Administration

1.1* Scope.

The scope of this document is water flow testing and marking of hydrants.

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1.2* Purpose.

This document provides recommended practices to test and determine the available water supply for fire protection systems and fire flow purposes and the marking of hydrants.

**1.2.1**

Water flow testing, water supply analysis, and hydrant classification for marking purposes should be performed by knowledgeable and trained personnel.

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1.3* Application.

The application of this document is the flow testing and marking of both public and private fire hydrants.

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1.4 Units.

Metric units of measurement in this recommended practice are in accordance with the modernized metric system known as the International System of Units (SI). Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection. These units are listed in **Table 1.4** with conversion factors.

**Table 1.4 SI Units and Conversion Factors**

| **Unit Name** | **Unit Symbol** | **Conversion Factor** |
| --- | --- | --- |
| Liter | L | 1 gal = 3.785 L |
| Liter per minute per square meter | $(L/min)/m^2$ | 1 gpm $ft^2$ = $(40.746\ L/min)/m^2$ |
| Cubic decimeter | $dm^3$ | 1 gal = 3.785 $dm^3$ |
| Pascal | Pa | 1 psi = 6894.757 Pa |
| Bar | bar | 1 psi = 0.0689 bar |
| Bar | bar | 1 bar = $10^5$ Pa |

Note: For additional conversions and information, see ASTM SI 10, *IEEE/ASTM SI 10 American National Standard for Metri* *Practice,* 2016.

**1.4.1**

If a value for measurement as given in this recommended practice is followed by an equivalent value in other units, the first value stated is to be regarded as the recommendation. A given equivalent value might be approximate.

## Referenced Publications

### 2.1 General.

The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

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### 2.2 NFPA Publications.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2023 edition.

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### 2.3 Other Publications.

**2.3.1 ASTM Publications.**

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM SI 10, *IEEE/ASTM SI 10 American National Standard for Metric Practice,* 2016.

**2.3.2 AWWA Publications.**

American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235.

ANSI/AWWA G200, *Standard for Distribution Systems Operation and Management,* 2015.

**2.3.3 Other Publications.**

*Merriam-Webster's Collegiate Dictionary,* 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

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### 2.4 References for Extracts in Recommendations Sections.

NFPA 1, *Fire Code,* 2024 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2025 edition.

NFPA 1140, *Standard for Wildland Fire Protection,* 2022 edition.

## Definitions

## 3.1 General.

**3.1.1**

The definitions contained in this chapter apply to the terms used in this recommended practice.

**3.1.2**

Where terms are not defined in this chapter or within another chapter, they should be defined using their ordinarily accepted meanings within the context in which they are used.

**3.1.3**

*Merriam-Webster's Collegiate Dictionary*, 11th edition, is the source for the ordinarily accepted meaning.

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## 3.2 NFPA Official Definitions.

**3.2.1* Authority Having Jurisdiction (AHJ).**

An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

**3.2.2* Listed.**

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

**3.2.3 Should.**

Indicates a recommendation or that which is advised but not required.

---

## 3.3 General Definitions.

**3.3.1 Fire Flow.**

The flow rate of a water supply, measured at 20 psi (1.4 bar) residual pressure, that is available for firefighting. [**1,** 2024]

**3.3.2 Rated Capacity.**

The flow available from a hydrant at the designated residual pressure (rated pressure), either measured or calculated.

**3.3.3 Residual Pressure.**

The pressure that exists in the distribution system, measured at the residual hydrant at the time the flow readings are taken at the flow hydrants.

**3.3.4 Static Pressure.**

The pressure that exists at a given point under normal distribution system conditions measured at the residual hydrant with no hydrants flowing.

---

3.4 Hydrant Definitions.

3.4.1* **Dry Barrel Hydrant (Frostproof Hydrant).**

A type of hydrant with the main control valve below the frost line between the footpiece and the barrel. [**24,** 2025]

**3.4.2 Fire Hydrant.**

A valved connection on a water supply system having one or more outlets and that is used to supply hose and fire department pumpers with water. [**1140,** 2022]

**3.4.3 Flow Hydrant.**

The hydrant that is used for the flow and flow measurement of water during a flow test. [**24,** 2025]

**3.4.4 Flush Hydrant (Below Ground Hydrant).**

A type of hydrant that is installed below the ground level that is intended for use in congested urban areas or aircraft movement areas.

**3.4.5 Private Fire Hydrant.**

A valved connection on a water supply system having one or more outlets that is used to supply hose and fire department pumpers with water on private property. [**24,** 2025]

**3.4.6 Public Hydrant.**

A valved connection on a water supply system having one or more outlets that is used to supply hose and fire department pumpers with water. [**24,** 2025]

**3.4.7 Residual Hydrant.**

The hydrant that is used for measuring static and residual pressures during a flow test. [**24,** 2025]

3.4.8* **Wet Barrel Hydrant.**

A type of hydrant that is intended for use where there is no danger of freezing weather and where each outlet is provided with a valve and an outlet. [**24,** 2025]

Flow Testing

4.1 Water Flow Testing Purposes.

**4.1.1**

Water flow tests are conducted to determine the available water supply for fire protection purposes, the flow that would be available from a fire hydrant for firefighting purposes, or the status of the water supply distribution system for fire protection systems or for firefighting purposes.

---

4.2 Rating Pressure.

**4.2.1**

For the purpose of uniform marking of hydrants, the ratings should be based on the flow available at the hydrant at a residual pressure of 20 psi (1.4 bar).

**4.2.2**

It is generally recommended that a minimum residual pressure of 20 psi (1.4 bar) should be maintained at hydrants when delivering the fire flow. Fire department pumpers can be operated where hydrant pressures are less, but with difficulty.

**4.2.3**

A primary concern should be the ability to maintain sufficient residual pressure to prevent back-siphonage of polluted water from some other interconnected source.

**4.2.4***

It should be noted that the use of residual pressures of less than 20 psi (1.4 bar) is not permitted by many water authorities and health departments.

---

4.3 Procedure.

**4.3.1***

Tests should be conducted during periods of peak demand, based on knowledge of the water supply and engineering judgment.

**4.3.2**

The procedure consists of discharging water at a measured rate of flow from the system at a given location and observing the corresponding pressure drop in the mains.

