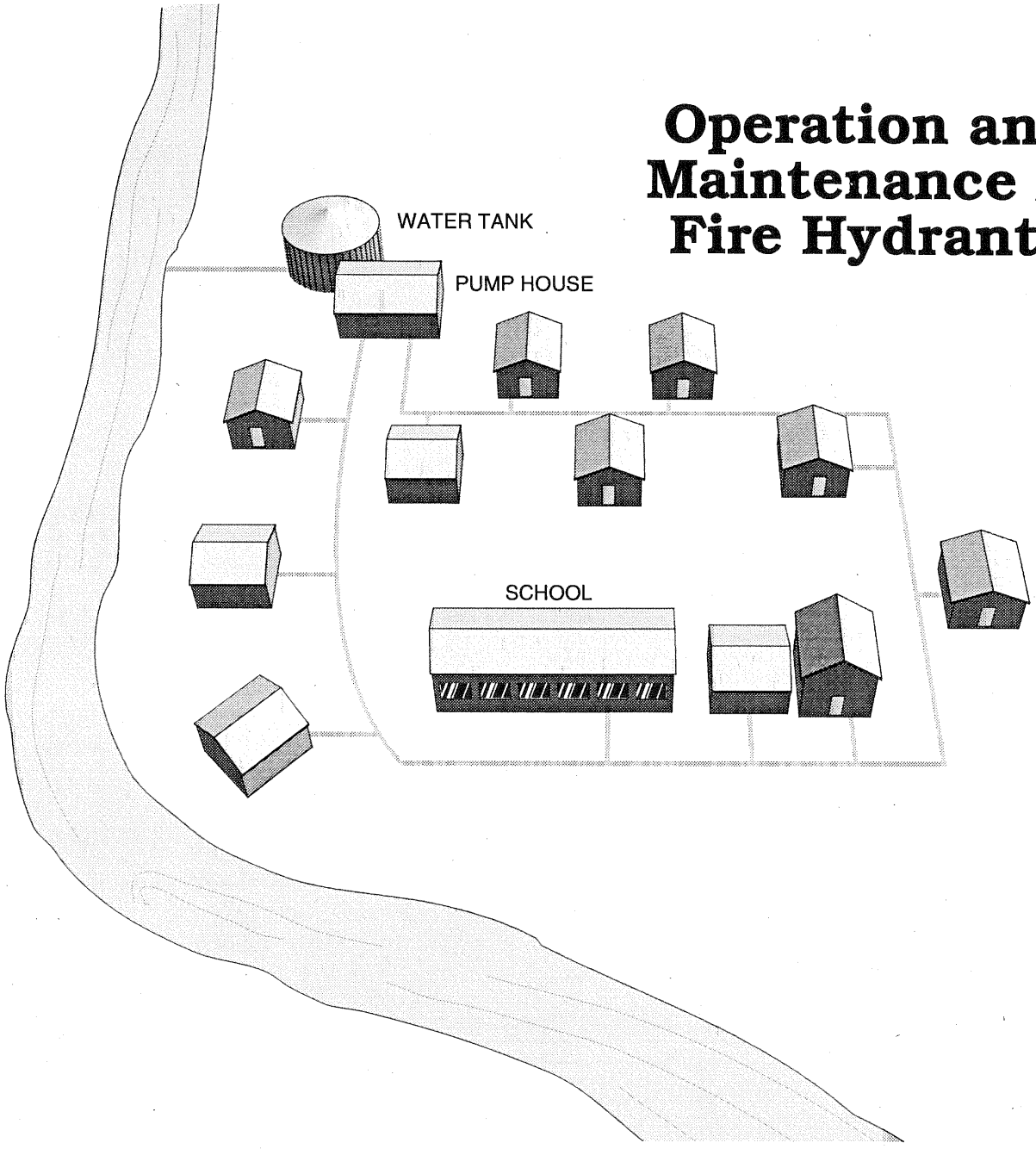
O & M of Small Water Systems

Operation and Maintenance of Fire Hydrants



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O & M of Small Water Systems

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TABLE OF CONTENTS

O & M of Fire Hydrants

O & M OF FIRE HYDRANTS

WHAT IS IN THIS MODULE?

1. Classification of fire hydrants.
2. Nomenclature of major hydrant components.
3. Operation of compression hydrants.
4. Operation of toggle hydrants.
5. Common brands used in small communities in Alaska.
6. Typical fire hydrant inspection.
7. Replacement of main valves on Mueller, Clow and American Darling fire hydrants.
8. Replacement of drain valve on Mueller, Clow, and American Darling fire hydrants.
9. The six most common fire hydrant problems and their solutions.

KEY WORDS

- Auxiliary valve
- Base
- Bonnet
- Bury
- Deflector
- Compression Hydrant
- Drain Valve
- Dry Barrel Hydrant
- Dry Top Hydrant
- Flush Hydrant
- Frost Jacket Hydrant
- High Pressure Hydrant
- Hose Outlet Nozzle
- Inlet Connection
- Lateral Line
- Lower Barrel
- Main Valve
- Main Valve Opening
- Nozzle Section
- Operating Nut
- Post Hydrant
- Propylene Glycol
- Pumper Outlet Nozzle
- Routine Inspection
- Slide Gate Hydrant
- Spanner Wrench
- Toggle Hydrant
- Traffic Model Hydrant
- Upper Barrel
- Wet Barrel Hydrant
- Wet Top Hydrant

MATH CONCEPTS DISCUSSED

No math concepts are discussed in this module

SCIENCE CONCEPTS DISCUSSED

- Corrosion
- Torque

SAFETY CONSIDERATIONS

- Traffic control
- Paint fumes
- Lifting
- Handling glycol

MECHANICAL EQUIPMENT DISCUSSED

- Dry barrel hydrants
- Toggle hydrants
- Main valves
- Thread gauges
- Hydrant seat wrench
- Compression hydrants
- Slide gate hydrants
- Hydrant drain valves
- Spanner wrench
- Pipe vice

O & M OF FIRE HYDRANTS

INTRODUCTION

Content

The materials in this module were designed for the few brands of fire hydrants found in rural Alaska. While some of the material is generic in nature, it in no way should be considered as comprehensive. The fire hydrants featured in this module are Mueller, American Darling and Clow.

PURPOSE AND USES OF FIRE HYDRANTS

Fire Suppression

Although fire hydrants are often used for other purposes, their primary function is for the supply of water for fire protection. Any other use is considered of secondary importance and should be controlled rigorously.

Line Flushing

The other common use of the fire hydrant is for line flushing. The hydrant's ease of operation and high flow capabilities make it a natural for use in flushing distribution system main lines. When line flushing is done in conjunction with systematic hydrant inspection, the primary function of the fire hydrant is kept in proper perspective.

Testing System

The owners and operators of the water system often use the fire hydrant as a means of testing the hydraulic capabilities of the distribution system. These tests, like the line flushing, should be conducted in conjunction with the need to test the distribution system flow in accordance with fire flow requirements. This allows for considerations of both fire flow requirements and customer flow and pressure needs.

Other Uses

Other common uses of the fire hydrant include a water source for street cleaning, sewer cleaning, commercial construction, street construction, recreation[1] and a watering point[2] for spray applicators used by farmers, street crews, highway maintenance personnel and commercial applicators. One of the most common conflicts between local government crews has to do with the use and control of water from fire hydrants. AWWA, through its fire hydrants standards committee, has taken the stand that any use of the fire hydrant for purposes other than fire protection and fire fighting should be carefully controlled and regulated.

[1] The use of fire hydrants for recreation is discouraged by many water utilities. However, in some locations a systematic controlled use of hydrants for recreation is common during the summer months.

[2] When using a fire hydrant for these purposes an approved backflow protection system must be installed.

Ownership & Responsibility

AWWA has also taken the stand that the fire hydrant, like all other appurtenances attached to the water distribution system, should be the property and responsibility of the water system owner. However, they realize that in some jurisdictions, individuals and local entities other than the water utility use and maintain the fire hydrants. Therefore, they have taken the position that when the responsibility to operate and maintain the hydrant has been transferred to someone other than the water utility, they should maintain a detailed written agreement governing this transfer of responsibility. It should be pointed out that even when there is a written agreement between the water utility and another party, the utility still maintains the responsibility to see that the proper maintenance is performed on the hydrants.

HYDRANT TYPES - GENERAL

General Divisions

Hydrants manufactured in the United States can be divided into two categories: wet barrel and **dry barrel hydrants**[3]**.** These categories are further divided. Hydrants that are designed with the entire operating unit placed underground and covered with a lid at ground level are called **flush hydrants**[4]**.** The flush hydrant is not very common in the United States. It is used on bridges and in airports or other situations where it would be dangerous for the hydrant to extend above the ground. The other category are those hydrants designed to extend above the ground, commonly referred to as **post hydrants**[5]**.**

Wet Barrel Hydrants

Wet barrel hydrants[6] are manufactured in accordance with AWWA Standard C-503. A wet barrel hydrant has the **main valve**[7] located on each outlet nozzle. The entire hydrant is full of water at all times.

Dry Barrel Hydrants

Dry barrel hydrants are manufactured in accordance with AWWA Standard C-502. Dry barrel hydrants have the main valve located below ground and the section that extends to above ground is void of water except during operation. These hydrants are also equipped with **drain valves**[8], which allow the entire portion of the hydrant that extends above the control valve to be automatically drained when the hydrant is not in use.

[3] **Dry Barrel Hydrant** - A hydrant designed with the operating mechanism located below the ground and with a drain valve that allows the barrel section to drain automatically.
[4] **Flush Hydrant** - A hydrant designed so that the outlet connections are below the ground line.
[5] **Post Hydrant** - A wet or dry barrel hydrant that is designed to extend above the ground. The outlet connections are commonly 24 inches above the ground line.
[6] **Wet Barrel Hydrant** - A hydrant designed with the operating mechanism above the ground. The hydrant sections are charged with water at all times.
[7] **Main Valve** - A part made of rubber, leather or similar resilient material that is forced against a seat to form a watertight seal when the hydrant is closed.
[8] **Drain Valve** - A valve located at or adjacent to the valve seat ring, which opens automatically when the main valve is closed and allows water to drain from the barrel to the ground.

