Guideline for Flow and Pressure Testing of Hydrants

1 Introduction

1.1 A fire hydrant is a mechanism that enables fire fighters to gain access to the water distribution system. Property owners / users should ensure that fire hydrants are inspected periodically by a competent person and that flow and pressure tests are regularly carried out.

1.2 Flow and pressure tests are carried out on the water distribution system to determine whether sufficient capacity is available to enable the Fire Service respond efficiently to an incident in the area-location serviced by the hydrant.

1.3 As these tests are to ascertain the volume of water available for fire-fighting purposes, the hydrant test equipment should attach to the standpipe using fittings in use by the Fire Service for fire-fighting. The hydrant test equipment should not restrict the flow of water from the hydrant.

1.4 Units: Metric units of measurement are used in this Guideline. These are listed in Table 1 with conversion factors for other units commonly used by international Fire Services.

Table 1. Measurement units and conversion factors.

Measurement	Unit Name	Unit Symbol	Conversion Factor
Flow	Litres per minute	L/min	Gal/min
Volume	Litre	L	1 (US) gal = 3.785 L
Pressure	Bar	Bar	1 bar = 14.51 psi

2. Definitions

2.1 Fire Hydrant - Underground. An assembly contained in a pit or box below ground level and comprising a valve and outlet connection from a water supply main.

2.2 Fire Hydrant - Pillar. An assembly comprising a valve and outlet connection whose outlet connection is fitted to a vertical component projecting above ground level.

2.3 Hydrant Outlet. The component of a fire hydrant to which a Fire Service fitting, such as a fire hose, can be connected.

2.4 Standpipe. An item of equipment used to bring the outlet of a hydrant to above ground level so that discharge hose can be connected to the hydrant.

2.5 Hydrant bar and key. Tools used to open up a hydrant and to turn on the valve.

2.6 Competent Person: A person with the necessary training and experience, who has the relevant tools, equipment and information which allows him carry out the procedures of this Guideline.

2.7 Static Pressure: The pressure measured when the hydrant(s) is closed. Please note that this is not the true static pressure of the water distribution system. It is the available static pressure under normal water usage conditions. The true static pressure can be measured when no water is being drawn from the distribution system.

2.8 Residual Pressure: The pressure measured when the hydrant(s) is fully opened and water is flowing from the hydrant.

2.9 Fire Flow: The flow rate in litres per minute drawn from the water distribution system by the Fire Service to extinguish a fire.

2.10 Rating Pressure: The residual pressure at the hydrant at which the fire flow is measured.

3 Rating

3.1 Rating Pressure.

3.1.1 A uniform rating of hydrants is achieved by measuring the flow rate of water at a specified residual pressure. A residual pressure of 1.4 bar (20 psi) is generally recommended to be retained at hydrants when delivering fire flows.

3.1.2 Hydrants having a static pressure of less than 2.8 bar (40 psi) should be rated at one-half of the static pressure. For example, if the measured static pressure is 2.2 bar, then the fire flow should be measured at a rating pressure of 1.1 bar.

3.1.3 Whilst Fire Service pumps can be operated when the residual pressure is less than 1.4 bar (20 psi), a primary concern is to maintain sufficient residual pressure to prevent developing a negative pressure at any point in the mains. Negative pressure could result in collapse of the mains or the back-siphonage of polluted water.

3.1.4 Many health departments do not permit the use of residual pressures of less than 1.4 bar (20 psi).

3.2 Rating Fire Flow.

3.2.1 The expected fire flow at the rating pressure (under normal distribution conditions) is specified either in the National Standard or in the risk assessment document for the area where the hydrant is located.

3.2.2 The British Standard (BS 5306:9.2) states that each hydrant on a town main should individually be capable of delivering a minimum of 1,500 litre/min at all times. Guidelines for high risk plants are given in Table 2.

3.2.3 The water authority should be notified when minimum fire flows are not obtained.

4 Procedure.

4.1 The flow test procedure is carried out by measuring the flow of water available from the distribution system at the rating pressure.

