Utilities use two distinct types of flushing programs to accomplish their goals—unidirectional water main flushing and fire hydrant flow testing, also called fire-flow testing and main capacity flow testing.

In fire hydrant flow testing, fire hydrants are opened and flushed, pressure and flow data are collected, and calculations are made to determine potential fire flow at a particular point in the water main. In unidirectional flushing, hydrants are opened, and flow in the water main is controlled in one direction so debris is flushed out of the main.

Many utilities flush hydrants without controlling the flow direction in the water main. Although this allows hydrants to be checked for function and flow coming out of the port, it doesn’t effectively flush the water main clear of debris. It also doesn’t allow residual pressure flow data to be collected so fire flow can be calculated. Fire flow is the amount of water a main can deliver when needed for fighting a fire. This article focuses on hydrant flow testing.

At the hydrant, static, residual, and Pitot readings are needed to determine the hydrant’s total available fire flow.
If distribution system changes are made—such as a new water tower, ground storage tank, new transmission main installation, distribution system looping, or new pumps at a booster station or water plant—the changes could affect fire flow at given points in the distribution system. An accurate record should be kept of each fire-flow test along with a hydrant inventory that includes a condition assessment of each hydrant. Utilities and fire departments often color-code hydrants according to National Fire Protection Association 291 standards to reflect fire-flow conditions at each hydrant location. With such coding, fire department personnel will know what the flow conditions will be. It’s important to note that fire-flow standards refer to potential flow at 20 psi at the hydrant where the residual pressure is measured, not actual flow at the flow hydrant.

**Equipment.** Personnel and equipment needed for each flow hydrant include:

- one hand-held Pitot tube or diffuser with a Pitot tube and a pressure gauge capable of reading 0–60 psi—greater than the pressure expected in the residual hydrant.
- a short ruler to measure the inside diameter of the outlet nozzle of each flow hydrant. If a diffuser is being used, the diameter or coefficient of the diffuser will need to be used.
- one hydrant wrench to operate the residual hydrant and one to operate the hydrant(s) where the flow will be measured.
- one person to read the gauge on the residual hydrant and one person to read the gauge on the Pitot tube or diffuser for the flow hydrant(s).
- clipboards and paper for recording data at each hydrant.

For wet-barrel hydrants, it may be necessary to install a specifically designed nozzle to minimize turbulence caused by the hydrant’s discharge valve.

**Plan Before Testing.** Review distribution system maps and determine which hydrants will be used to measure flow and which will be used to measure residual pressures. If all hydrants aren’t approximately at the same elevation, test results may need to be corrected for elevation differences. Water tower levels or tank levels should be recorded as well. Review the previous flow tests to see which flows and pressures can be expected. It’s usually a good idea to start out at water sources, such as the water plant, wells, towers, or ground storage tanks. This will help minimize, but not entirely eliminate, the amount of debris stirred up in the water main.

Because of the potential for stirring up debris and causing discoloration of water in the mains, customers should be notified before the flushing program begins. Use the local cable channel or publish an article in the local newspaper explaining the project’s goals and process. Post signs in areas where flushing will be conducted. A few days before flushing, the utility may also choose to hang door tags in affected areas to warn residents and businesses of possible dirty water. Some utilities use a reverse 911 call system to inform water customers about the activity. Public notification will reduce the number of customer complaints. However, those who answer such calls should be able to address customers’ questions about the flow-testing activities and where utility crews are flushing each day. Utilities should also notify the fire and police departments about the activity.

Select a day for testing when consumption will be normal and the weather is predicted to be reasonably good. Notify the water production staff of the time and area in which the flushing crew will be working so water production can be adjusted to accommodate extra demand. Testing may affect traffic flow, so investigate traffic patterns. Night work may be required in some areas, but flushing programs can often be done during the day, which enables the public to see the utility taking a proactive stance on fire flows. In addition, day-time testing allows water quality to be readily observed during testing.

**FIELD PROCEDURES**

Field personnel should use the following flow-test guidelines:
Minimize traffic interruptions and arrange for adequate water drainage.

Locate the residual hydrant and

- Flush the residual hydrant to eliminate sediment that may damage the gauge.
- Install an outlet-nozzle cap, which is equipped with a pressure gauge, on the hydrant nozzle.
- Open the main valve slowly until air is vented; close the vent and fully open the main valve.
- Read the gauge (the static pressure reading).

Locate the flow hydrant(s) and take the following steps:

- Measure and record the inside diameter of the outlet nozzle from which the flow is measured. Take the measurement to the nearest 1/16 in. (0.159 cm). If you’re using a diffuser, use the diameter of the diffuser according to the manufacturer.
- Determine the discharge. At hydrants used for flow during the tests, the discharges from the open butts are determined from measurements of the diameter of the outlets flowed, the velocity pressures of the streams as indicated by the Pitot gauge readings, and the coefficient of the discharge outlet being flowed, as determined from the diffuser coefficient or the style of the hydrant outlet. There are three hydrant-outlet styles, known as A, B, or C outlet. An A outlet has a rounded edge inside the outlet from the hydrant; a B outlet is squared off; and a C-style outlet partially protrudes inside the body of the hydrant. If flow tubes or stream strengtheners are used, coefficients for the outlet are 0.9 for A, 0.8 for B, and 0.7 for C.
- Conduct a flow test as follows:
  - Station one observer at the residual hydrant and one observer at each flow hydrant.
  - Open each flow hydrant slowly until it’s fully open. Open one hydrant at a time to avoid a pressure surge.
  - When pressure at the residual hydrant is stabilized, the observer signals the observer stationed at the flow hydrants to take the readings. The readings for residual pressure and the Pitot tube readings of each flow hydrant must be taken simultaneously. Air should be exhausted from the flowing hydrant before the reading is taken. For an accurate reading, hold the Pitot tube in the center of the nozzle with the axis of the Pitot tube opening parallel to the direction of flow. The Pitot tube should be held away from the end of the nozzle at a distance of about half the nozzle diameter.
  - Record the residual reading and the Pitot gauge reading at each flow hydrant. Then close the flow hydrants slowly, one at a time. Closing the hydrant rapidly causes a pressure surge, or water hammer, which could cause a weak main to fail.

For reasonably accurate test results, the pressure drop between the static and the residual pressures should be at least 10 psi. If the distribution system is strong (as it should be near a supply main) and the pressure drop is less than 10 psi, an additional flow hydrant should be tested. Flow should be calculated in the field, so the test can be immediately repeated if results appear to be in error.

Gauges used for testing are sensitive instruments and should be handled with care. They should be tested regularly against a standard gauge to ensure accuracy. If there is any doubt about a gauge’s accuracy, the gauge should be tested or replaced. Remember that insurance ratings and distribution system performance are based on these tests, so extreme care should be used in performing the tests.

System operators can take advantage of fire-flow tests and coordinate other procedures at the same time. For example, hydrant valve inspection and maintenance can be conducted. It may also be a good time to inspect air-and-vacuum relief valves and check backflow-prevention devices.