Indiana Water Operator Training Manual

Lesson Three – DSM operators

Contents

DSM systems and operators

Both water systems and water system operators receive classifications from IDEM. As discussed in lesson one, a class DSM (distribution system medium) system includes systems that meet one of the following:

(A) Serve a population greater than or equal to three thousand three hundred one (3,301) but less than or equal to ten thousand (10,000) people and have no mechanical means of movement of water other than one (1) of the following:
- (i) Pressure tanks
- (ii) Storage tanks

(B) Consist of the following:
- (i) Pump
- (ii) Storage tanks
- (iii) Booster pumps to storage tanks

A DSM operator is a certified operator qualified to operate a Class DSS and DSM water distribution system after having fulfilled the following requirements:

(A) Possess a high school diploma or its equivalent

(B) Meet the qualifications of the certification rule

(C) Attain one (1) of the following acceptable work experience requirements:
- (i) One (1) year in the operation of a Class DSM water distribution system
- (ii) Two (2) years in the operation of a Class DSS water distribution system

Storage tank booster pumps

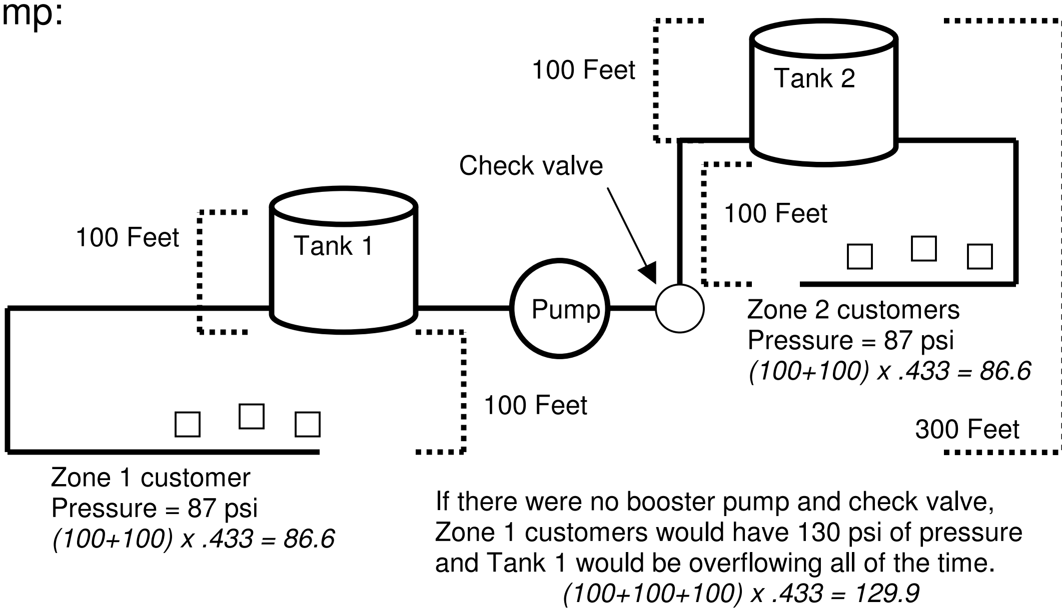
In some small water systems, elevated storage tanks may not be practical. Such tanks are expensive to construct and maintain. While a shallow well pump or submersible pump and pressure tank may provide adequate pressures if the distribution system is small and within generally level terrain, long pipe runs (especially uphill) may result in unacceptably low pressures.

An inline booster pump can be added to a water system to increase pressures. Small inline pumps are sometimes referred to as demand pumps. These pumps have a pressure control switch that senses a drop in pressure and turns on the pump. When the pressure in the system gets high enough again, the pump shuts off.

Inline booster pumps function very much as do water system pumps for large recreational vehicles.

Larger water systems may have very long runs of pipe and hilly terrain. These systems will often have distribution system storage tanks. To increase system pressures and fill the storage tanks, large pumps known as booster pumps are necessary. The structure in which these pumps are installed is called a booster station.

This drawing shows a typical water system employing a booster pump:



Pump maintenance

Proper pump maintenance extends the useful life of the pump. Longer life translates into money saved and more dependable and reliable service.

Different types of pumps require different levels of maintenance. Let us examine some of the more common kinds of pumps.

Centrifugal pump

Small centrifugal pumps are often used to pump water from shallow wells. These pumps suck the water up through a pipe, much as one might draw up a soda with a straw. Since they depend upon atmospheric pressure to push the water up the intake pipe, they will only withdraw water down to about 25 feet.