4.2 A typical town main can be tested at a single hydrant using a suitable flow and pressure test instrument.

4.3 Larger mains of higher capacity will require the simultaneous testing of several hydrants. The number of hydrants to test will depend on the demand flow rate specified in the user risk assessment document and on the strength of the mains in the vicinity of the test location.

4.4 For testing of large capacity mains, one hydrant is designated for the recording of static and residual pressures. The flow rates are measured from this hydrant and all other open hydrants. Sufficient hydrants are opened so that the residual pressure at the test hydrant drops to the rating pressure. Flow rates from all hydrants open during the flow test are recorded and totalled to give the rating fire flow.

4.5 Care should be taken to avoid causing nuisance during and after the tests. Fire flows can cause damage to surroundings (e.g., vehicles, pedestrians, landscapes) and can cause flooding in the vicinity or remote to the site. Pooled water can ice over in frosty weather and become a hazard. Scheduling of tests should be avoided under such weather conditions.

4.6 The local water authority should be informed prior to carrying out hydrant tests and tests should proceed with the approval of the local municipal water authority.

5 Equipment for Flow and Pressure Tests.

5.1 The equipment necessary for carrying out flow and pressure tests according to this Guideline consists of a standpipe with the correct adaptors, hydrant bar and key, crow bar and a suitable flow and pressure test instrument.

5.2 There are different test instruments available. This Guideline deals with the use of a digital flow and pressure test instrument incorporating a pressure gauge and a flow meter. Digital units have the advantage that they can be data logged and once calibrated, testing can be reproduced.

5.3 The flow and pressure test instrument is attached to the standpipe using fittings in use by the Fire Service / Emergency Response Team.

5.4 A pressure gauge of bourdon type having maximum range of 10 bar and 0.2 bar graduations is suitable for typical town hydrants. A bourdon pressure gauge having a larger maximum range (typically 20 bar) will be necessary for testing high pressure ring mains found in industrial facilities.

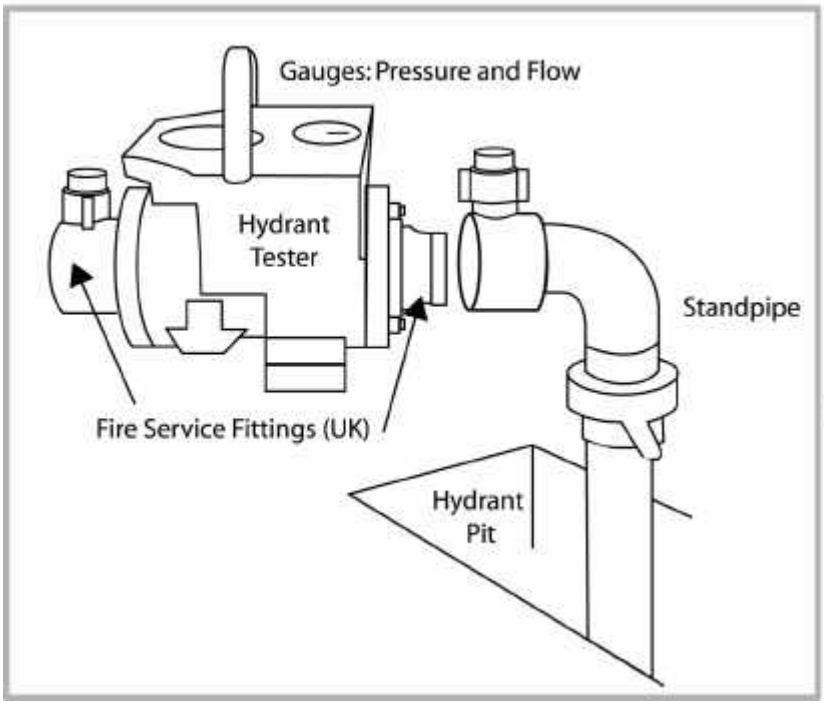
5.5 The flow meter should be of a type that does not impede the water flow in any way and that cannot be damaged by the debris found on opening most hydrants. Any type of mechanical protrusion into the water stream is not suitable. A flow meter of electromagnetic type is the most suitable as it has no mechanical moving parts, is robust, has a wide dynamic range and holds its calibration over time. Other advantages of electromagnetic flow meters are that they can be used with brackish water supplies and are not subject to blocking up - therefore giving reproducible readings as per the calibration result.