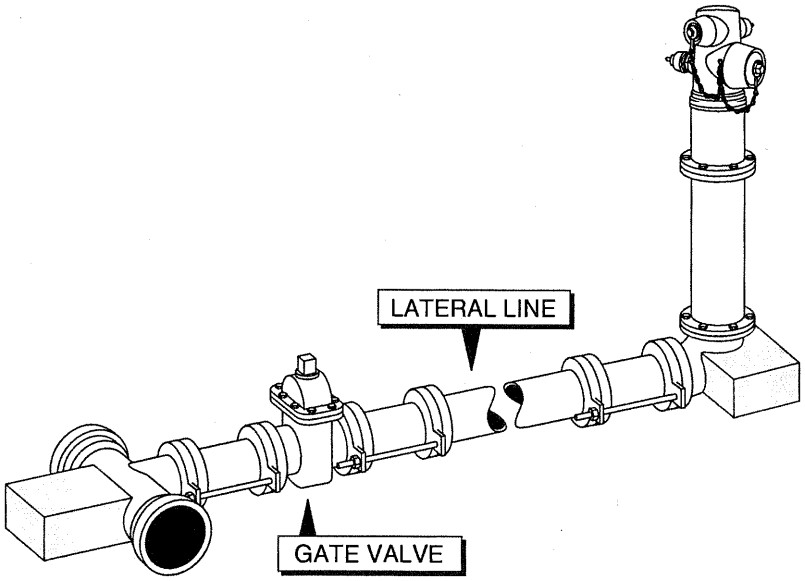
High Pressure Hydrants

Special hydrants not covered by either of the above standards are manufactured to meet high pressure requirements by communities. Both wet and dry barrel **high pressure hydrants**[9] are manufactured. High pressure means that the hydrant was designed to be used when the normal distribution system operating pressure is above 150 psi.

WET BARREL HYDRANT DESCRIPTION

Connection to the Main

The wet barrel hydrant is connected to the distribution system main through a tee placed in the line. The line leading from the main to the hydrant is called the **lateral line**[10] and is normally 6 inches or larger. A valve is commonly located in the lateral between the hydrant and the main. This valve allows the operator to shut off the water during repair of the hydrant.



Outlet Connections

The valves used to control the hydrant flow are located in the top portion of the hydrant. The hydrant can be equipped with either two **hose outlet nozzles**[11], which are commonly 2 1/2 inches, or two hose outlet nozzles and one **pumper outlet nozzle**[12]. The pumper outlet nozzle is normally 4 inches or larger.

Advantage of Wet Barrel

The primary advantage to the wet barrel hydrant is the ease at which a fire company can connect a second hose to the hydrant when the hydrant is in use. This is because each outlet nozzle is independently valved.

Disadvantage Wet Barrel

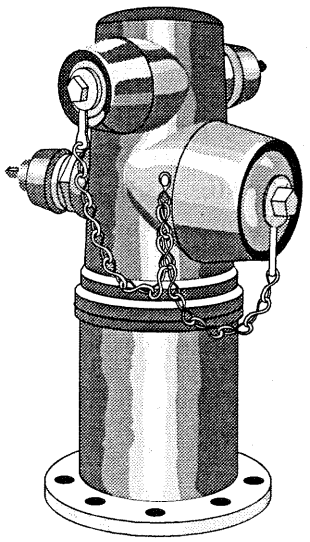
The major disadvantage is the obvious freezing problem and the fact that when these hydrants are

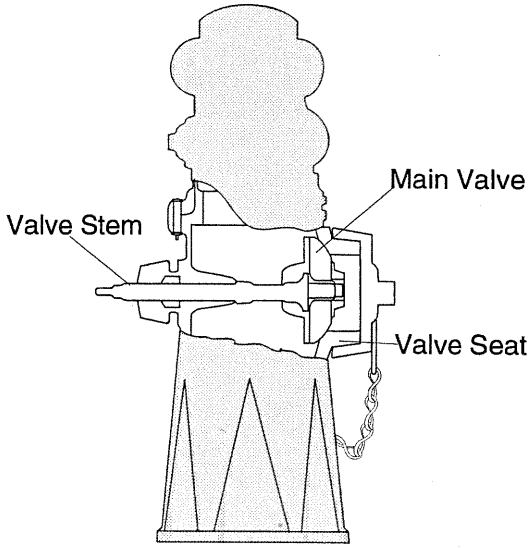
[9] **High Pressure Hydrant** - A hydrant designed to operate at pressures above 150 psi.
[10] **Lateral Line** - The line leading between the main and the hydrant.
[11] **Hose Outlet Nozzle** - An outlet nozzle having an opening smaller than 3 1/2 inches in diameter and suitable for attachment of 2 1/2-inch or 3-inch fire hose.
[12] **Pumper Outlet Nozzle** - An outlet nozzle having an opening at least 3 1/2 inches in diameter and suitable for attachment of 3 1/2-inch or larger fire hose.

knocked over by a vehicle, they leak water. This is the type of hydrant that is depicted in the movies, showing water squirting into the air after being struck by an automobile.

Where Used

Wet barrel hydrants are primarily used in locations where freezing is extremely uncommon. Common locations include southern California and Hawaii.

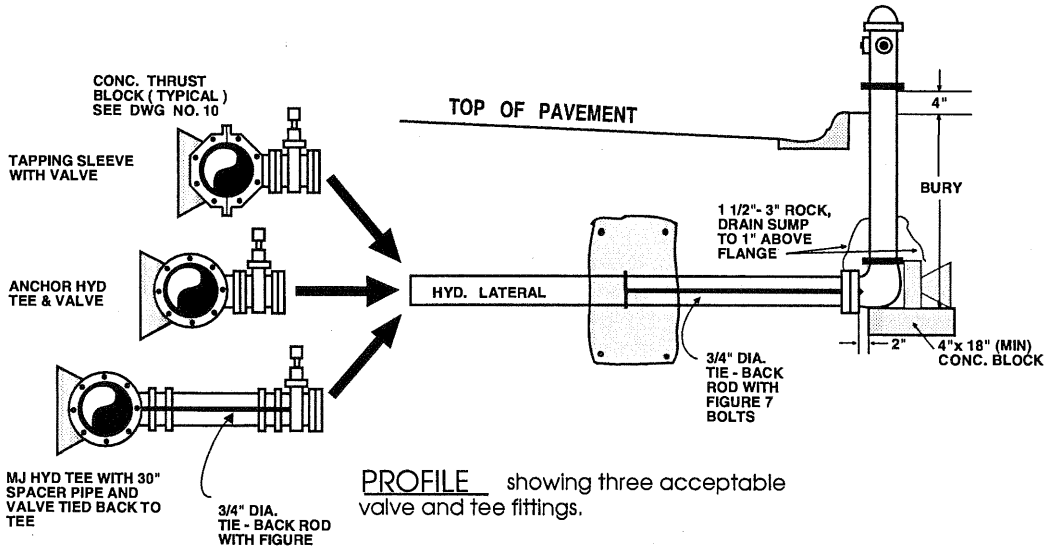




DRY BARREL HYDRANT DESCRIPTION

Connection to Main

The dry barrel hydrant is connected to the distribution system main through a tee in the main line. The line leading from the tee to the hydrant is called the lateral line and is normally 6 inches in diameter or larger. A valve is commonly placed in the lateral line. This valve allows the operator to shut off the water to the hydrant during hydrant repair. The valve is commonly placed as close as possible to the main line. This gives



PROFILE showing three acceptable valve and tee fittings.

the greatest protection should a leak or break occur in the lateral.

General Operation

There are three major styles of dry barrel hydrants, and in each case, the operating valve, called the main valve, is located in the bottom section of the hydrant close to the inlet from the lateral. The main valve may operate either horizontally or vertically, depending on the style of hydrant. A drain valve is located so that when the main valve is closed, the drain valve will drain the interior portion of the hydrant. The drain valve is closed during normal flow from the hydrant. This drain valve is automatically opened and closed when the hydrant is opened and closed.

Advantage - Dry Barrel

The major advantage that dry barrel hydrants have over wet barrel hydrants is the reduction in the potential for freezing during cold weather. Their other advantage is that they can be manufactured so that when hit by traffic they break at a designed point, reducing repair cost and when broken, there is no loss of water.

Disadvantage - Dry Barrel

The major disadvantage is the difficulty of connecting a second fire hose to the hydrant once it has been opened. The hydrant must either be shut off to make this connection or a manually installed valve must be placed on the second discharge nozzle during the connection of the first hose.

COMMON TYPES OF DRY BARREL HYDRANTS

Three Types

There are three common types of dry barrel hydrants: the **compression hydrant**[13], the **toggle hydrant**[14], and the **slide gate hydrant**[15]. In each case, the operating valve, called the main valve, is located in the bottom section of the hydrant close to the inlet from the lateral. The main valve may operate either horizontally or vertically, depending on the style of the hydrant. All dry barrel hydrants have a drain valve located in the bottom section that is closed when the main valve is open and open when the main valve is closed. This drain valve allows water in the barrel of the hydrant to drain into the soil.