Components of a centrifugal pump include:

- Suction pipe
- Impeller
- Discharge pipe
- Motor
- Shaft

Very little maintenance of these kinds of pumps is required. The most important aspects of long-term operation of these units are the proper installation of the pump (following the manufacturer's instruction) and keeping the impeller free of debris, sand, etc. Keeping the pump primed is also very important. Dry impellers will self-destruct in a very short time if run without water.

Jet pump

Jet pumps are centrifugal pumps that use a venturi to increase the effectiveness of the pump. A venturi is a restriction at the nozzle on the suction pipe that creates a vacuum as water from the impeller passes it. The vacuum draws the water up the well through the suction tube and into the main flow going through the impeller.

Maintenance requirements for jet pumps are about the same as for centrifugal pumps.

<u>Submersible pumps</u>

These pumps are designed to be placed within the well casing. Submersibles are constructed as an all-in-one unit containing a motor, turbine pump and water screen. Their motors usually operate at about 3,600 revolutions per minute (RPM).

Small pumps of this type, say one to four or six inches, are basically "throw-a-ways." They are sealed at the factory and are not designed to be repaired. Qualified personnel can repair larger units. Repair of a submersible pump is not a do-it-yourself project.

<u>Deep well turbines</u>

Deep well turbines consist of both underground and aboveground components. The pump's bowl and turbine are submerged and the motor is mounted aboveground with a connecting drive shaft inside the column (discharge) pipe. Pump motors usually run at about 1,800 RPM.

Proper maintenance of these pumps is important to help ensure long life. Automatic oilers must be checked regularly and kept full of the proper lubricant. Any glands should be properly packed with the recommended material and checked regularly. Shaft alignment is critical and must be properly maintained. Adequate electrical power must be maintained. Higher horsepower motors may be multi-phased and require 220, 440 or 880 voltages. Proper safety procedures must be followed at all times.

Most pump maintenance is preventive in nature. Here are some suggestions:

- Lubricate at recommended intervals
- Use the recommended lubricants
- Use the proper packing materials
- Do not over-tighten packing glands

- Keep everything aligned
- Exercise isolation valves
- Keep spare parts on hand
- Schedule maintenance instead of emergency response
- Keep good records

Keep four main things in mind about pump maintenance.

- Look for
  - Proper alignment
  - Leaks

- Listen for
  - Squealing
  - Grinding

- Touch for
  - Temperature
  - Vibration

- Record for comparison
  - Pressure
  - Flow
  - Electrical current

Remember, change in most of these conditions usually is not good, but better to get bad news early than too late.

Records

Maintaining proper records of the operation of a water system can be a hassle but is worth the trouble. Records can paint a history of a water system. A water system operator can show compliance with regulations with proper records. A written history helps to deal with problems that are new to the current operator, but have been dealt with by others in the past.

Examples of records that are often maintained by water systems include:

- Laboratory tests
- Financial matters
- Valves and hydrants
- Maintenance logs
- System maps
- As-builts*
- Manuals
- Customer complaints

**Maps or drawings depicting the actual installation of pipes and equipment. Also called record drawings. As-builts often differ from original plans.*

Some records must be retained for certain periods of time by IDEM regulations:

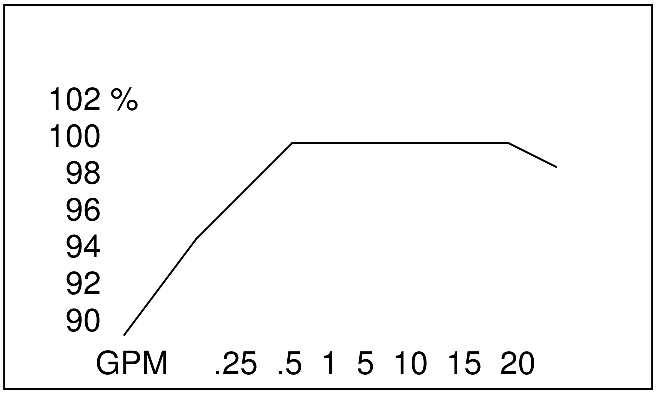
Bacteriological	5 years
Radiological and chemical	10 years
Lead & copper	12 years
Violation remediation	3 years
Sanitary surveys	10 years
Variances	5 years