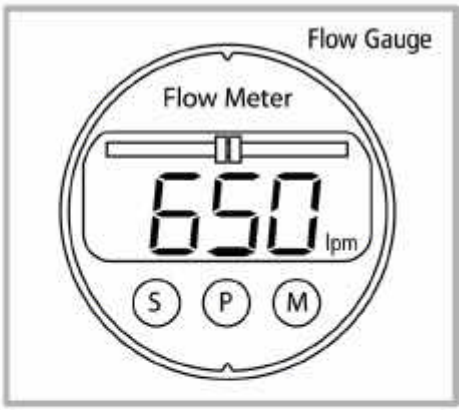
5.6 The flow reading should be shown as a number in litres/min or gallons/min on a digital readout so as to eliminate errors introducible when reading charts and tables or performing post-test calculations using formulae.

5.7 A blanking cap with an integral pressure relief valve is attached to the hydrant tester to facilitate static pressure testing.

5.8 When several hydrants are flowed, it may be useful to use portable radios to facilitate communication between test personnel.

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





6 Test Procedure.

6.1 Static Pressure Test.

6.1.1 A standpipe is fitted to the outlet and a flow and pressure test instrument to the standpipe outlet. A blank cap is fitted to the hydrant tester outlet and the pressure relief valve is left open.

6.1.2 The hydrant valve is partially opened to allow a small amount of water to flow and expel air from the equipment. The pressure relief valve on the blank cap is closed and the hydrant valve is fully opened.

6.1.3 Whilst under pressure, all joints are visually inspected for signs of leakage. Leakage's should be reported.

6.1.4 The static pressure is recorded.

6.1.5 The hydrant is then turned off without excessive force. The pressure relief valve is opened to exhaust pressure.

6.1.6 The pressure relief valve is opened to exhaust pressure.

6.2 Water Flow and Residual Pressure Test.

6.2.1 This hydrant test is carried out by fitting a standpipe to the outlet and a flow and pressure test instrument to the standpipe outlet. (Proceed directly from step 5.1.5 by removing the blank cap). Attach a short length of hose to the flow and pressure test instrument outlet to direct water to drain and to facilitate residual pressure measurement.

6.2.2 The hydrant valve is slowly opened and water is allowed to flow for a sufficient period[1] to flush the pipe-work of any debris present.

6.2.3 Typical town water distribution system: Open the hydrant valve until the residual pressure drops to the rating pressure for that hydrant. Record the flow reading from the digital readout on the hydrant tester and the residual pressure reading from the pressure gauge.

6.2.4 High capacity water distribution system: Open sufficient hydrants in succession until the residual pressure drops to the rating pressure for the test hydrant. Then record the flow reading from the digital readout on the flow and pressure test instrument for each hydrant that is open and the residual pressure reading from the pressure gauge on the test hydrant. The readings should be noted simultaneously.

6.2.5 The hydrants are turned off slowly, one at a time, and without excessive force. The flow and pressure test instrument and the standpipe are removed and the hydrant pit cover replaced

[1] Typically 30 seconds.

7 Records and reporting

The results of the fire hydrant test should be reported to the property owner / user. A typical report format for a town water distribution system is outlined in Figure 2. Any hydrant failing a test should be retested following receipt of notice of rectification of fault. A typical report card for high capacity water distribution systems is shown in Figure 3.

Figure 2. Typical hydrant test report.