**4.3.3***

The fire hydrant and the area around the fire hydrant should be visually inspected for safety concerns prior to conducting the flow test.

---

4.4* Layout of Test and Procedure to Determine the Available Water Supply in a Water Main.

**4.4.1**

After the location where the test is to be run has been determined, a group of test hydrants in the vicinity is selected.

**4.4.2**

Once selected, due consideration should be given to potential interference with traffic flow patterns, damage to surroundings (e.g., roadways, sidewalks, landscapes, vehicles, and pedestrians), and potential flooding problems both local and remote from the test site.

**4.4.3**

One hydrant, designated the residual hydrant, is chosen to be the hydrant where the normal static pressure will be observed with the other hydrants in the group closed, and where the residual pressure will be observed with the other hydrants flowing.

**4.4.4**

This hydrant is chosen so it will be located between the hydrant to be flowed and the large mains that constitute the immediate sources of water supply in the area. In **Figure 4.4.4**, test layouts are indicated showing the residual hydrant designated with the letter R and hydrants to be flowed with the letter F.

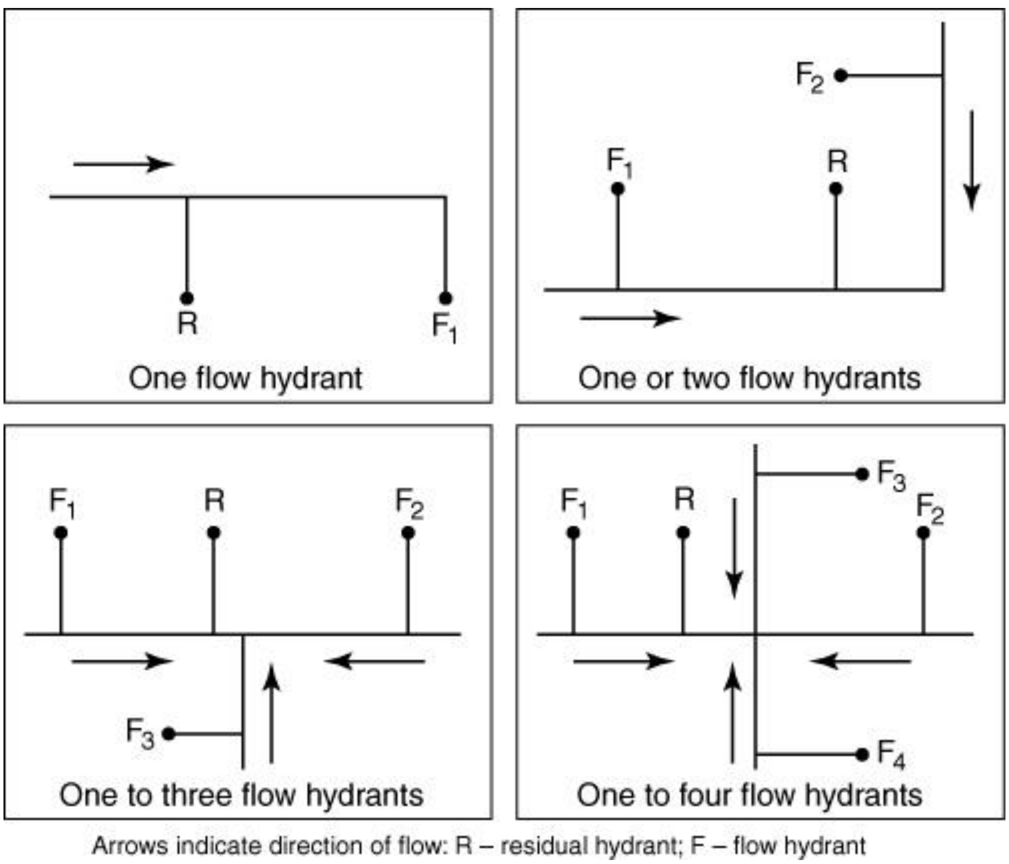


**Figure 4.4.4** Suggested Test Layout for Hydrants.

**4.4.5**

The number of hydrants to be used in any test depends upon the strength of the distribution system in the vicinity of the test location.

**4.4.6**

To obtain satisfactory test results of theoretical calculation of expected flows or rated capacities, sufficient discharge should be achieved to cause a drop in pressure at the residual hydrant of at least 10 percent. In water supply systems where additional municipal pumps increase the flow and pressure as additional test hydrants are opened, it might be necessary to declare an artificial drop in the static pressure of 10 percent to create a theoretical water supply curve.

**4.4.7***

When conducting a flow test for the purpose of fire protection system design, the flow and pressure results should be adequate for the total demand of the system.

**4.4.8**

If the mains are small and the system weak, only one or two hydrants need to be flowed.

**4.4.9**

If the mains are large and the system strong, it might be necessary to flow as many as seven or eight hydrants.

---

4.5 Layout of Test and Procedure to Evaluate the Available Flow Through a Fire Hydrant.

**4.5.1**

When the purpose of a flow test is to determine the available flow through an individual hydrant only, the static and residual pressures should be taken at a single hydrant. The flow hydrant is also used as the static/residual hydrant.

**4.5.1.1**

This procedure should be used to evaluate the available water flow at a given hydrant.

**4.5.1.2**

The recommended procedures for determining the available water supply for the design of a water-based protection system should be in accordance with Section **4.4**.

**4.5.2**

A pressure gauge (or other pressure measuring device) should be located on one of the 2 1⁄2 in. (65 mm) hydrant outlets *[see **4.6.1(1)**]*.

**4.5.3**

A closed control valve connected to a discharge nozzle(s) for the purpose of rate of flow measurement should be located on one of the other hydrant outlets.

**4.5.4**

The test procedures in Section **4.7** for venting air and taking static/residual readings and Section **4.8** for taking pitot readings should be followed.

**4.5.5**

The control valve on another hydrant outlet should be opened. When the rate of flow stabilizes, rate of flow and residual pressure measurements are taken and recorded.

---

4.6 Equipment.

**4.6.1**

The equipment necessary for field work can consist of the following:

- (1)

A special hydrant cap tapped with a hole into which is fitted a short length of 1⁄4 in. (6 mm) nipple provided with a “T” connection for a pressure gauge and a petcock at the end for relieving air pressure

- (2)

A single 100 psi (6.9 bar) or 200 psi (13.8 bar) bourdon pressure gauge with 1 psi (0.07 bar) graduations fixed onto the hydrant cap [If the static pressure on the system is greater than 100 psi (6.9 bar), the 200 psi (13.8 bar) gauge will be required.]