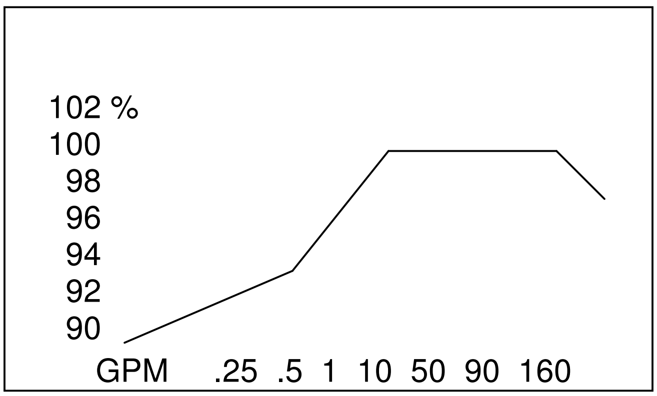
Meter selection

Water meters are often said to be like cash registers for your business. If you sell water to your customers, you need to be able to show that the charges are related to the amount of the water consumed by the user.

Meters are a necessity for plant operation. The proper mixing of chemicals depends upon knowing how much water you are dealing with. Meters may be required to determine backwash rates.

Be sure to match meter characteristics to normal demands. The wrong type of meter for a particular application may result in inaccurate readings. That makes for unhappy customers and bad operations.





These charts show the accuracy curves for a 5/8” x ¾” and 2” meter. The meter is accurate down to about .25 GPM, but cannot pass more than about 20 GPM.

The 2” meter can meter up to about 160 GPM, but its accuracy falls way off below 1 GPM. It probably will not even register very small flows like dripping leaks.

The two basic types of water meters are positive displacement (piston or disk) and turbine. Positive displacement meters are best applied at lower flows, say .25 to 150 GPM. These meters are sized from about ½” to 2”. At flows above about 150 GPM, turbine meters are usually the best choice.

Turbine meters are sized beginning at 3” and go up to about 20”. Most modern meters use magnetically-coupled registers to allow register changes without removing the meter.

As with most rules, there are exceptions. There are several small turbine meters that can work in residential settings. Make sure the meter you choose is American Water Works Association (AWWA) compliant and appropriate for the flow range application.

Pressure vessels

Certain types of pressurized water tanks, water softeners and other specialized water treatment equipment may be classified as *pressure vessels* by the Indiana Department of Homeland Security (DHS).

Generally speaking, pressure vessels are regulated if they are located in an area intended for public assembly for civic, educational, worship, correctional, entertainment and other similar purposes.

A water treatment plant usually is not considered an area of public assembly, however, a water treatment facility located in a school, church, prison or other qualifying facility, containing a pressure vessel, may be subject to regulation by DHS.

There are exemptions to the pressure vessel regulations that may be found on the next page of this manual.

If you have questions concerning pressure vessels, you should contact the DHS Boiler and Pressure Vessel Safety Division at 317-232-1921. Its Website may be visited at http://www.in.gov/dhs/fire/branches/boilers/index.html.

Vessels Exempt from ASME Standard construction & Boiler and Pressure Vessel Safety Div. Regulation.

(a) "Regulated boiler or pressure vessel" refers to any part of a boiler or pressure vessel not described in subsection (b).
(b) The term does not include any of the following:

(1) Water heaters commonly known as domestic water heaters having a size and heat input that does not exceed that specified by the rules board.
(2) Pressure vessels other than nuclear vessels operated entirely full of water or other liquid that the rules board specifically found to be not materially more hazardous than water, if the temperature of the vessel's contents does not exceed one hundred eighty degrees Fahrenheit (180 F).
(3) Boilers and pressure vessels under federal regulation.
(4) Pressure vessels meeting the requirements of the Interstate Commerce Commission for shipment of liquids or gases under pressure.
(5) Air tanks located on vehicles operating under the rules of other state authorities and that are also used for carrying passengers or freight.
(6) Air tanks installed on the right-of-way of railroads and used directly in the operation of trains.
(7) Pressure vessels that were installed before July 1, 1971, and that have a volume of:

(A) fifteen (15) cubic feet or less if located in a place other than a place of public assembly; and
(B) five (5) cubic feet or less if located in a place of public assembly.

(8) Pressure vessels, other than nuclear vessels that were installed after June 30, 1971, and that have a volume of:

(A) fifteen (15) cubic feet or less, if adequately protected by pressure relieving devices set to function at three hundred (300) pounds per square inch or less and located in a place other than a place of public assembly;
(B) five (5) cubic feet or less if adequately protected by pressure relieving devices set to function at two hundred fifty (250) pounds per square inch or less and located in a place of public assembly; or
(C) one and one-half (1 1/2) cubic feet or less regardless of pressure or location, unless otherwise covered by this article.