Hydrant Flow and Pressure Test Report

Location: XYZ Ltd, Business Park, London Date: 17-02-2003

Test by: A.N. Other Representative of Services Ltd Time: 11:00 am

If pumps affect flows and pressures, indicate operating pumps: _____

	Hydrant Number					
Test Description	1	2	3	4	5	6
Static Pressure (bar)						
Residual Pressure (bar)						
Flow Rate (litre/min)						
Volume used (litre)						
Test Result						

Notes: _____

Signed: Competent Tester Witnessed By: Safety Officer

Location Map: Indicate hydrant location on a site map

It is recommended that the property owner / user establish a communication process with the local Municipal Fire Brigade as the water available from hydrants can have a significant impact on their anticipated ability to fight fires. This information will allow the local Municipal Fire Brigade, if appropriate, to amend their response to an incident to take account of actual conditions.

Figure 3. Typical hydrant test report for high capacity water distribution system.

Hydrant Flow and Pressure Test Report

Location: _____ Date: _____

Test by: _____ Representative of _____ Time: _____

If pumps affect flows and pressures, indicate operating pumps: _____

Hydrant Number (1): _____

Static Pressure (bar): _____ Residual Pressure (bar): _____

Hydrant Number	Flow Rate (litre/min)	Volume Used (L)
1		
2		
3		
4		
5		
6		
7		
TOTAL FLOW		

Notes: _____

_____

Signed: Competent Tester Witnessed By: Safety Officer

Location Map: Indicate hydrant location on a site map

For further information contact:
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Appendix A: Referenced documents

BS 5306: Part 1: 1976. Code of practice for fire extinguishing installations and equipment on premises, Part 1. Hydrant systems, hose reels and foam inlets.

DCOL2002/3: National guidance document on the provision of water for fire fighting, Water UK.

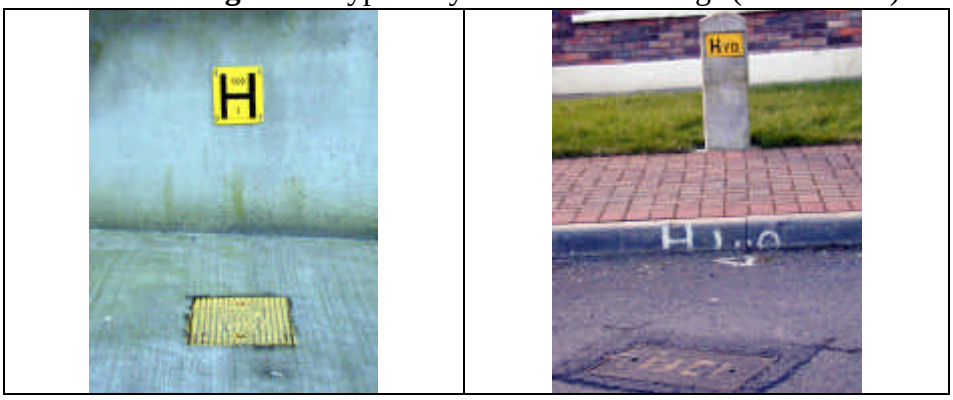
NFPA 291: Recommended Practice for Fire Flow Testing and Marking of Hydrants, 2002 Edition.

Fire Protection Handbook – NFPA.

Manual of Firemanship, Book 7: Hydraulics, pumps and pump operation – Home Office.

Appendix B: Typical hydrant and markings.

Figure 4. Typical hydrants and markings (UK version).



Appendix C. Requirement to test

The regulations concerning fire hydrants are BS5306, DCOL2002/3 and NFPA14. These documents state that hydrants shall be tested regularly to ensure proper functioning and to ensure that supplies have not deteriorated. Recommendations concerning the frequency of flow and pressure testing range from six to twelve months (BS5306 and NFPA14) and risk assessed whereby frequency of testing is determined according to the nature of the risk in the hydrant vicinity (DCOL2002/3).

Appendix D. Demand Flow Rates for High-Risk Plants.

Table 2. Estimation of total water requirement for major fires at high-risk facilities.