- (3)

A pitot tube and a 100 psi (6.9 bar) bourdon pressure gauge with 1 psi (0.07 bar) graduations, for each hydrant to be flowed simultaneously

- (4)

A sufficient number of hydrant wrenches to operate the hydrants simultaneously

- **(5)***

Playpipes, stream straighteners, or other specially designed flow test outlets with known coefficients of discharge

**4.6.2**

It is preferred to use playpipes or stream straighteners or other specially designed flow test outlets with known coefficients of discharge when testing hydrants due to more streamlined flows and more accurate pitot readings.

**4.6.3**

All pressure gauges should be calibrated at least every 12 months, or more frequently depending on use.

**4.6.4**

When more than one hydrant is flowed, it is desirable and could be necessary to facilitate communications between team members.

---

4.7 Test Procedure.

**4.7.1**

In a typical test, the 100 psi (6.9 bar) or 200 psi (14 bar) gauge is attached to one of the 21⁄2 in. (65 mm) outlets of the residual hydrant using the special cap.

**4.7.2**

The cock on the gauge piping is opened, and the hydrant valve is opened full.

**4.7.3**

As soon as the air is exhausted from the barrel, the cock is closed.

**4.7.4**

A reading (static pressure) is taken when the needle comes to rest.

**4.7.5**

At a given signal, each of the other hydrants is opened in succession, with discharge taking place directly from the open hydrant butts.

**4.7.6**

Hydrants should be opened one at a time.

**4.7.7**

With all hydrants flowing, water should be allowed to flow for a sufficient time to clear all debris and foreign substances from the stream(s).

**4.7.8**

At that time, a signal is given to the people at the hydrants to read the pitot pressure of the streams simultaneously while the residual pressure is being read.

**4.7.9**

The final magnitude of the pressure drop can be controlled by the number of hydrants used and the number of outlets opened on each.

**4.7.10**

After the readings have been taken, hydrants should be shut down slowly, one at a time, to prevent undue surges in the system.

---

4.8 Pitot Readings.

**4.8.1**

When measuring discharge from open hydrant butts, it is always preferable from the standpoint of accuracy to use 21⁄2 in. (65 mm) outlets rather than pumper outlets.

**4.8.2**

In practically all cases, the 21⁄2 in. (65 mm) outlets are filled across the entire cross-section during flow, while in the case of the larger outlets there is very frequently a void near the bottom.

**4.8.3**

When measuring the pitot pressure of a stream of practically uniform velocity, the orifice in the pitot tube is held downstream approximately one-half the diameter of the hydrant outlet or nozzle opening, and in the center of the stream. *(See **Figure 4.8.3**.)*

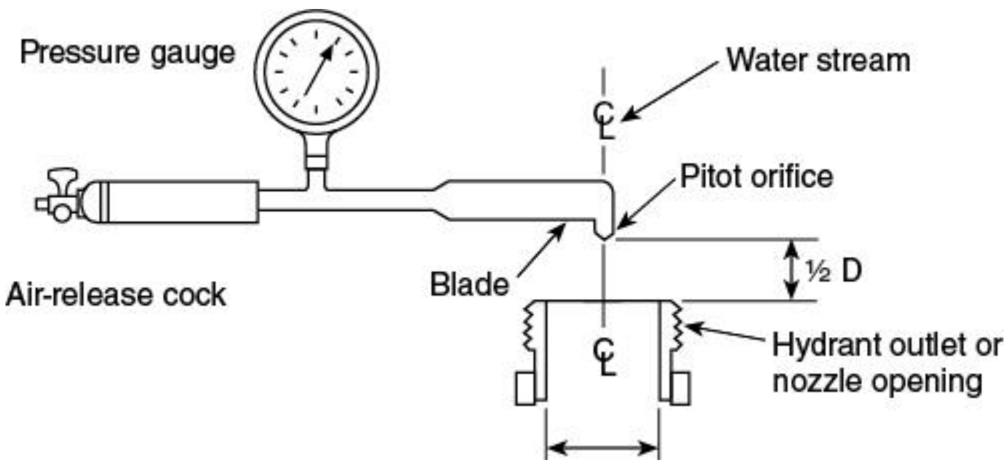


**Figure 4.8.3** Pitot Tube Position.

**4.8.4**

The center line of the orifice should be at right angles to the plane of the face of the hydrant outlet.

**4.8.5**

The air chamber on the pitot tube should be kept elevated.

**4.8.6**

Pitot readings of less than 10 psi (0.7 bar) should be avoided, if possible.

**4.8.7**

Opening additional hydrant outlets will aid in controlling the pitot reading.

**4.8.8**

With dry barrel hydrants, the hydrant valve should be wide open to minimize problems with underground drain valves.

**4.8.9**

With wet barrel hydrants, the valve for the flowing outlet should be wide open to give a more streamlined flow and a more accurate pitot reading.

---

4.9 Determination of Discharge.

**4.9.1**

At the hydrants used for flow during the test, the discharges from the open butts are determined from measurements of the diameter of the outlets flowed, the pitot pressure (velocity head) of the streams as indicated by the pitot gauge readings, and the coefficient of the outlet being flowed as determined from **Figure 4.9.1**.

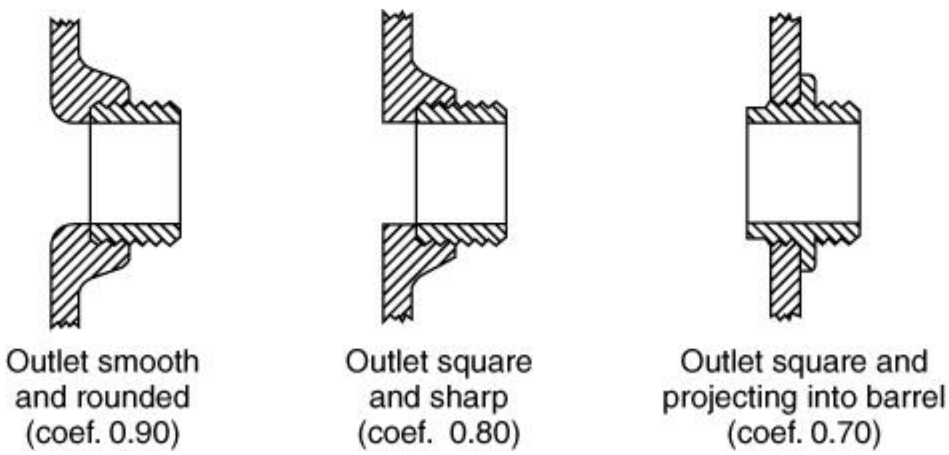


**Figure 4.9.1** Three General Types of Hydrant Outlets and Their Coefficients of Discharge.

**4.9.2**

If flow tubes (stream straighteners) are being utilized, a coefficient of 0.95 is suggested unless the coefficient of the tube is known.