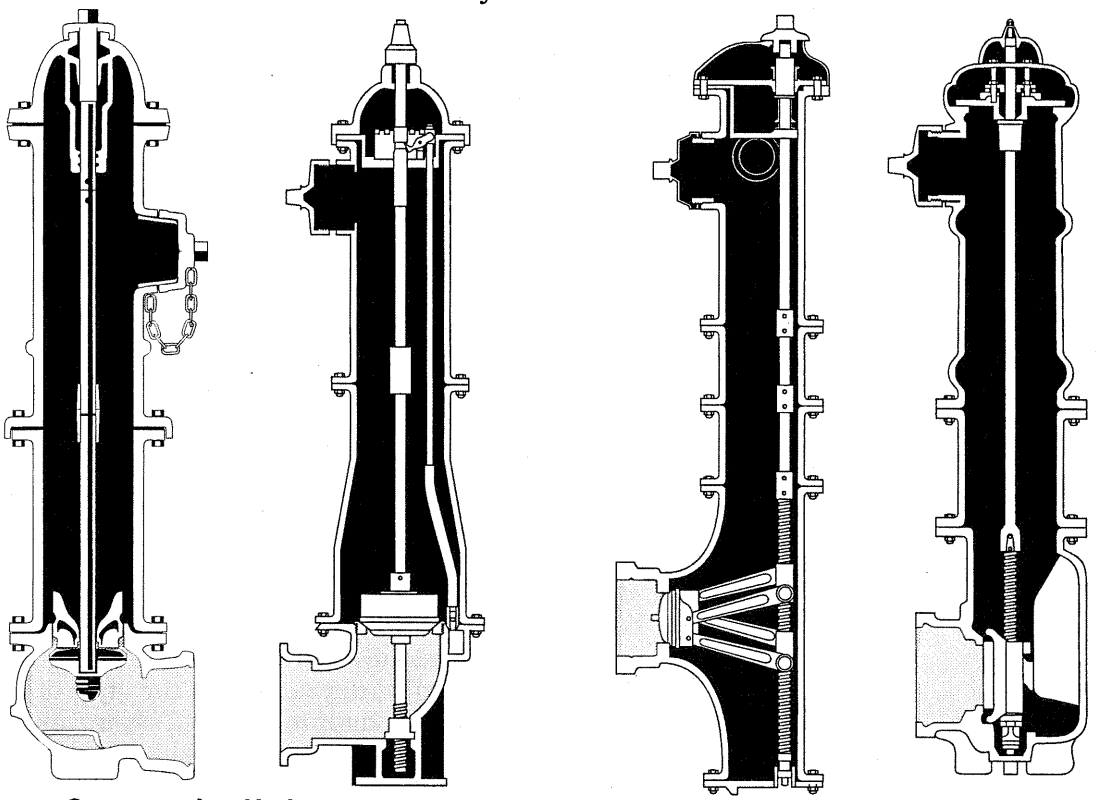
Compression Hydrants

The most common hydrant used in the United States is the compression hydrant. Some of the common manufacturers of this hydrant include American Darling, Canada Valve, Clow Corp., Dresser, Kennedy, Mueller, Terminal City, U. S. Pipe, Waterous and

[13] **Compression Hydrant** - A dry barrel hydrant with the main valve mounted horizontally on a vertical shaft. The main valve is moved vertically to open and close the hydrant.
[14] **Toggle Hydrant** - A dry barrel hydrant with the main valve mounted vertically on a horizontal toggle device. The device is moved by rotating a vertical shaft. The valve is moved horizontally to open and close the hydrant.
[15] **Slide Gate Hydrant** - A dry barrel hydrant with a vertically mounted valve that is shaped very much like a gate on a gate valve. The valve is moved vertically up and down a threaded shaft to open and close the hydrant.

Crane of Canada. The compression hydrant is designed with the main valve mounted horizontally on a vertical operating stem. The main valve opens by moving vertically away from the main valve seat (which is commonly made of brass). With the exception of the Eddy hydrant, manufactured by Clow, the main valve opens by being forced down against the pressure. The Eddy opens by moving the main valve upward with the flow.

The operating stem on compression hydrants is located in the center of the hydrant and is rotated to open and close the hydrant. With the exception of the Eddy hydrant, the **operating nut**[16] that is rotated does not move up or down during opening and closing of the hydrant.



Compression Hydrants

Opens against flow

Opens with flow

Toggle Hydrant

Slide Gate Hydrant

Toggle Hydrants

The second type of dry barrel hydrant is the toggle hydrant (also referred to as the Corey hydrant). Some of the common manufacturers of this hydrant are Pacific States, Clow, Corey and Rensselear. With the toggle hydrant, the main valve is mounted vertically and is moved horizontally back and forth against a brass seat to open and close the hydrant. The main valve is connected to a vertical shaft by two or more

[16] **Operating Nut** - A part that is internally threaded and engages with threads on the stem so that when it is rotated, the stem is raised, lowered or otherwise moved to open and close the main valve.

arms. When the main shaft is rotated, the one set of arms is moved up the shaft while the other is moved down the shaft. This movement causes the main valve to move away from the valve seat. The valve stem is normally offset from the center of the hydrant. The drain valve is placed on the very bottom of the hydrant.

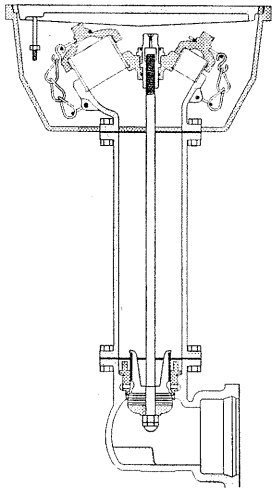
Slide Gate Hydrant

The third style of dry barrel hydrant is the slide gate hydrant. The two existing manufacturers of these hydrants are Ludlow and Terminal City. The slide gate hydrant has a valve very similar to the gate in a gate valve, mounted vertically on a vertical shaft. When the shaft is rotated, the valve makes a slight horizontal movement away from the brass valve seat and is then moved vertically upward. The operating shaft is commonly in the center of the hydrant and the drain valve is placed in the very bottom of the hydrant.

SPECIAL TYPES OF DRY BARREL HYDRANTS

As mentioned previously, dry barrel hydrants are also manufactured as flush hydrants and high pressure hydrants. Besides these two styles, there are also flush hydrants, **frost jacket hydrants**[17], **traffic model hydrants**[18], special Arctic hydrants and wet and **dry top hydrants**[19]. What follows is a brief description of each of these styles of hydrants.

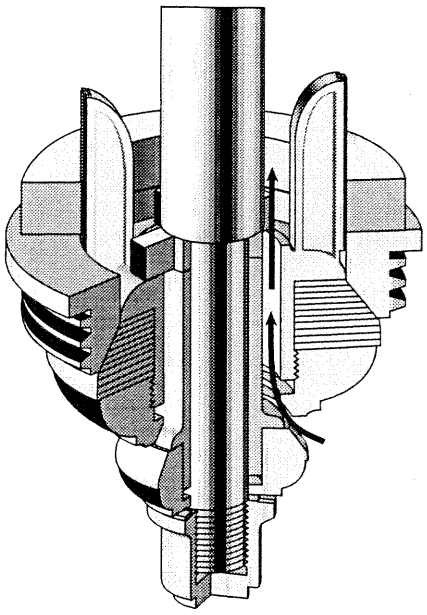
Flush hydrants



Flush hydrants are those hydrants that are designed with the entire operating unit placed underground and covered with a lid at ground level. The flush hydrant is not very common in the United States. It is used on bridges and in airports or other situations were it would be dangerous for the hydrant to extend above the ground. The lower section of a flush hydrant is identical to the lower section of a post hydrant.

[17] **Frost Jacket Hydrant** - A hydrant designed with a protective sheet extending from the base to the ground line.
[18] **Traffic Model Hydrant** - A hydrant designed and constructed so that if it is struck by a vehicle, certain easily replaceable components will break and allow the upper portion above ground line to become detached from the lower portion below the ground line.
[19] **Dry Top Hydrant** - A compression-type hydrant in which the operating mechanism at the top of the hydrant is sealed from the barrel so that water does not contact the mechanism during hydrant use.

High Pressure Hydrants

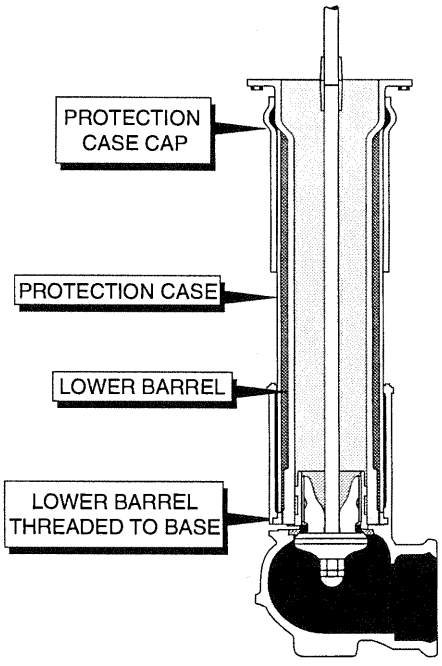


High pressure hydrants are hydrants manufactured to be operated at pressures above 150 psi. Most dry barrel high pressure hydrants look the same as standard pressure hydrants. The difference is in the strength of the materials and the design of the operating mechanism so that the hydrant can be more easily opened under these high pressures. One exception to this design is a special pilot valve in the center of the main valve. At the present time, only U. S. Pipe manufacturers such a valve. The pilot valve opens, first allowing water into the upper section of the hydrant and equalizing the pressure above and below the main valve. After a few more turns of the operating stem, the main valve begins to open.

Upon closing, the main valve closes first and then the pilot valve. This closing sequence reduces the possibility of water hammer during shutdown.

Frost Jacket Hydrants

The frost jacket hydrant is no longer being manufactured in the U.S. However, there are thousands of them in existence in systems throughout the country. They are a post-type hydrant designed with a metal tube attached to the **base**[20] of the hydrant and extending above the ground line. The barrel of the hydrant, including the main valve, was inserted inside of this tube and threaded into the base. The air space between the tube and the barrel

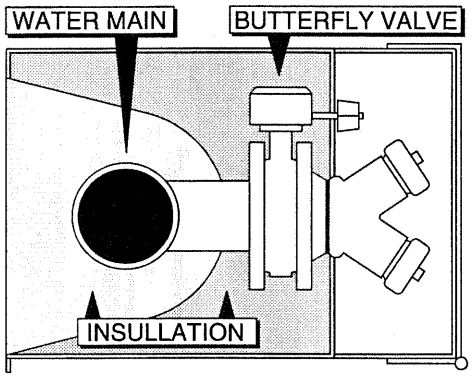


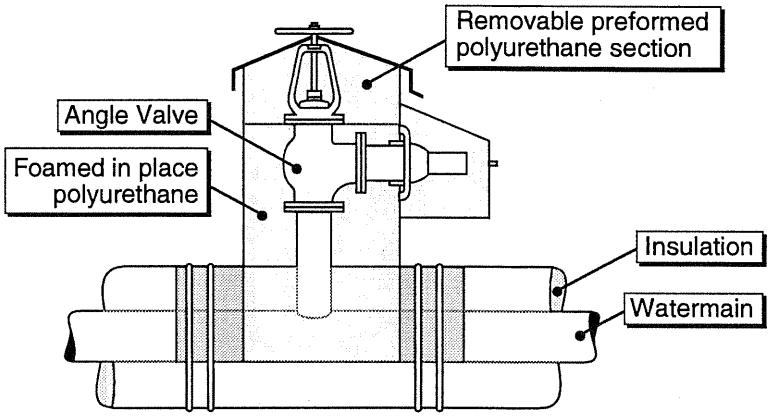
[20] **Base** - A part that provides a lateral connection to the water distribution system and directs the flow vertically upward.

of the hydrant serves to give some protection from freezing. The major disadvantage to this type of hydrant is strictly in the area of maintenance. In order to work on the main valve, the entire assembly from the base up had to be unthreaded and withdrawn from the tube.