(9) Pressure vessels, other than nuclear vessels protected by adequate pressure relieving devices, set to function at not over fifteen (15) pounds per square inch gauge.
(10) Pressure vessels containing liquified petroleum gases and regulated by the commission.
(11) Surgical sterilizers, coffee urns, and steam jacketed food cookers that do not exceed size limits specified by the rules board.
(12) Commercial toy boilers and miniature model boilers constructed as a hobby that do not exceed a size specified by the board.
(13) Pressure vessels containing anhydrous ammonia, used in transportation, distribution, or use storage of the product as a liquid fertilizer, and for which a general scheme of construction, installation, and safety requirements has been adopted by statute or rule of another state agency. This exemption does not apply to vessels in refineries or in manufacturing or processing plants.
(14) Nuclear vessels for the collection and disposal of nuclear waste from a nuclear energy system that are not subject to pressures greater than would prevail if they were vented to the atmosphere.
(15) Standard and miniature traction engine boilers and other boilers used solely for exhibition purposes.
(16) A locomotive boiler used only on a railway that is used as a tourist attraction.

Distribution system flushing

Water main flushing is performed to maintain water quality in the distribution system and provides the opportunity to test valves and hydrants.

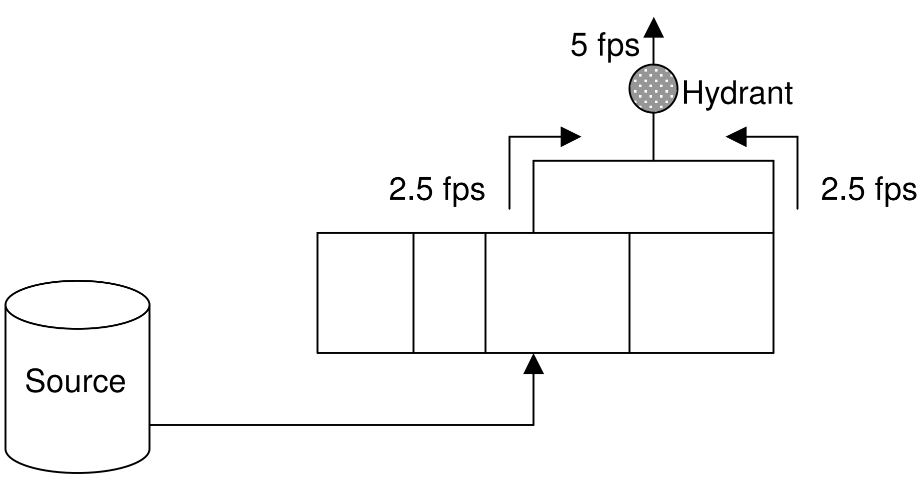
Safety is always an issue with system flushing. Running water attracts children and adult spectators. Traffic control is very important. If you will be working in the public right-of-way, be sure to coordinate your activities with local authorities.

Think about where the water will go. Flushed water loves basements, garages, driveways and flowerbeds.

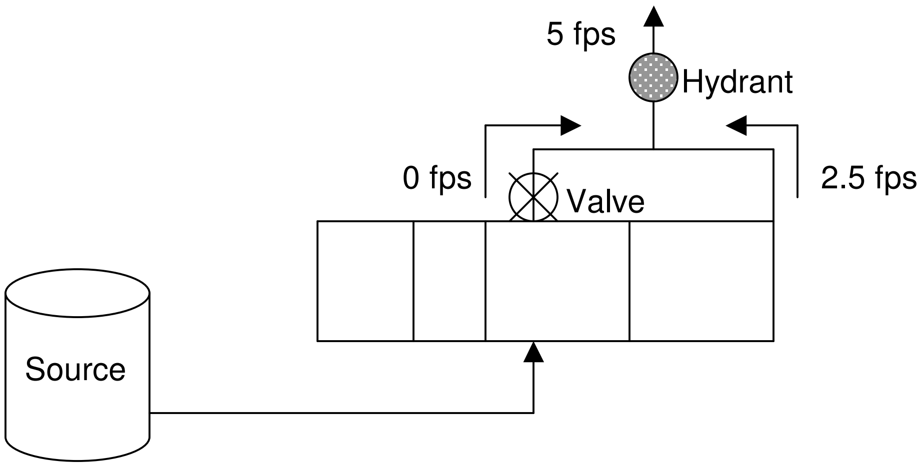
There are two kinds of flushing: Multi-directional (multiple directions at the same time) and unidirectional (only one direction at a time). Both types should start from the source of supply, and work out from there. The idea is to always flush with clean water.