**4.9.3**

The formula used to compute the discharge, *Q*, in gpm (L/min) from these measurements is as shown in Equations 4.9.3a and 4.9.3b.

[4.9.3a]

$$Q = 29.84cd^2\sqrt{p}$$

where:

*Q*=

flow (gpm)

*c*=

coefficient of discharge *(see **Figure 4.9.1**)*

*d*=

diameter of the outlet (in.)

*p*=

pitot pressure (velocity head) (psi)

[4.9.3b]

$$Q_M = 0.666cd^2\sqrt{p_M}$$

where:

$Q_M$=

flow (L/min)

*c*=

coefficient of discharge *(see **Figure 4.9.1**)*

*d*=

diameter of the outlet (mm)

$p_M$=

pitot pressure (velocity head) (bar)

---

4.10 Use of Pumper Outlets.

**4.10.1**

If it is necessary to use a pumper outlet, and flow tubes (stream straighteners) are not available, the best results are obtained with the pitot pressure (velocity head) maintained between 5 psi and 10 psi (0.34 bar and 0.7 bar).

**4.10.2**

For pumper outlets, the approximate discharge can be computed from Equations 4.9.3a and 4.9.3b using the pitot pressure (velocity head) at the center of the stream and multiplying the result by one of the coefficients in **Table 4.10.2**, depending upon the pitot pressure (velocity head).

**Table 4.10.2 Pumper Outlet Coefficients**

**Pitot Pressure (Velocity Head)**

| psi | bar | Coefficient |
|---|---|---|
| 2 | 0.14 | 0.97 |
| 3 | 0.21 | 0.92 |
| 4 | 0.28 | 0.89 |
| 5 | 0.35 | 0.86 |
| 6 | 0.41 | 0.84 |
| 7 and over | 0.48 and over | 0.83 |

**4.10.3**

These coefficients are applied in addition to the coefficient in Equations 4.9.3a and 4.9.3b and are for average-type hydrants.

---

4.11 Determination of Discharge Without a Pitot.

**4.11.1**

If a pitot tube is not available for use to measure the hydrant discharge, a gauge of sufficient pressure range, tapped into a hydrant cap can be used when the flow is through a hydrant outlet or a nozzle attached to a hydrant outlet.

**4.11.2**

The hydrant cap with gauge attached is placed on one outlet, and the flow is allowed to take place through the other outlet at the same elevation.

**4.11.3**

The readings obtained from a gauge so located, and the readings obtained from a gauge on a pitot tube held in the stream, are approximately the same.

---

4.12 Calculation Results.

**4.12.1**

The discharge in gpm (L/min) for each outlet flowed is obtained from **Table 4.12.1(a)** and **Table 4.12.1(b)** or by the use of Equations 4.9.3a and 4.9.3b.

Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|
| | | 1.75 | 2 | 2.25 | 2.375 | 2.5 |
| 1 | 2.31 | 91 | 119 | 151 | 168 | 187 |
| 2 | 4.61 | 129 | 169 | 214 | 238 | 264 |
| 3 | 6.92 | 158 | 207 | 262 | 292 | 323 |
| 4 | 9.23 | 183 | 239 | 302 | 337 | 373 |
| 5 | 11.54 | 204 | 267 | 338 | 376 | 417 |
| 6 | 13.84 | 224 | 292 | 370 | 412 | 457 |
| 7 | 16.15 | 242 | 316 | 400 | 445 | 493 |
| 8 | 18.46 | 258 | 338 | 427 | 476 | 528 |
| 9 | 20.76 | 274 | 358 | 453 | 505 | 560 |
| 10 | 23.07 | 289 | 377 | 478 | 532 | 590 |
| 11 | 25.38 | 303 | 396 | 501 | 558 | 619 |
| 12 | 27.68 | 317 | 413 | 523 | 583 | 646 |
| 13 | 29.99 | 329 | 430 | 545 | 607 | 672 |
| 14 | 32.30 | 342 | 447 | 565 | 630 | 698 |
| 15 | 34.61 | 354 | 462 | 585 | 652 | 722 |
| 16 | 36.91 | 366 | 477 | 604 | 673 | 746 |
| 17 | 39.22 | 377 | 492 | 623 | 694 | 769 |
| 18 | 41.53 | 388 | 506 | 641 | 714 | 791 |
| 19 | 43.83 | 398 | 520 | 658 | 734 | 813 |
| 20 | 46.14 | 409 | 534 | 676 | 753 | 834 |
| 22 | 50.75 | 429 | 560 | 709 | 789 | 875 |
| 24 | 55.37 | 448 | 585 | 740 | 825 | 914 |
| 26 | 59.98 | 466 | 609 | 770 | 858 | 951 |
| 28 | 64.60 | 484 | 632 | 799 | 891 | 987 |

Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|
| | | 1.75 | 2 | 2.25 | 2.375 | 2.5 |
| 30 | 69.21 | 501 | 654 | 827 | 922 | 1022 |
| 32 | 73.82 | 517 | 675 | 855 | 952 | 1055 |
| 34 | 78.44 | 533 | 696 | 881 | 981 | 1087 |
| 36 | 83.05 | 548 | 716 | 906 | 1010 | 1119 |
| 38 | 87.67 | 563 | 736 | 931 | 1038 | 1150 |
| 40 | 92.28 | 578 | 755 | 955 | 1065 | 1180 |
| 42 | 96.89 | 592 | 774 | 979 | 1091 | 1209 |
| 44 | 101.51 | 606 | 792 | 1002 | 1116 | 1237 |
| 46 | 106.12 | 620 | 810 | 1025 | 1142 | 1265 |
| 48 | 110.74 | 633 | 827 | 1047 | 1166 | 1292 |
| 50 | 115.35 | 646 | 844 | 1068 | 1190 | 1319 |
| 52 | 119.96 | 659 | 861 | 1089 | 1214 | 1345 |
| 54 | 124.58 | 672 | 877 | 1110 | 1237 | 1370 |
| 56 | 129.19 | 684 | 893 | 1130 | 1260 | 1396 |
| 58 | 133.81 | 696 | 909 | 1150 | 1282 | 1420 |
| 60 | 138.42 | 708 | 925 | 1170 | 1304 | 1445 |
| 62 | 143.03 | 720 | 940 | 1189 | 1325 | 1469 |
| 64 | 147.65 | 731 | 955 | 1209 | 1347 | 1492 |
| 66 | 152.26 | 742 | 970 | 1227 | 1367 | 1515 |
| 68 | 156.88 | 754 | 984 | 1246 | 1388 | 1538 |
| 70 | 161.49 | 765 | 999 | 1264 | 1408 | 1560 |
| 72 | 166.10 | 775 | 1013 | 1282 | 1428 | 1583 |
| 74 | 170.72 | 786 | 1027 | 1300 | 1448 | 1604 |
| 76 | 175.33 | 797 | 1041 | 1317 | 1467 | 1626 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|
| | | 1.75 | 2 | 2.25 | 2.375 | 2.5 |
| 78 | 179.95 | 807 | 1054 | 1334 | 1487 | 1647 |
| 80 | 184.56 | 817 | 1068 | 1351 | 1505 | 1668 |
| 82 | 189.17 | 828 | 1081 | 1368 | 1524 | 1689 |
| 84 | 193.79 | 838 | 1094 | 1385 | 1543 | 1709 |
| 86 | 198.40 | 847 | 1107 | 1401 | 1561 | 1730 |
| 88 | 203.02 | 857 | 1120 | 1417 | 1579 | 1750 |
| 90 | 207.63 | 867 | 1132 | 1433 | 1597 | 1769 |
| 92 | 212.24 | 877 | 1145 | 1449 | 1614 | 1789 |
| 94 | 216.86 | 886 | 1157 | 1465 | 1632 | 1808 |
| 96 | 221.47 | 895 | 1169 | 1480 | 1649 | 1827 |
| 98 | 226.09 | 905 | 1182 | 1495 | 1666 | 1846 |
| 100 | 230.70 | 914 | 1194 | 1511 | 1683 | 1865 |
| 102 | 235.31 | 923 | 1205 | 1526 | 1700 | 1884 |
| 104 | 239.93 | 932 | 1217 | 1541 | 1716 | 1902 |
| 106 | 244.54 | 941 | 1229 | 1555 | 1733 | 1920 |
| 108 | 249.16 | 950 | 1240 | 1570 | 1749 | 1938 |
| 110 | 253.77 | 958 | 1252 | 1584 | 1765 | 1956 |
| 112 | 258.38 | 967 | 1263 | 1599 | 1781 | 1974 |
| 114 | 263.00 | 976 | 1274 | 1613 | 1797 | 1991 |
| 116 | 267.61 | 984 | 1286 | 1627 | 1813 | 2009 |
| 118 | 272.23 | 993 | 1297 | 1641 | 1828 | 2026 |
| 120 | 276.84 | 1001 | 1308 | 1655 | 1844 | 2043 |
| 122 | 281.45 | 1009 | 1318 | 1669 | 1859 | 2060 |
| 124 | 286.07 | 1018 | 1329 | 1682 | 1874 | 2077 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|
| | | **1.75** | **2** | **2.25** | **2.375** | **2.5** |
| 126 | 290.68 | 1026 | 1340 | 1696 | 1889 | 2093 |
| 128 | 295.30 | 1034 | 1350 | 1709 | 1904 | 2110 |
| 130 | 299.91 | 1042 | 1361 | 1722 | 1919 | 2126 |
| 132 | 304.52 | 1050 | 1371 | 1736 | 1934 | 2143 |
| 134 | 309.14 | 1058 | 1382 | 1749 | 1948 | 2159 |
| 136 | 313.75 | 1066 | 1392 | 1762 | 1963 | 2175 |

Notes:

(1) This table is computed from the formula $Q = 29.84cd^2\sqrt{p}$ , with *c* = 1.00. The theoretical discharge of seawater, as

(2) Appropriate coefficient should be applied where it is read from hydrant outlet. Where more accurate results are requi
discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle t