Arctic Hydrants

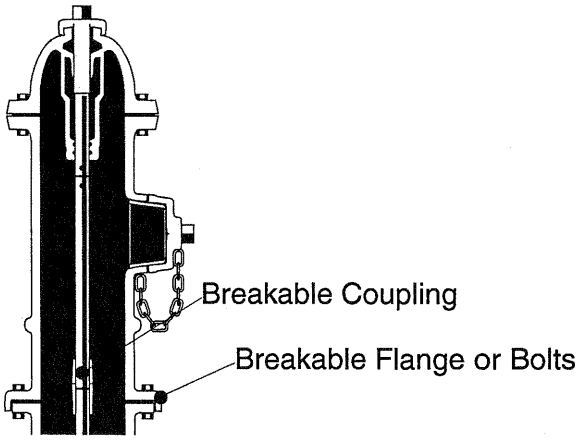
It is difficult to install and use standard fire hydrants with above ground utilidors such as those used in many of the Arctic villages. In order to provide fire protection in these situations a ball, globe or butterfly valve is often installed on a tee on the line. A hand wheel or other quick acting mechanism. The hydrant is protected from freezing with insulation.





Traffic Model Hydrants

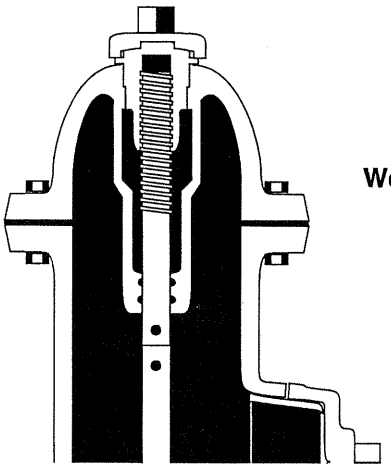
Traffic model hydrants are unique to the dry barrel hydrants. They are designed so that if they are struck by a vehicle they will break at a predesignated point with very little damage to the hydrant. The breaking point of the barrel is normally just above the ground line. The breakable component may be a flange or breakable bolts or some combination. There is also a breakable point on the stem coupling. All of the breakable components are easily replaced and typically are low in cost, making it relatively easy to put the hydrant back in service in an hour or less.



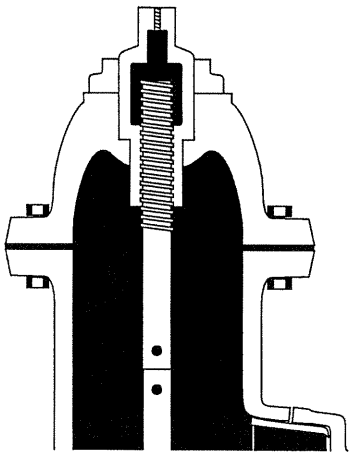
Wet Top and Dry Top Hydrants

The operating nut on most dry barrel hydrants is usually hollow and threads over the operating stem. The nut rotates and the stem is moved up and down inside of the nut. When a hydrant is designed so that water within the hydrant, when it is flowing, can reach these threads, the hydrant is referred to as a **wet top hydrant**[21]. When the threads are protected from the flow of water, the hydrant is called a dry top hydrant. The dry top hydrant requires a packing plate and some type of packing or "O" ring around the shaft. While this requires added maintenance, it reduces the maintenance problems associated with the operating stem threads being exposed to water each time the hydrant is used.

Dry Top Hydrant



Wet Top Hydrant



NOMENCLATURE FOR DRY BARREL HYDRANTS

Reference to AWWA

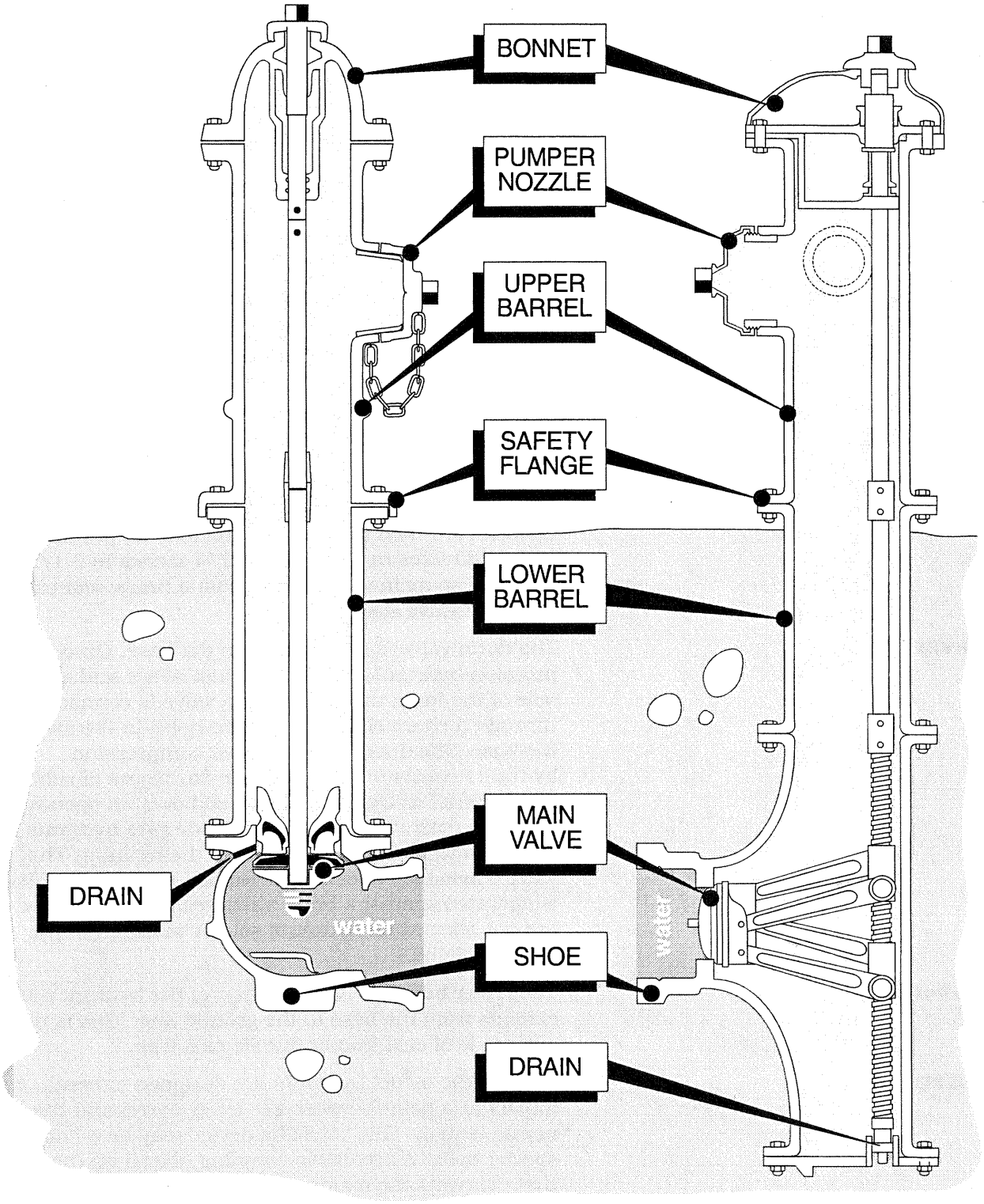
Each manufacturer of fire hydrants incorporates some unique features not available on other hydrants. These features and related components must be named. It is because of the uniqueness of each brand of hydrant that there are so many names for some of the common components. In order to bring some order to this situation, the AWWA Fire Hydrant Standards Committee, in its 1988 publishing of the M-17 manual, offered a listing of "preferred terms" for the most common hydrant components. The descriptions offered here are consistent with those found in M-17. The descriptions that follow trace the water flow through the hydrant from the main to the top of the hydrant.

Lateral Line

The line leading from the main to the hydrant is referred to as the lateral line. It has also been referred to as the hydrant **lead**[22] and hydrant branch. This line is typically 6 inches and is made of the same material as the main line.

[21] **Wet Top Hydrant** - A compression-type hydrant in which the operating mechanism at the top of the hydrant is not sealed from the hydrant barrel.

[22] **Lead Line** - The line leading between the main and the hydrant.



Auxiliary Valve

The **auxiliary valve**[23] is the valve placed in the lateral. This valve is normally a non-rising stem gate valve. The valve's primary function is to allow the operator to shutdown the hydrant for repair without any portion of the main being shutdown. It is common practice to

[23] **Auxiliary valve** - The valve placed in the line leading between the hydrant and the main; the lateral line.

place this valve as close to the main line as possible. By doing so, the valve can be used to shutdown the lateral should it be broken or develop a leak.

Base

The lateral connects to the hydrant at the hydrant base. The base houses the **inlet connection**[24] and the main valve *seat* is threaded into or otherwise secured to the base. The inlet connection is commonly 6 inches and may be a Mechanical Joint, rubber ring push on for PVC, cast iron or AC, or it may be a flanged joint.

Main Valve & Seat

The main valve and main valve seat are located in the base. The main valve is commonly some resilient material such as neoprene or leather. A common replacement material for main valves is polyurethane. The size of a hydrant is judged by the inside diameter of the main valve seat. This size is referred to as the MVO, **main valve opening**[25], and normally ranges from 4 1/4 inches to 6 inches. The size of the inlet connection does not dictate the MVO size. For instance a 6-inch inlet connection may be purchased with MVO sizes ranging from 4 1/4 inches to 6 1/2 inches. The main valve sits against a brass seat called the main valve seat.

