singlejet, and compound meters have their places and their advocates. Those who prefer the displacement meter have indicated that it is simpler to use, is lower in cost, and records consumption remarkably well at low flow rates. Proponents of the compound meter emphasize that it is more accurate on very low flows or leaks and has lower pressure loss at high flow rates. Proponents of the multijet and singlejet meters emphasize their quiet operation and their ability to pass dirt particles and other entrained flow debris. The life expectancy of any meter will be greatly limited if exposed to excessive debris.

The choice between compound and turbine meters in 3-in. (80-mm) to 4-in. (100-mm) sizes appears to be determined by the average flow rates to be measured. If close accuracy at very low flows is important, but large capacity is also needed, the compound meter should be used. If large capacity is of primary importance, flows are usually above 10 percent of maximum rating, and low-flow accuracy is secondary, the turbine meter should be used, especially one of the newer models with very low pressure loss.

LARGE FLOWS

For lines 3 in. and larger, the traditional choice of meters is the compound, turbine, singlejet, propeller, or fire-service meter. Ultrasonic and electromagnetic meters are now an option for this type of application, though currently AWWA does not publish a standard on these meter types for revenue-collecting purposes.

For some light commercial or larger living complexes (condos, apartments, and motels), the compound meter is frequently purchased. This type of meter registers well over the widest flow range and has relatively low pressure loss at high flow rates. There are two variations of compound meter design.

In the first, or parallel meter, the main-line meter does not operate until the compounding valve opens. The bypass meter may or may not continue operating when the main-line meter starts. If this meter has two registers, and if either unit fails, the trouble can be detected by the stoppage of its register.

In the second, or series meter, when the compounding valve is closed, water flows through the main-line meter and then through the bypass meter. When the pressure differential in the bypass meter is great enough to cause the compounding valve to open, the main-line meter is already running. The register is driven by a pair of ratchet drives, allowing the unit that is producing more registration to drive the register. The main-line unit is not required to start from rest at the changeover point. All compound meters lose a certain degree of accuracy operating within the changeover flow range by varying amounts. It is important to size any compound meter installation to minimize the total flow each installation experiences in the changeover flow range.

Turbine and current meters, including electronic flowmeters, are used when flows are large, minimum flows are usually above 10 or 12 percent of maximum rating, and the low-pressure loss at high flows is valuable. These meters have a separate inner measuring chamber or cage, which may be removed with the rotor for servicing. ANSI/ AWWA C701, Standard for Cold-Water Meters—Turbine Type, for Customer Service, divides turbine meters into class I and class II meters. Both classes of meters register by recording the revolutions of a turbine set in motion by the force of flowing water striking the blades. Class I turbine meters are the vertical-shaft and low-velocity, horizontal-shaft models. Class II turbine meters are in-line, horizontal-axis, high-velocity turbines characterized by lower head loss and wider normal test-flow limits. Magnetic flowmeters are covered in AWWA Manual M33, *Flowmeters in Water Supply*.

Propeller meters are intended for main-line or pump station discharge measurements. They operate with the minimum of pressure loss for a mechanical meter. In small propeller meters, the propeller is built into a section of pipe of precise diameter and forms part of the meter; in large sizes, saddlemounting of the propeller is customary, with the interior of the pipe serving as the measuring tube. At the point of measurement, the velocity profile should be uniform. This requires that there are no elbows, valves, constrictions, or enlargements in the pipe for several pipe diameters of distance upstream and for a lesser distance downstream. For detailed instructions, users should consult the manufacturer of the proposed meter.

Where fire hydrants or large sprinkler systems are served by the metered line, the insurance underwriters usually insist on using a fire-service meter. Where these service conditions are encountered, the applicable insurance requirements should be ascertained before the meter is selected. Fire-service meters permit day-to-day usage to be drawn from a line serving hydrants or sprinklers, with the entire flow metered. For detecting the unauthorized use of water in lines for unmetered fire-service applications, a unit called a detector check, double check detector assembly, or reduced pressure principle detector assembly is installed. This same construction permits authorized metered use of small quantities of water from a fire-service line.

The detector check meter, a UL-listed, FM-approved device, is designed for dedicated fire-service applications. These devices are not intended to meter consumption; rather, utilities use these devices to detect leaks and unauthorized water usage. A second, normally smaller, service line is installed with an appropriately sized water meter for measurement of normal domestic water consumption.

Consider, for example, a warehouse that requires a high volume of water flow for fire protection but may also have a small bathroom and maybe a coffee maker. By utilizing a detector check meter for the fire-service and a second domestic-service line, the utility can save on initial cost and ongoing maintenance compared to the cost of a fire-service meter.