**Table 4.12.1(b) Theoretical Discharge Through Circular Orifices (Liters of Water per Minute)**

| Pitot Pressure (kPa) | Pitot Pressure (bar) | Meters (m) | Orifice Size (mm) | | | | |
|---|---|---|---|---|---|---|---|
| | | | **44.5** | **50.8** | **57.2** | **60.3** | **63.5** |
| 5 | 0.05 | 0.51 | 295 | 384 | 487 | 541 | 600 |
| 10 | 0.10 | 1.02 | 417 | 544 | 689 | 766 | 849 |
| 15 | 0.15 | 1.53 | 511 | 666 | 844 | 938 | 1040 |
| 20 | 0.20 | 2.04 | 590 | 769 | 974 | 1083 | 1201 |
| 25 | 0.25 | 2.55 | 659 | 859 | 1090 | 1211 | 1343 |
| 30 | 0.30 | 3.06 | 722 | 941 | 1194 | 1326 | 1471 |
| 35 | 0.35 | 3.57 | 780 | 1017 | 1289 | 1433 | 1589 |
| 40 | 0.40 | 4.08 | 834 | 1087 | 1378 | 1532 | 1698 |
| 45 | 0.45 | 4.59 | 885 | 1153 | 1462 | 1624 | 1801 |
| 50 | 0.50 | 5.10 | 933 | 1215 | 1541 | 1712 | 1899 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1.75 | 2 | 2.25 | 2.375 | 2.5 |
| 55 | 0.55 | 5.61 | 978 | 1275 | 1616 | 1796 | 1992 |
| 60 | 0.60 | 6.12 | 1022 | 1331 | 1688 | 1876 | 2080 |
| 65 | 0.65 | 6.63 | 1063 | 1386 | 1757 | 1952 | 2165 |
| 70 | 0.70 | 7.14 | 1103 | 1438 | 1823 | 2026 | 2247 |
| 75 | 0.75 | 7.65 | 1142 | 1488 | 1887 | 2097 | 2326 |
| 80 | 0.80 | 8.16 | 1180 | 1537 | 1949 | 2166 | 2402 |
| 85 | 0.85 | 8.67 | 1216 | 1585 | 2009 | 2233 | 2476 |
| 90 | 0.90 | 9.18 | 1251 | 1631 | 2067 | 2297 | 2548 |
| 95 | 0.95 | 9.69 | 1285 | 1675 | 2124 | 2360 | 2617 |
| 100 | 1.00 | 10.20 | 1319 | 1719 | 2179 | 2422 | 2685 |
| 105 | 1.05 | 10.71 | 1351 | 1761 | 2233 | 2481 | 2752 |
| 110 | 1.10 | 11.22 | 1383 | 1803 | 2285 | 2540 | 2817 |
| 115 | 1.15 | 11.73 | 1414 | 1843 | 2337 | 2597 | 2880 |
| 120 | 1.20 | 12.24 | 1445 | 1883 | 2387 | 2653 | 2942 |
| 125 | 1.25 | 12.75 | 1475 | 1922 | 2436 | 2707 | 3002 |
| 130 | 1.30 | 13.26 | 1504 | 1960 | 2484 | 2761 | 3062 |
| 140 | 1.40 | 14.28 | 1560 | 2034 | 2578 | 2865 | 3178 |
| 150 | 1.50 | 15.30 | 1615 | 2105 | 2669 | 2966 | 3289 |
| 160 | 1.60 | 16.32 | 1668 | 2174 | 2756 | 3063 | 3397 |
| 170 | 1.70 | 17.34 | 1720 | 2241 | 2841 | 3157 | 3501 |
| 180 | 1.80 | 18.36 | 1769 | 2306 | 2923 | 3249 | 3603 |
| 190 | 1.90 | 19.38 | 1818 | 2369 | 3004 | 3338 | 3702 |
| 200 | 2.00 | 20.40 | 1865 | 2431 | 3082 | 3425 | 3798 |
| 210 | 2.10 | 21.42 | 1911 | 2491 | 3158 | 3509 | 3892 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | | Feet | Orifice Size (in.) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1.75 | 2 | 2.25 | 2.375 | 2.5 |
| 220 | 2.20 | 22.44 | 1956 | 2549 | 3232 | 3592 | 3983 |
| 230 | 2.30 | 23.46 | 2000 | 2607 | 3305 | 3673 | 4073 |
| 240 | 2.40 | 24.48 | 2043 | 2663 | 3376 | 3752 | 4160 |
| 250 | 2.50 | 25.50 | 2085 | 2718 | 3445 | 3829 | 4246 |
| 260 | 2.60 | 26.52 | 2127 | 2771 | 3514 | 3905 | 4330 |
| 270 | 2.70 | 27.54 | 2167 | 2824 | 3581 | 3979 | 4413 |
| 285 | 2.85 | 29.07 | 2226 | 2902 | 3679 | 4088 | 4534 |
| 300 | 3.00 | 30.60 | 2284 | 2977 | 3774 | 4194 | 4651 |
| 315 | 3.15 | 32.13 | 2341 | 3050 | 3867 | 4298 | 4766 |
| 330 | 3.30 | 33.66 | 2396 | 3122 | 3958 | 4399 | 4878 |
| 345 | 3.45 | 35.19 | 2450 | 3192 | 4047 | 4498 | 4988 |
| 360 | 3.60 | 36.72 | 2502 | 3261 | 4134 | 4595 | 5095 |
| 375 | 3.75 | 38.25 | 2554 | 3328 | 4220 | 4689 | 5200 |
| 390 | 3.90 | 39.78 | 2605 | 3394 | 4303 | 4782 | 5303 |
| 405 | 4.05 | 41.31 | 2654 | 3459 | 4385 | 4873 | 5404 |
| 420 | 4.20 | 42.84 | 2703 | 3522 | 4466 | 4963 | 5504 |
| 435 | 4.35 | 44.37 | 2751 | 3585 | 4545 | 5051 | 5601 |
| 450 | 4.50 | 45.90 | 2798 | 3646 | 4622 | 5137 | 5697 |
| 465 | 4.65 | 47.43 | 2844 | 3706 | 4699 | 5222 | 5791 |
| 480 | 4.80 | 48.96 | 2889 | 3765 | 4774 | 5306 | 5884 |
| 495 | 4.95 | 50.49 | 2934 | 3824 | 4848 | 5388 | 5975 |
| 510 | 5.10 | 52.02 | 2978 | 3881 | 4921 | 5469 | 6065 |
| 525 | 5.25 | 53.55 | 3022 | 3938 | 4993 | 5549 | 6153 |
| 540 | 5.40 | 55.08 | 3065 | 3994 | 5064 | 5627 | 6240 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1.75 | 2 | 2.25 | 2.375 | 2.5 | |
| 555 | 5.55 | 56.61 | 3107 | 4049 | 5133 | 5705 | 6327 |
| 570 | 5.70 | 58.14 | 3149 | 4103 | 5202 | 5782 | 6411 |
| 585 | 5.85 | 59.67 | 3190 | 4157 | 5270 | 5857 | 6495 |
| 600 | 6.00 | 61.20 | 3231 | 4210 | 5338 | 5932 | 6578 |
| 615 | 6.15 | 62.73 | 3271 | 4262 | 5404 | 6005 | 6660 |
| 630 | 6.30 | 64.26 | 3310 | 4314 | 5469 | 6078 | 6740 |
| 645 | 6.45 | 65.79 | 3349 | 4365 | 5534 | 6150 | 6820 |
| 660 | 6.60 | 67.32 | 3388 | 4415 | 5598 | 6221 | 6899 |
| 675 | 6.75 | 68.85 | 3426 | 4465 | 5661 | 6292 | 6977 |
| 690 | 6.90 | 70.38 | 3464 | 4515 | 5724 | 6361 | 7054 |
| 705 | 7.05 | 71.91 | 3502 | 4563 | 5786 | 6430 | 7130 |
| 720 | 7.20 | 73.44 | 3539 | 4612 | 5847 | 6498 | 7206 |
| 735 | 7.35 | 74.97 | 3576 | 4660 | 5908 | 6565 | 7281 |
| 750 | 7.50 | 76.50 | 3612 | 4707 | 5968 | 6632 | 7354 |
| 765 | 7.65 | 78.03 | 3648 | 4754 | 6027 | 6698 | 7428 |
| 780 | 7.80 | 79.56 | 3683 | 4800 | 6086 | 6763 | 7500 |
| 795 | 7.95 | 81.09 | 3719 | 4846 | 6144 | 6828 | 7572 |
| 810 | 8.10 | 82.62 | 3754 | 4892 | 6202 | 6892 | 7643 |
| 825 | 8.25 | 84.15 | 3788 | 4937 | 6259 | 6956 | 7713 |
| 840 | 8.40 | 85.68 | 3822 | 4981 | 6315 | 7019 | 7783 |
| 855 | 8.55 | 87.21 | 3856 | 5026 | 6372 | 7081 | 7852 |
| 870 | 8.70 | 88.74 | 3890 | 5069 | 6427 | 7143 | 7921 |
| 885 | 8.85 | 90.27 | 3923 | 5113 | 6482 | 7204 | 7989 |
| 900 | 9.00 | 91.80 | 3957 | 5156 | 6537 | 7265 | 8056 |