Drain Valve

The drain valve is also located in the base. On compression hydrants, it is located just above and along side of the main valve. The drain valve is connected through a channel to one or more holes in the side of the base. The drain valve on most compression hydrants consists of one or more flat pieces of rubber-like material or leather that are slid over an opening to close the drain. With toggle and slide gate hydrants, the drain valve is in the bottom of the hydrant. The valve consists of a leather or rubber-like material that is operated against a brass valve seat. (Drain valves are not allowed on hydrants sold or installed in the state of Maine.)

Lower Barrel

The **lower barrel**[26] is the section of the hydrant that extends from the base to the ground line. This is usually made of cast iron or ductile cast iron.

Safety Flange

Most traffic model hydrants are designed to break on impact at a point between the lower barrel and the nozzle section. This breaking device may be a flange or special bolts. A breakable coupling placed on the shaft that connects the main valve with the operating nut. This coupling, like the safety flange is designed to break when the hydrant is hit and without damage to the hydrant.

[24] **Inlet Connection** - The connection to the lateral line; usually a 6-inch MJ, rubber ring push on or flange connection.
[25] **Main Valve Opening** - The inside diameter of the main valve seat.
[26] **Lower Barrel** - A part that extends from the base to the ground line, enclosing the operating mechanism, and conducts water from the base to the upper portion of the hydrant.

Nozzle Section

The section that extends above the ground may be one or two components. When it is one component, it is referred to as the **nozzle section**[27] because it houses the outlet nozzles. When this section is a two-piece section, the top section is referred to as the nozzle section and the section between the lower barrel and the nozzle section is called the **upper barrel**[28].

Outlet Nozzles

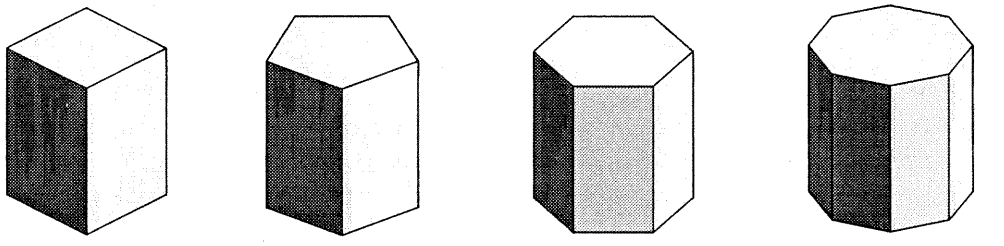
There are two types of outlet nozzles. The most common outlet nozzles are the hose nozzle outlets. These nozzles are designed to connect fire hoses up to 3 inches in diameter. The most common hose outlet nozzles are 2 1/2 inches with National Standard Threads. However, many specific fire departments have requirements for special threads that are only used in that fire jurisdiction. Most hydrants are manufactured with two 2 1/2-inch hose nozzle outlets. The other common outlet nozzle is the pumper nozzle outlet. The pumper nozzle is 3 1/2 inches or larger. Most hydrants with a pumper nozzle have only one pumper nozzle and two hose nozzles. In summary, then, there are two common hose nozzle combinations: two 2 1/2-inch hose nozzles or two 2 1/2-inch hose nozzles and one pumper nozzle.

Bonnet & Packing Plate

The **bonnet**[29] sits on top of the nozzle section and houses the operating nut and, if present, the packing plant.

Operating Nut

Operating nuts come in a variety of sizes and shapes. The common shapes are pentagon, square and octagon. The hydrant wrench connection on the outlet nozzle is the same size and shape as the operating nut on the hydrant. From an operations standpoint, it would be desirable to standardize the size and shape of all operating nuts on all the hydrants in the system. These nuts can be changed with relative ease so that if



SQUARE (4- Sided) PENTAGON (5- Sided) OCTAGON (6- Sided) HEXAGON (8- Sided)

[27] **Nozzle Section** - A part that extends upward from the barrel and contains the outlet nozzles. It may be integral with the upper barrel.

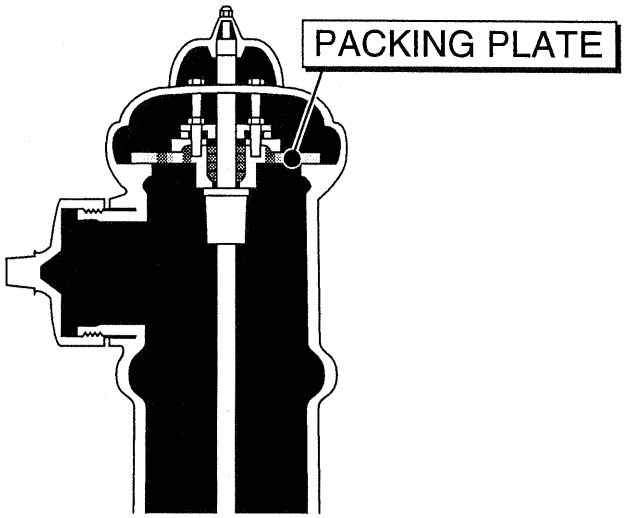
[28] **Upper Barrel** - The part that extends from the lower barrel to the nozzle section, enclosing the operating mechanism. It may be integral with the nozzle section.

[29] **Bonnet** - A part that attaches to the top of the nozzle section and encloses the support portions of the operating mechanism. It may be integral with the nozzle section.

a standard is not present, you have various sizes that can all be changed to a single size and shape with relatively little cost.

Packing and O-rings

The packing plate is only found on dry top hydrants. The packing plate forms a physical barrier between the nozzle section and the bonnet. It protects the threads on the operating stem and operating nut from the water in the nozzle section. The operating stem passes through the packing plate. To prevent water from traveling upward around the operating stem, packing or "O" rings are placed around the stem. Until very recently, the packing material used in fire hydrants was made from a combination of long fibrous asbestos and graphite. Due to the health hazards in the manufacture of asbestos-based packing, it is no longer available. The fire hydrant manufacturers recommend that when you replace the existing packing, you do so with a non-asbestos material. The life expectancy for the new packing material varies from type to type so you need to check with the packing manufacturer. The older asbestos-based material should be replaced every three to five years. The packing is held in place and the leakage controlled with a packing gland. This gland is drawn down against the packing with two nuts.



Bury

The **bury**[30] is not a hydrant component, but a description. Bury is the distance from the bottom of the trench to some predetermined point on the lower barrel of the hydrant. The point is usually 2" below the flange that connects the lower barrel to the nozzle section.

[30] **Bury** - The nominal vertical distance between the ground line and the bottom of the pipe connected to the hydrant inlet, measured to the nearest six-inch increment.

RECORD KEEPING AND DATA COLLECTION

WHY GATHER DATA?

Collecting and analyzing data from a systematic fire hydrant inspection and maintenance program will allow you to:

Inventory Control

Maintain an accurate inventory, allowing you to keep the proper quantities of items on hand and reduce the possibility of running out of parts and increasing the cost of maintenance. Maintenance costs are increased when the hydrant must be put back together or tagged out of service, requiring the crew to make a second visit.

Order Parts

Accurately order parts from the supplier. You need several pieces of data about a given hydrant to allow you to order the proper components. For instance, over a period of several years, a manufacturer may make a number of modifications to a hydrant that are not apparent by observation. Only knowing the actual date of manufacture can you obtain the correct components.

Locate Problems

Locate hydrants with chronic problems. Some organizations have determined that a particular hydrant should be replaced because the five-year repair cost was continuing to rise and was predicted to be greater than the cost of a new hydrant.

TYPES OF DATA COLLECTION SYSTEMS

Card Systems & Computers

Hydrant data, like other types of data, may be stored on cards or other paper products or in a computer system. With the development of the microcomputer, it has become much easier and more cost effective for even the smallest system to afford and use a micro computer. The advantage the computer system offers is the ability to easily analyze data and identify problems as described above.

Computer Programs

Two common computer systems lend themselves to use with the data that is collected from a distribution system. Using a common database such as Alpha on the IBM™ PC and its compatibles and acquiring the data described below, along with a good work order system, will allow you to generate the reports that are necessary to analyze the hydrant data. The use of the Apple Macintosh™ and a database such as File Maker Pro™ will allow you to do the same task. The advantage of the File Maker Pro™ program is the ability to develop input screens that look identical to the field report forms, thus making data input an easy task that can be accomplished by field personnel.

THE MASTER RECORD

Card System

The heart of any data system is the master record. The record system that you use need not be identical to the one described here. It should be a system that is useful to you. However, before you discard any of this data, think it through thoroughly.

The following description is in conjunction with the card shown below. Each entry will be indicated, but only those that need explanation will be expanded on.

Fields

Manufacturer	Self-explanatory.
Date	The date of manufacture of the hydrant.
Hydrant No.	The number as assigned by the utility.
Type	The hydrant is a toggle, compression, slide gate, wet top, dry top, traffic model, or does it have a model number or name?
MVO	The inside diameter of the main valve opening.
	Inlet - The type of inlet connection (flange, M. J., push-on, etc.) and size (typically four or six-inch).
Hose nozzle size	This should include both the number and size. Normally there will be two 2 1/2-inch hose outlet nozzles.
Thread type	This is the thread type on the hose nozzles. Typically, they are NST (National Standard Thread) but may be any one of several different common thread types. There may not be a type name. In this case the number of threads per inch is recorded.
Pumper nozzle size	The nominal hose size of the pumper nozzle, normally three, four, five or six-inch.
Thread type	The number of threads per inch on the pumper nozzle.
Installed by	This is for a notation on which contractor or crew installed the hydrant.
Date	The date of installation.
W/O No.	The work order number, only used when a work order number system is being used.
Operating nut	The size and shape of the operating nut.
OL - OR	Open left or open right.
Location	The street location or survey station location.
Main line	The line size and pipe material.
Connection	How the lead is connected to the main hot tap or tee.
Auxiliary valve	The location in feet from the hydrant and the type of valve (butterfly or gate).
Turns to open	The number of turns to open or close the auxiliary valve.
Static line pressure	Taken at the discharge nozzle of the hydrant without an adjustment for the difference in elevation between the nozzle and the main.
Bury	To the nearest six inches.