Flushing should obtain a minimum velocity 2.5 feet per second within the pipe being flushed. Ideally, the velocity should reach 5 feet per second.

Here is an example of multi-directional flushing:



This drawing illustrates unidirectional flushing:



To calculate the velocity of water in a pipe, we need to understand how to figure the volume (amount) of water in the pipe.

Calculating volumes

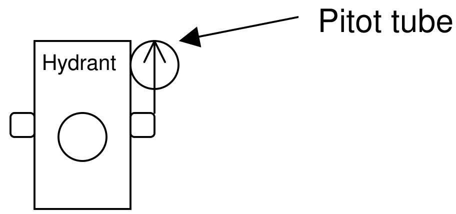
V = A x L
V = Volume in cu. ft.
A = (area in square ft.) = *π x R (squared-number times itself)*
π = 3.14 (π is a Greek letter Pi pronounced pie)
R = radius of main (in feet); radius is ½ the diameter
π is the ratio of a circle's circumference divided by its diameter: 22 ÷7= 3.142857 (rounded to 3.14)
L = Length of main (in feet)

V= A x L V (cu. ft.) = [3.14 **x** (.5ft x .5ft.)] **x** 500 ft. V (cu. ft.)= [3.14 **x** (.25 sq. ft.)] **x** 500 ft. V (cu. ft.)= .785 sq. ft. **x** 500 ft. V (cu. ft.)= 392.5 cu. ft.	1 cubic foot of water = 7.48 gallons of water V (g*allons*) = 392.5 cu. ft. **x** 7.48 gallons/cu. ft. V (g*allons*) = 2,935.9 gallons

Example: 500 ft. of 12" water main has how many gallons of water in it?

We now know that 500 feet of 12” water main has 2,936 gallons of water in it. 500 feet divided by 2.5 fps (the minimum velocity we need to flush properly) = 200 seconds or 3.33 minutes. 2,936 gallons divided by 3.33 minutes = 882 GPM.

882 GPM is the rate-of-flow we need. To measure the flow from the hydrant a Pitot tube (gauge) is used. These are obtained from most water works suppliers, or might be borrowed from the local fire department. The tube is placed into the flow of the hydrant and the gauge will display the flow based on the water pressure and the size of the port on the hydrant.



Congratulations. You have completed lesson three of the Indiana Water Operator Training Manual.

To test your comprehension of the material included in lesson three, a self-graded examination has been prepared for your use. The examination begins on the next page. There are 10 questions that will take a total of about 10-15 minutes to complete. Do not over analyze the questions. Just look for the best answer.

Good luck with the test. You will find the answers in Appendix G-3 of this manual.

There is a Microsoft PowerPoint® slideshow associated with these lessons. The slideshow is located on the compact disc included with this manual.

If you do not have the disc, or would like to view the slideshow on the Internet, you may find it at http://www.Indianawateroperatortraining.org.

Indiana Water Operator Training

Self-graded examination

Lesson 3

Check one best answer per question

Question1.
Why might a distribution system have multiple pressure districts (zones)?
___A. To store extra water in case of emergency
___B. To avoid excessively high pressure in low lying areas
___C. To reduce pump maintenance requirements
___D. To separate cold and hot water tanks

Question 2.
In a jet pump, the venturi should be at least 18 inches from the suction tube.
___A. True
___B. False

Question 3.
In a deep well turbine, the motor is located below the impeller.
___A. True
___B. False

Question 4.
Which item is not a good pump maintenance practice?
___A. Tighten packing glands until they stop leaking
___B. Use the proper packing materials
___C. Keep spare parts on hand
___D. Keep the manuals and refer to them

Question 5.
Records of sanitary surveys should be retained for at least:
___A. 2 years
___B. 4 years
___C. 8 years
___D. 10 years

Question 6.
A 2-inch water meter is more accurate at very low flows than a 5/8”x3/4” meter.
___A. True
___B. False

Question 7.
Nutating and piston disk water meters are examples of displacement meters.
___A. True
___B. False

Question 8.
Turbine water meters are generally a better choice for very high flows than displacement meters.
___A. True
___B. False

Question 9.
What is the minimum desired water flow velocity when flushing a distribution system?
___A. 1 foot per second
___B. 2.5 feet per second
___C. 10 feet per second
___D. 25 feet per second

Question 10.
A water system's Sample Site Plan should be:
___A. Kept on file at the water system and available for review by IDEM field personnel
___B. Sent to the Drinking Water Branch for review and filing
___C. Updated regularly to reflect actual practices
___D. All of the above