Severity	M^3/hr	L/min
Low	540 ~ 1,080	9,000 ~ 18,000
Medium	1,080 ~ 1,620	18,000 ~ 27,000
High	1,620 ~ 3,280	27,000 ~ 54,000

Appendix E. Estimation of Strength of a High Capacity Water Distribution System using Data acquired by testing a Single Hydrant.

Full flow testing of high capacity systems is not always desirable. By emptying water storage tanks or by depleting the water distribution system, a temporary fire protection weakness can be created until the tanks have been refilled. In such a case it may be sufficient to test a single hydrant (subject to insurer and fire brigade approval) and estimate the water distribution system capacity using a proportion derived from the Hazen-Williams formula.

This proportion allows the measured flows and pressures to be converted to any desired residual pressure or flow rate. The Hazen-Williams formula shows that the flow rate in litres per minute is directly proportional to the 0.54^{th} power of the drop in pressure from static to residual observed during the test.

$$Q_2 / Q_1 = (S - R_2)^{0.54} / (S - R_1)^{0.54} \qquad (1)$$

and $$Q_2 = Q_1 (S - R_2)^{0.54} / (S - R_1)^{0.54} \qquad (2)$$

where Q = flow rate in litres per minute
S = static pressure in bar
R = residual pressure in bar

Example: The flow rate recorded from a hydrant test was 1,800 lpm, the static pressure was 5.2 bar and residual pressure was 4.1 bar. What would the flow rate be when the residual pressure is 1.4 bar? An estimation of flow rate can be made using the proportional Hazen-Williams formula as demonstrated here. The 0.54^{th} power of typical numbers encountered is given in Table 2 where h = (S – R).

$S - R_2 = 5.2 - 1.4 = 3.8$ bar and $3.8^{0.54} = 2.056$
$S - R_1 = 5.2 - 4.1 = 1.1$ bar and $1.1^{0.54} = 1.053$
$Q_2 = 1{,}800 \times (2.056/1.053) = 3{,}516$ lpm.

Table 2. Numbers to 0.54 Power

h	$h^{0.54}$	h	$h^{0.54}$	h	$h^{0.54}$	H	$h^{0.54}$	h	$h^{0.54}$
0	0	1.6	1.2889	3.2	1.8740	4.8	2.3328	6.4	2.7248
0.1	0.2884	1.7	1.3318	3.3	1.9054	4.9	2.3589	6.5	2.7477
0.2	0.4193	1.8	1.3736	3.4	1.9364	5	2.3848	6.6	2.7705
0.3	0.5220	1.9	1.4143	3.5	1.9670	5.1	2.4104	6.7	2.7931
0.4	0.6097	2	1.4540	3.6	1.9971	5.2	2.4358	6.8	2.8155
0.5	0.6878	2.1	1.4928	3.7	2.0269	5.3	2.4610	6.9	2.8378
0.6	0.7589	2.2	1.5308	3.8	2.0563	5.4	2.4860	7	2.8599
0.7	0.8248	2.3	1.5680	3.9	2.0853	5.5	2.5107	7.1	2.8819
0.8	0.8865	2.4	1.6044	4	2.1140	5.6	2.5353	7.2	2.9038
0.9	0.9447	2.5	1.6402	4.1	2.1424	5.7	2.5596	7.3	2.9255
1	1.0000	2.6	1.6753	4.2	2.1705	5.8	2.5838	7.4	2.9470
1.1	1.0528	2.7	1.7098	4.3	2.1982	5.9	2.6077	7.5	2.9685
1.2	1.1035	2.8	1.7437	4.4	2.2257	6	2.6315	7.6	2.9898
1.3	1.1522	2.9	1.7770	4.5	2.2529	6.1	2.6551	7.7	3.0110
1.4	1.1992	3	1.8099	4.6	2.2798	6.2	2.6785	7.8	3.0320
1.5	1.2448	3.1	1.8422	4.7	2.3064	6.3	2.7017	7.9	3.0529