Fire Hydrant Master Record
_____ Water Utility

Hydrant No. _____

Manufacturer _____ Date _____ Type _____

MVO _____ Inlet Type/Size _____ Connection _____

Hose Nozzle size _____ Thread type _____ Main Line size _____

Pumper Nozzle size _____ Thread type _____

Installed by _____ Date _____ W/O No. _____

Operating Nut _____ Turns to Open _____ OL OR

Line Static Pressure _____ psi Bury _____

Auxilary Valve _____ Turns to Open _____

Location _____

Date	Inspected by	Tested	Repaired	Painted	Operated by	Cost	Remarks

DATA COLLECTION

The collection of data on new hydrants prior to installation is a relatively easy task and one that should be part of the regular installation process. The major problem with data collection systems is how to gather the data on existing hydrants. The description below is in relationship to the data needed for the master data card.

Data From the Casting

The following data can be gathered from the casting information on the nozzle section and/or barrel:

The manufacturer's name.

The date of manufacture.

The MVO size.

The bury is noted on the upper portion of the lower barrel section.

Data from Observations

By making observations and measurements, the following data can be gathered.

The type of hydrant.

The hose nozzle and pumper nozzle size and threads.

The operating nut size and shape, the number of turns to open and the direction to open.

Location.

The auxiliary valve location and number of turns to open.

The static line pressure taken at the discharge nozzle.

The bury may be determined by dropping a plumb bob through a nozzle and down the barrel.

Data Not Available

The following items are nearly impossible to obtain from existing hydrants without doing some excavating.

The inlet type and size.

Who installed the hydrant, the date of installation and the W/O No.

Main line type and size.

Method of connection to the main.

Auxiliary valve type.

Piping scheme for connecting the hydrant to the main.

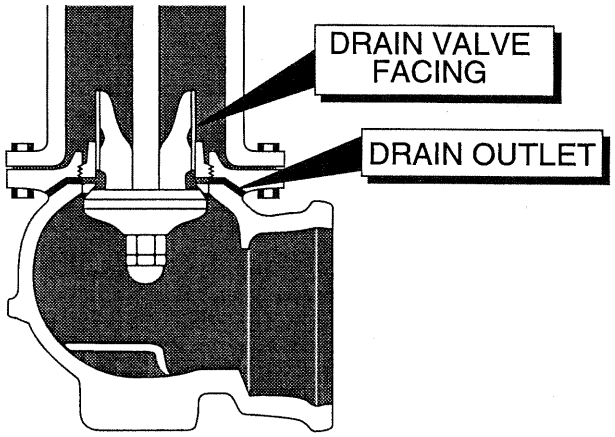
OPERATION OF DRY BARREL HYDRANTS

Compression & Toggle

The main differences between the operation of the compression and toggle hydrants are the direction that the main valve moves and the design of the drain valve. The operation of the main valve is fairly obvious, what is not so obvious is the operation of the drain valve.

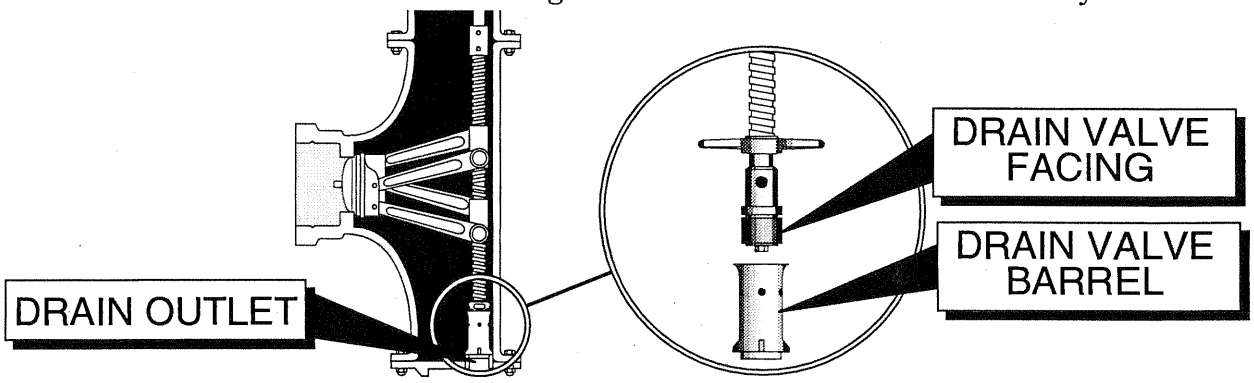
Drain Valve Compression

The compression hydrant opens against the pressure. The drain valve on this type of hydrant is composed of one or two leather or neoprene plates. These plates are attached to the upper valve plate. In order to close the drain valve, the plates slide across an opening in the main valve seat when the main valve is opened.



Drain Valve Toggle

The toggle hydrant forces a neoprene-like material against a valve seat in the bottom of the hydrant

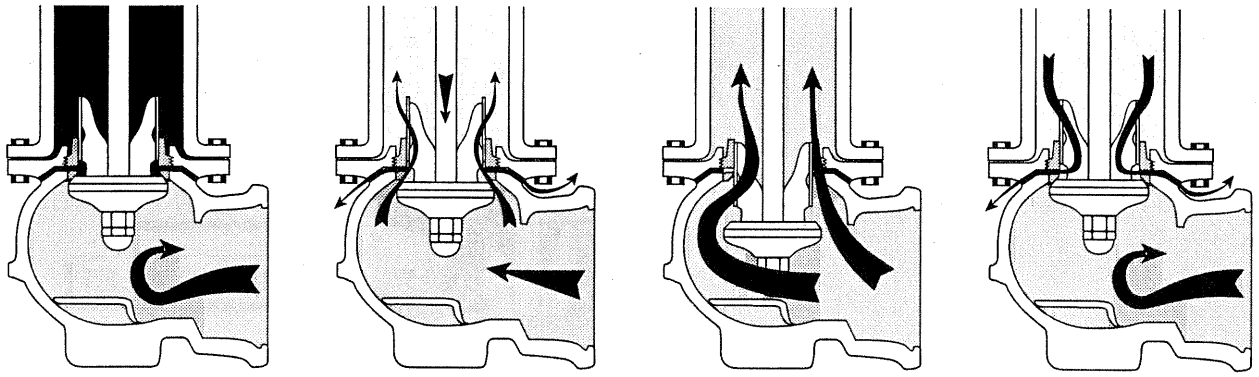


Operation Sequence - Opening

When a dry barrel hydrant is in a closed position, the main valve is closed and the drain valve is completely open. As the main valve is opened, the drain valve is closed. The drain valve will remain open during the first 1 to 5 turns of the stem. This will allow a positive pressure to develop in the hydrant prior to the closing of the drain valve, thus helping to clear the drain valve opening. After about 1 to 5 turns, the drain valve is completely open and all flow is directed out through the outlet nozzles.

Operating Sequence - Closing

During closing of the hydrant, the drain valve remains closed until the main valve is within 1 to 5 turns of being closed. At this time the drain valve will begin to open, allowing water under pressure to once again clear the drain holes. As the main valve reaches full closure, the drain valve returns to a full open position. All remaining water in the barrel of the hydrant will drain through the drain valves. This assumes that the drain valve is not below the water table, plugged or frozen.



CLOSED OPENING OPENED CLOSING

PROPER OPENING AND CLOSING PROCEDURE: DRY BARREL

Do Not Trap Air

With all dry barrel hydrants, it is important that the hydrant be opened slowly. The air that is in the barrel should be allowed to exit the barrel before the hydrant is fully opened. It is a good practice to open the hydrant only enough to start a flow of water but not enough to close the drain valve. This allows the air to exit slowly and the drain valve to be cleared. Should you open the hydrant too quickly, you could produce a water hammer.

Do Not Throttle

After all the air has exited, the hydrant should be fully opened. At no time should a hydrant be left in a partially open condition. In this condition, water may exit the drain valve and erode the base under the hydrant causing failure to the hydrant or lateral.

The Last 5 to 8 Turns

Closing is similar to the opening process. The hydrant may be closed rather quickly down to the last 5 to 8 turns. Slowly moving through these last few turns is critical in order to prevent water hammer. Considerable damage to main lines, service connections and household water heaters can be attributed to water hammer created by closing hydrants too rapidly. *All hydrants can be closed with sufficient speed to cause water hammer. However, the center stem hydrants that close with the pressure can cause considerably more damage.*

Check Drain Valve

After the hydrant is closed, wait until the barrel has drained before replacing the nozzle caps. If the nozzle caps are replaced prematurely, they may prevent the hydrant from draining and allow water to stand in the barrel.

Should be Easy to Operate

It should not take excessive pressure to close the hydrant. If it does, then there is probably some damage to the main valve and the hydrant should be scheduled for repair.

Back-off 1/4 Turn

After the hydrant is closed, you should back off on the opening nut about 1/4 turn. This removes the pressure from the opening nut and stem. The main valve will remain closed. This also allows the next person who opens the hydrant to determine quickly if they are turning the operating nut in the wrong direction. If they are, it will move easily for 1/4 turn, then stop.

ROUTINE CONDITIONS

PROTECTION FROM FREEZING

Introduction

Throughout Alaska, freezing weather during the winter months is very common. Various practices have been adopted by utilities to reduce and prevent damage to fire hydrants during freezing weather and allow location of the hydrants.

High Water Table

When hydrants are placed in areas of high water table and the drain valve is not plugged, the hydrant will need to be flushed on a frequent bases. Once the ground around the hydrant freezes the water from the lower barrel can be pumped out reducing the probability of freezing.

Plugged Drain Valves

Hydrants that have been installed with the drain valves plugged must be pumped after each use. Should the main valve leak on one of these hydrants, it could be damaged easily from freezing because there is no way for the water to exit the hydrant. Therefore, frequent inspections may be required during winter months.