Detector check meters consist of an automatic-weight or spring-loaded main check valve with an elastomer seal, a bypass piping system that incorporates a $\frac{5}{8} \times \frac{3}{4}$ in. meter, $\frac{3}{4}$ in. check valve, $\frac{3}{4}$ in. ball valves, and a meter test valve. In operation, the main-line valve is held closed by the weight or spring with any low flow being directed through and measured by the bypass meter. When the pressure loss through the bypass reaches the engineered main valve opening point (normally a pressure loss of 1 to 2 psi or approximately 5 to 10 gpm), the main valve opens automatically, allowing full flow for emergencies. Water continues to be measured through the bypass meter, but flow though the main check valve is unmetered. The detector check meter is the appropriate device for most commercial and industrial fire systems. If, however, the water is from an outside source or additives are present for antifreeze, regulatory agencies for fire-protection systems require a testable backflow preventer. These double check or reduced pressure devices are also available with metered bypasses. AWWA Manual M14, *Recommended Practice for Backflow Prevention and Cross-Connection Control*, contains more information.

Like all measurement devices, detector check meters require some maintenance to ensure proper operation. While the main valve assembly can be virtually maintenance-free, the bypass meter requires examination to ensure continued operation. By opening the meter test valve located downstream of the meter, a small amount of water is vented to the atmosphere, and the dial should be checked to ensure proper meter operation. Because the meter is being used as a tattletale and not as an accurate consumption-measuring device, volumetric accuracy is of less importance. It is very important that the meter register a small flow to detect leaks and unauthorized use. The main check valve elastomer sealing can be tested by setting up a differential pressure (DP) gauge to ensure that a differential pressure of 1 to 2 psi is maintained. This test is done by simply removing the meter and installing the appropriate DP gauge fittings.

Detector check meters can be installed inside a building or outside in a vault. Weight-loaded check valves require horizontal installation for proper operation, whereas spring-loaded valves can be installed horizontally or vertically on the firesystem standpipe.

It is common for utilities to ask building owners to remove a detector check and install a fire-service meter if consumption is registered more than once annually. Normal consumption should occur during the annual fire system test. The selection of the proper device for each application and an understanding of the limitations of a metering device will ensure that the highest value is obtained.

Other types of meters for large lines include the Venturi or its modifications, the flow tube, or the flow nozzle. These meters differ from the other meters because they measure by differential pressure instead of by velocity or quantity. Flow ranges for accuracy vary with size and with details of design, so information should be obtained from the manufacturer of the meter. Although built in smaller sizes, these meters usually are used in 6-in. (150-mm) or larger lines.

Improvements in the microprocessor readouts for both electromagnetic and ultrasonic large electronic velocity meters have enabled these devices to have not only raw and wastewater applications, but also to apply to nonrevenue measurement of finished water and water treatment chemicals. Both meters offer the advantage of an unobstructed flow tube with no moving parts and high accuracy; both, however, require electronic power.

For temporary measurements, the Pitot tube may be used in main lines. In the hands of skilled operators, the meter is valuable in making surveys to ascertain rates of flow in large lines, to locate leaks, and to measure the flow from fire hydrants.

Manifolding of Meters

For 3-in. (80-mm) or larger lines, instead of using one meter to measure the entire flow, multiple smaller-sized meters are installed in a manifold (also called a battery). Typically, a manifold should consist of two meters or more, with each meter one pipe size or more smaller than the main line (e.g., two 2-in. [50-mm] meters in a 3-in. [80-mm] manifold). For example, on a 3-in. (80-mm) line, the manifold may consist of two displacement meters. On a 6-in. (150-mm) or 10-in. (250-mm) line, the manifold

may consist of two or three compound or turbine meters. All meters in a manifold should be of the same brand, model (type), and size.

Branch manifolds are only recommended if there is close coordination of the technical details with the meter manufacturer or other experts in flow hydraulics. It is imperative that the flow through the multiple branches be balanced for proper meter registration and performance. Figure 4-5 illustrates a typical 3-meter and 2-meter hydraulically balanced manifold of large meters.

Manifolding of meters has the following advantages:

- 1. One meter can be serviced by closing its shutoff valves while the water supply is still available to the customer through the other meter.
- 2. Since the meters within the manifold are smaller than a single meter for the same service, fewer personnel are required for meter servicing or removal.
- 3. Inventory of repair parts can be minimized, and the knowledge of repair and testing techniques can be less involved when the variety of size and type of meters in the system is controlled.
- 4. The manifold can be side-wall mounted to conserve floor space.