**Table 4.12.1(a) Theoretical Discharge Through Circular Orifices (US Gallons of Water per Minute)**

| Pitot Pressure (psi) | Feet | Orifice Size (in.) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1.75 | 2 | 2.25 | 2.375 | 2.5 | |
| 915 | 9.15 | 93.33 | 3989 | 5199 | 6591 | 7325 | 8123 |
| 930 | 9.30 | 94.86 | 4022 | 5241 | 6645 | 7385 | 8190 |
| 945 | 9.45 | 96.39 | 4054 | 5283 | 6699 | 7444 | 8255 |

Notes:

(1) This table is computed from the formula $Q_M = 0.666cd^2\sqrt{p_M}$ , with *c* = 1.00. The theoretical discharge of seawater

(2) Appropriate coefficient should be applied where it is read from the hydrant outlet. Where more accurate results are re discharge from circular openings of sizes other than those in the table can readily be computed by applying the principle t

**4.12.1.1**

If more than one outlet is used, the discharges from all are added to obtain the total discharge.

**4.12.1.2**

The formula that is generally used to compute the available flow in the desired test location (either the underground main or static/residual hydrant, depending on the test), the specified residual pressure, or for any desired pressure drop is Equation 4.12.1.2:

[4.12.1.2]

$$Q_R = Q_F \times \frac{h_r^{0.54}}{h_f^{0.54}}$$

where:

$Q_R$=

flow predicted at desired residual pressure

$Q_F$=

total flow measured during test

$h_r$=

pressure drop to desired residual pressure

$h_f$=

pressure drop measured during test

**4.12.1.3**

In Equation 4.12.1.2, any units of discharge or pressure drop can be used as long as the same units are used for each value of the same variable.

**4.12.1.4**

In other words, if $Q_R$ is expressed in gpm, $Q_F$ must be in gpm, and if $h_r$ is expressed in psi, $h_f$ must be expressed in psi.

**4.12.1.5**

These are the units that are normally used in applying Equation 4.12.1.2 to fire flow test computations.

---

4.13 Data Sheet.

**4.13.1**

The data secured during the testing of hydrants for uniform marking can be valuable for other purposes.

**4.13.2**

With this in mind, it is suggested that the form shown in **Figure 4.13.2** be used to record information that is taken.

## WATER FLOW TEST REPORT

NFPA®

Location: ______________________ Test by: ______________________

Address: ______________________ Date: ______________________

______________________ Time: ______________________

**SYSTEM DATA**

Size of main: __________ Dead end: __________ Looped: __________

Comments: ____________________________________________

**TEST DATA**

Location of test hydrants: Residual hydrants: ______________________

Flow hydrant A: ______________________

Flow hydrant B: ______________________

Static pressure: __________

| Test No. | No. of Outlets | Orifice Size (in.) | Orifice Coeff. | Residual Pressure (psig) | Pitot Pressure (psig) | Flow (US gpm) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |

Projected results @ 20 psi: __________

**Sketch of test configuration**

**Figure 4.13.2** Sample Report of a Hydrant Flow Test.

**4.13.3**

The back of the form should include a location sketch.

**4.13.4**

Results of the flow test should be indicated on a hydraulic graph, such as the one shown in **Figure 4.13.4**.