Antifreeze

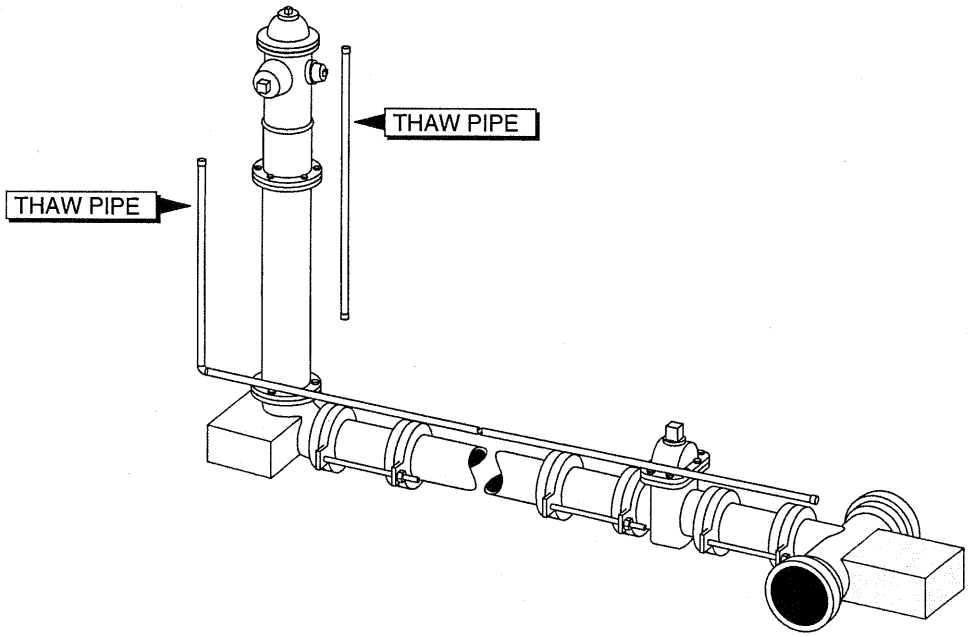
Some utilities have made it a practice to place a non-corrosive non-toxic antifreeze (**propylene glycol**[31]) on the threads of outlet nozzles and around the operating nut. This practice reduces the possibility of the caps or nut freezing in place.

Steam Lines

Utilities in the Arctic and sub-Arctic regions of the US and Canada have developed unique methods of protecting hydrants from freezing. Two conditions prevail. One is the freezing of water in the lead and/or shoe of the hydrant and the other is damage to the hydrant

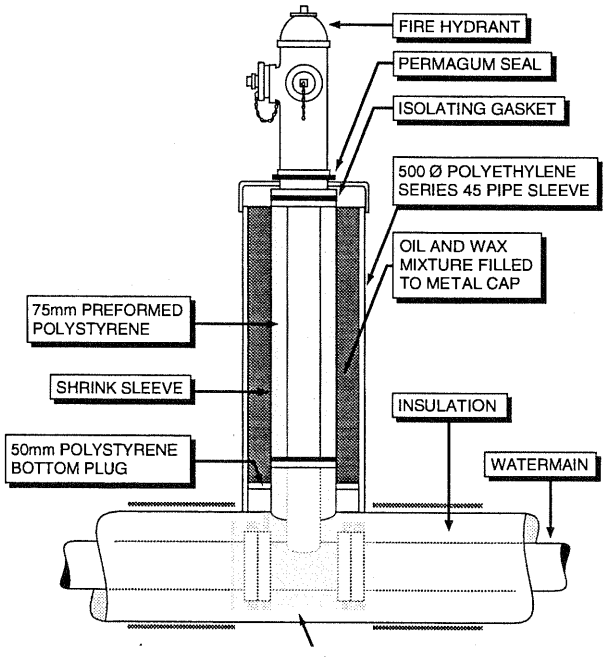
[31] **Propylene Glycol** - An anti-freeze material that can safely be used around fire hydrants. This material should never be placed in the hydrant barrel.

caused by frost heaving. A common techniques of dealing with both of these problems involves the installation of a perforated 3/4" steel pipe adjacent to the hydrant and lead. On a regular basis, live steam is injected through the pipe. This keeps the ground from freezing and at the same time prevents freezing in the hydrant shoe or lead.



With Arctic Pipe

In regions where Arctic pipe is commonly used, a detailed installation technique has been devised. A frost gasket is installed just below the nozzle section and a second one at the bottom of the lower barrel. The lower barrel is then coated with a preformed 3-inch thick polyurethane cover. This is placed inside of a 20-inch polyethylene series 45 pipe sleeve. The bottom of the sleeve is plugged with polystyrene. The space between the cover and the sleeve is filled with a mixture of oil



and wax. This material will give and prevent damage to the hydrant due to frost heave. The top of the sleeve is covered with a metal cap. A felt gasket is placed between the metal cap and the hydrant.

Arctic Hydrants

In Arctic regions with permafrost, the utility lines are placed either in above ground or under ground utilidors. With above ground utilidors, heated and insulated angle globe valves are commonly used. With underground systems, heated and insulated manholes are the common connection ports for fire hydrants. The heat reduces the possibility of freezing.(See drawings on page 11.)

LOCATION DEVICES

Common methods used to locate fire hydrants in the snow are:

Poles

Poles set in the ground adjacent to the hydrant. In urban areas, a short section of pipe with a threaded insert is placed in the sidewalk or street adjacent to the hydrant. As winter approaches, the threaded insert is removed and a section of brightly colored pipe is inserted. This pipe is tall enough to be seen after a snowfall and allows for easy location and uncovering of the hydrant.

Flags

A metal flag is welded to a section of 1/4-inch rod. The end of the rod is shaped into a circle that will fit over the discharge nozzle. As winter approaches, the flag is attached to the hydrant and held in place by the nozzle cap. The flag is long enough to be seen after a snow storm.

Snow Removal

One technique used to remove snow from around a fire hydrant with a front end loader is the construction of a special bucket with a "U" in the front that allows the snow to be removed without hitting the hydrant.

INOPERABLE HYDRANTS

Notify Fire Department

Hydrants that are inoperable should be tagged, the fire department notified and repairs scheduled ASAP.

Metal Tags

There are two common methods of tagging inoperable fire hydrants. One is the use of a metal tag placed over the outlet nozzle and held in place by the nozzle cap. The tag has "Out of Service" written in bold letters on the front side.

Bags

The second method is the placement of a sack over the hydrant. The sack is tied at the bottom or taped on with duct tape.

COLOR CODING FIRE HYDRANTS

Purpose

Fire hydrants are color coded to indicate various system conditions including flow, type of fire main (for instance wood), type of distribution system (potable, non-potable or private) and system pressure zone.

Typical Systems

It must be understood that there is no required system of color scheme. However, the NFPA (National Fire Prevention Association) standard number 219 recommends that if hydrants are to be color coded for flow that the following color scheme be used. This color scheme is based on a calculated flow at the hydrant with a calculated system residual of 20 psi and an actual residual adjacent to the hydrant of at least 40 psi. If the actual residual is less than 40 psi, the color code should be based on one-half of the actual observable flow rather than the calculated flow.

The Color Code

Flow	Color
Greater than 1000 gpm	Green
1000 gpm down to 500 gpm	Orange
Less than 500 gpm	Red

Which Portion to Paint

The portion of the hydrant that gets painted varies as much as the color schemes used. Some typical painting patterns include:

1. Painting the entire hydrant to proper color.
2. Paint only the bonnet with the proper color.
3. Paint the nozzle caps.
4. Paint both the nozzle caps and the bonnet.

REMOVING WATER

Pumps

The most common pumps used to remove water from a fire hydrant are small diaphragm pumps similar to chemical feed pumps and small gear pumps. The diaphragm pumps can raise water from 12 to 15 feet. The gear pumps are placed inside of the hydrant and are best when the hydrant bury is greater than 12 feet.

ROUTINE INSPECTION

Frequency

The AWWA fire hydrant standards committee recommends that dry barrel fire hydrants be inspected at least annually and after each use. In freezing climates, they recommend inspection twice annually. One common practice is to inspect once in the fall and once in the spring. In severe winter conditions, the inspections may need to be more frequent. This is especially true of hydrants installed in areas that have a high water table. The dual inspection does not substitute

for the need to inspect each hydrant after it has been used.

Plugged Drain Valves

Hydrants installed with their drain valves plugged will need to be pumped after each use. This is true even if the uses were during the summer months. Water standing in the hydrant barrel will increase the rate of deterioration of the internal components of the hydrant.

Time Consumption - Routine

The **routine inspection**[32] of common dry barrel hydrants by experienced operators should take approximately 20 minutes per hydrant. The lack of experiences the operators have with the brands of hydrants being inspected, as well as time between inspections will both contribute to an increase in the length of time necessary to inspect a fire hydrant.

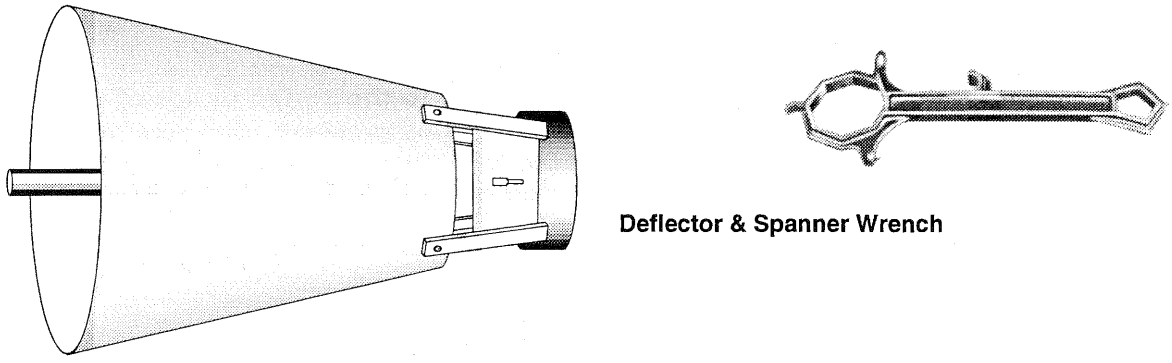
Time Consumption - New Program

If you are just starting a hydrant inspection program, you may need to allot 30 to 40 minutes to each hydrant. This extra time will be needed to gather pertinent hydrant data and make minor repairs.

Tools Needed

In order to properly perform hydrant inspections, you would need the follow basic tools:

1. A hydrant **spanner wrench**[33]. Several styles are available.
2. Hydrant **deflector**[34]
3. One or two operating personnel
4. Inspection forms
5. Thread lubricant
6. Hand tools
7. Valve wrench
8. Tarp, 12' x 12'



Deflector & Spanner Wrench

[32] **Routine Inspection** - An inspection that is done in a prescribed way at specified times.
[33] **Spanner Wrench** - A wrench designed to operate a hydrant. The wrench may be designed for a set size of operating nut with the opposite ends designed to fit the hold down nut. The wrench may be adjustable for various sizes of operating nut. When the wrench is adjustable, it will not fit the hold down nut.
[34] **Deflector** - A device use to absorb or deflect the velocity head of water exiting a fire hydrant. It is used to protect streets, traffic and private property from damage resulting from the flow of water from a fire hydrant.