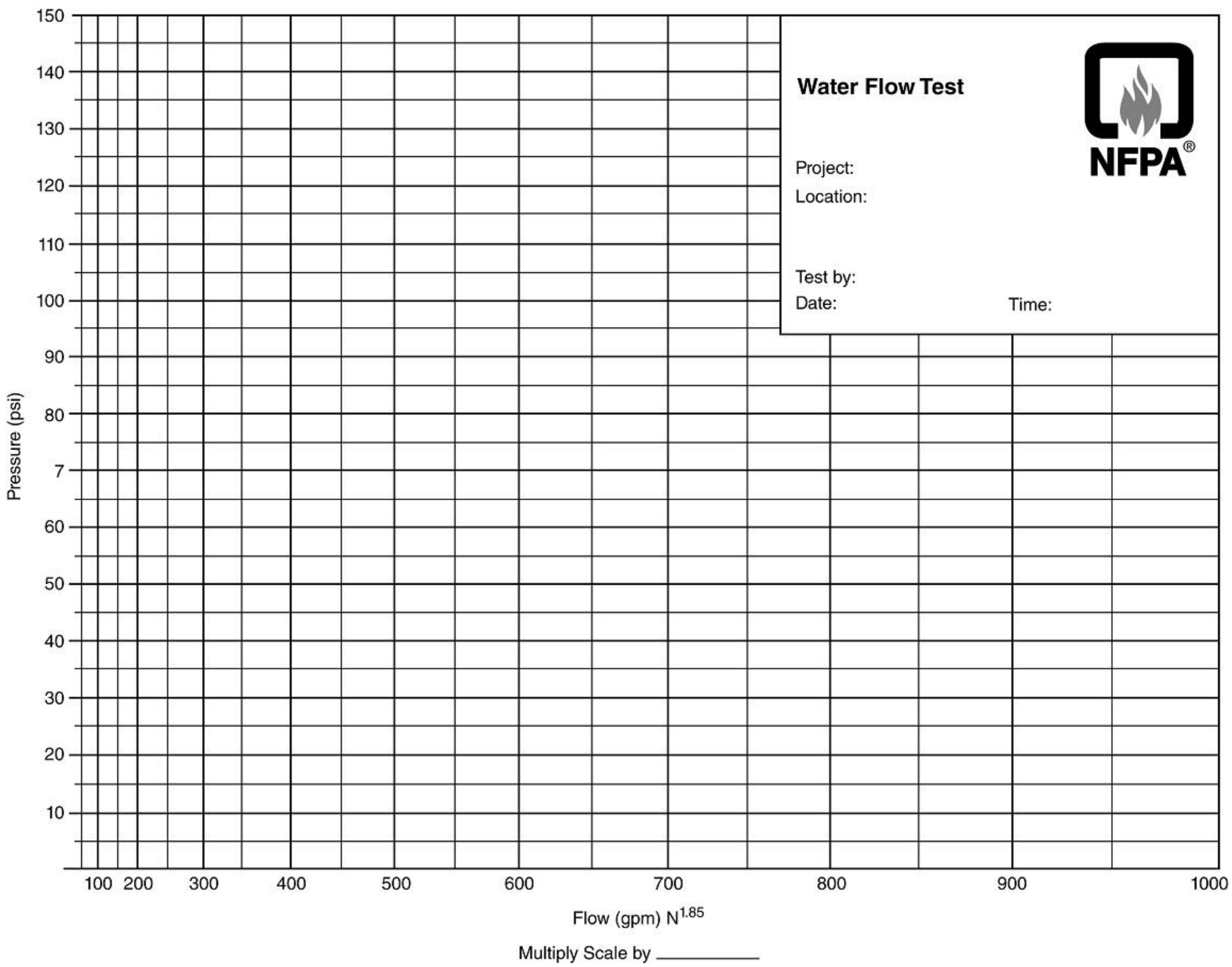


**Figure 4.13.4** Sample Graph Sheet.

**4.13.5**

When the tests are complete, the forms should be filed for future reference by interested parties.

---

4.14* System Corrections.

Flow test results show the strength of the distribution system at the time and date of the testing. It does not necessarily indicate the degree of adequacy of the entire water works system. If the testing does not occur during a period of peak demand, then the flow test results might not provide an accurate representation of the water available during those peak periods.

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4.15 Public Hydrant Testing and Flushing.

**4.15.1***

Public hydrants should be flow tested at least every 5 years to verify capacity and marking of the hydrant.

**4.15.2**

Public hydrants should be flushed at least annually to verify operation, address repairs, and verify reliability.

**4.15.3**

Public fire hydrants should be inspected, tested, and maintained in accordance with ANSI/AWWA G200, *Standard for Distribution Systems Operation and Management*.

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4.16 Private Hydrant Inspection, Testing, and Maintenance.

Private fire hydrants should be inspected, tested, and maintained in accordance with NFPA 25.

Marking of Hydrants

5.1 Classification of Hydrants.

Hydrants should be classified in accordance with their rated capacities [at 20 psi (1.4 bar) residual pressure or other designated value] shown in **Table 5.1**.

**Table 5.1 Classification and Marking of Hydrants**

| **Hydrant Classification** | **Color Scheme** | **Hydrant Capacity (gpm)** | **Hydrant Capacity (L/min)** |
|---|---|---|---|
| AA | Light blue | >1500 | >5700 |
| A | Green | 1000–1499 | 380–5699 |
| B | Orange | 500–999 | 1900–3799 |
| C | Red | <500 | <1900 |

---

5.2 Marking of Hydrants.

**5.2.1 Public Hydrants.**

**5.2.1.1**

All barrels should be chrome yellow except in cases where another color has already been adopted.

**5.2.1.2**

The tops and nozzle caps should be painted with the capacity-indicating color scheme shown in **Table 5.1** to provide simplicity and consistency with colors used in signal work for safety, danger, and intermediate condition.

**5.2.1.3**

For rapid identification at night, it is recommended that the capacity colors be of a reflective-type paint.

**5.2.1.4**

Hydrants rated at less than 20 psi (1.4 bar) should have the rated pressure stenciled in black on the hydrant top.

**5.2.1.5**

In addition to the painted top and nozzle caps, it can be advantageous to stencil the rated capacity of high-volume hydrants on the top.

**5.2.1.6**

The classification and marking of hydrants provided for in this chapter anticipate determination based on individual flow test.

**5.2.1.7**

Where a group of hydrants can be used at the time of a fire, some special marking designating group-flow capacity could be desirable.

**5.2.2 Permanently Inoperative Hydrants.**

Hydrants that are permanently inoperative or unusable should be removed.

**5.2.3 Temporarily Inoperative Hydrants.**

Hydrants that are temporarily inoperative or unusable should be wrapped or otherwise provided with temporary indication of their condition.

**5.2.4 Flush Hydrants.**

Location markers for flush hydrants should carry the same background color as stated above for class indication, with such other data stenciled thereon as deemed necessary.

**5.2.5 Private Hydrants.**

**5.2.5.1**

All barrels should be red except in cases where another color has already been adopted.

**5.2.5.2**

The tops and nozzle caps should be painted with the following capacity-indicating color scheme to provide simplicity and consistency with colors used in signal work for safety, danger, and intermediate condition:

- (1)

Class AA — Light blue

- (2)

Class A — Green

- (3)

Class B — Orange

- (4)

Class C — Red

**5.2.5.3**

For rapid identification at night, it is recommended that the capacity colors be of a reflective-type paint.

**5.2.5.4**

Hydrants rated at less than 20 psi (1.4 bar) should have the rated pressure stenciled in black on the hydrant top.

**5.2.5.5**

In addition to the painted top and nozzle caps, it can be advantageous to stencil the rated capacity of the high-volume hydrants on the top.

**5.2.5.6**

The classification and marking of hydrants provided for in this chapter anticipate determination based on individual flow test.

**5.2.5.7**

Where a group of hydrants can be used at a time of a fire, some special marking designating group-flow capacity could be desirable.