Standard Procedures

Each utility should adopt a standard inspection routine that is to be used by each individual involved in the inspection process. The routine should be in a written form and summarized with a checklist.

Reference to AWWA

The sequence of the routine that follows was developed by the AWWA fire hydrants standards committee. It may be adapted to local conditions and the sequence altered to meet individual needs. However, changes and deletions should be reviewed with care.

Sequence

1. Check the hydrant appearance. Remove any brush or grass that obstructs the view of the hydrant. If it needs painting, either paint or schedule for painting. Check the hydrant height. If the hydrant needs to be raised due to a change in ground level (the flange between the lower barrel and nozzle section should be two inches above the ground) due to construction in the area, then schedule the work.
2. Remove one nozzle outlet cap. Use a listening device to check for leakage of the main valve.
3. Use a plumb bob or a mirror and light to check for the presence of water (ice in the winter) in the lower barrel. If water is present, determine cause and correct problem.
4. Lubricate operating nut. On some brands of hydrants, lubrication is via grease; on others, an oil reservoir is provided. Mueller - check oil level, it should be 1" below the fill plug. American Darling - remove the bonnet, the housing cover and the operating nut, lubricated the threads with a water resistant grease. Clow remove operating nut and lubricate the threads.
5. Replace the nozzle cap. Leave it loose enough to allow air to vent from the hydrant.

Warning:

If the manufacturer's caps have been replaced with plastic nozzle caps, they will need to be replaced prior to proceeding.

If you feel that due to the design or age of the hydrant or due to line pressure, the caps may blow off during the test, then a safety device similar to the one shown below should be installed.

6. Open the hydrant two to three turns. Allow air to vent from the hydrant.
7. Tighten the cap.
8. Fully open the hydrant. Check for ease of operation. Some water conditions will cause a buildup on the threads of toggle and compression hydrants that open with the pressure. This can often be removed by a series of opening and closing. Other common problems that lead to difficulty in opening are bad packing,

stuck "O" rings and bent shafts.

9. Check for leakage at flanges, operating nut, packing or seals, nozzles and nozzle caps. Repair as needed.

10. Close the hydrant enough to cause the drain valve to work. Allow water to flow under pressure through the drain valve for about ten seconds. This will help to flush the drain valve and keep it in working order. *With hydrants that have a plugged drain valve, this step should be skipped.*

11. Close the hydrant completely. Back off the operating nut so that pressure is taken off of the thrust bearing or thrust collar.

12. Remove one nozzle cap.

13. Attach a deflector. The recommendation of the hydrant standards committee is to use a deflector that can be set in the gutter and attached to the hydrant by using a fire hose. *Read the section on deflectors including the warning.* When you use the style of deflector that attaches directly to the hydrant, there is still a potential for damage to property. This can be minimized by placing a tarp under the deflector and using the tarp to direct the flow of water to the gutter or storm drain.

14. Open the hydrant fully to flush the hydrant barrel and lead. Be sure to protect private property, streets and traffic. Storm sewer grates and culverts should be observed and kept clear of debris. During the fall, the grates can be easily plugged from leaves.

    When the hydrant is flowing full, a flow test can be conducted. Some styles of deflectors offer an opening designed specifically to allow a pilot tube measurement to be taken.

15. Close the hydrant completely and remove the deflector. Count the number of turns to close and compare with existing data. If the number of turns is significantly different, then the hydrant should be scheduled for disassembly.

    With the hydrant closed, check for proper working of the drain valve by placing your hand over the nozzle. A slight suction should be felt if the drain valve is working properly.

16. Remove all nozzle caps. Clean the nozzle and cap threads and replace any damaged or missing nozzle cap gaskets. A mixture of Graphite and various never-size compounds are commonly used to lubricate the threads. In cold climates, a non-toxic non-corrosive antifreeze can be placed on the threads and around the operating nut to prevent freezing.

With hydrants that have plugged drain valves the water in the barrel must be pumped out.

17. Check for free action of the nozzle cap chains or cables. If they bind, then remove paint or rust and/or open the loop so that they move more freely. If the chains have become damaged or rusted together, they should be replaced. This action will prevent the chains from kinking during emergencies, making removal difficult.

18. Replace the nozzle caps. Tighten and then back off slightly. They should be tight enough to prevent removal by hand but loose enough to be removed with ease using a spanner wrench.

19. Locate and exercise the auxiliary valve. Count the number of turns to close and open. Compare the turns with the data file.

20. Fill out report form.

Dry Barrel Inspection Checklist

- ❑ 1. Appearance clean and paint as needed
- ❑ 2. Remove outlet-nozzle cap; check main valve leakage
- ❑ 3. Check for water and or ice in lower barrel
- ❑ 4. Loosely replace nozzle cap
- ❑ 5. Lubricate operating nut; check oil reservoir
- ❑ 6. Open hydrant 2 to 3 turns; allow air to vent through cap
- ❑ 7. Check drain valve
- ❑ 8. Open the hydrant fully
- ❑ 9. Check for ease of operation & Leakage, ❑ Yes, ❑ No
- ❑ 10. Partially close the hydrant; allow drain valve to work
- ❑ 11. Close the hydrant completely
- ❑ 12. Flush barrel and lead; use deflector
- ❑ 13. Close hydrant; count turns
- ❑ 14. Remove all nozzle caps, clean and lube threads; replace damaged or lost gaskets
- ❑ 15. Check nozzle cap chains and/or cable for free action
- ❑ 16. Locate and exercise auxiliary valve
  - Count number of turns to close and open _____
- ❑ 17. Fill out report form

REPAIRING MUELLER - IMPROVED (1962 AND NEWER)

Introduction

The procedure described below references the individual part numbers as identified in the standard literature provided by Mueller. A copy of one of the Mueller drawings is provided as a convenience. We recommend that you request a wall poster from the supplier. The wall poster is much easier to read.

Lubrication

The operating nut on a Mueller fire hydrant is lubricated from an oil reservoir in the bonnet.

Check oil level by removing the oil plug. The level should be just at the bottom of fire plug when the hydrant is closed.

Nozzle threads can be lubricated with a silicon based lubricant. The lubricant must be able to withstand low temperatures.

MAIN VALVE REPLACEMENT

Tools & Parts

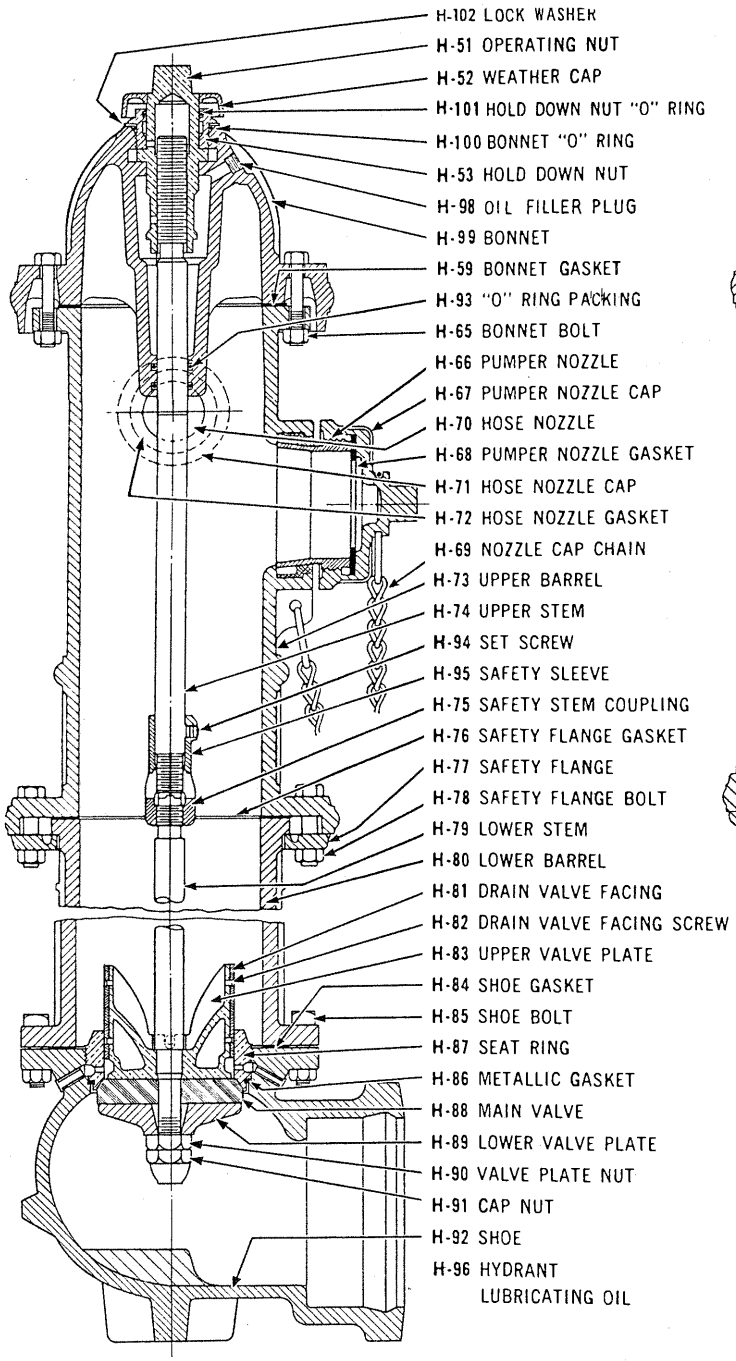
The following tools and spare parts should be available before you proceed with this task.

- A-311 Operating wrench
- A- 24099 brass sleeve
- Seat wrench & spanner wrench
- Hand tools
- Lubricants - oil for operating nut H-96 & silicon grease for nozzle caps
- Complete set of gaskets H-101, H100, H-59, H-93 (2), H-68, H-72 (2), H-76
- Drain valves, H-81 (2), H-82 (4)
- Main valve, H-88

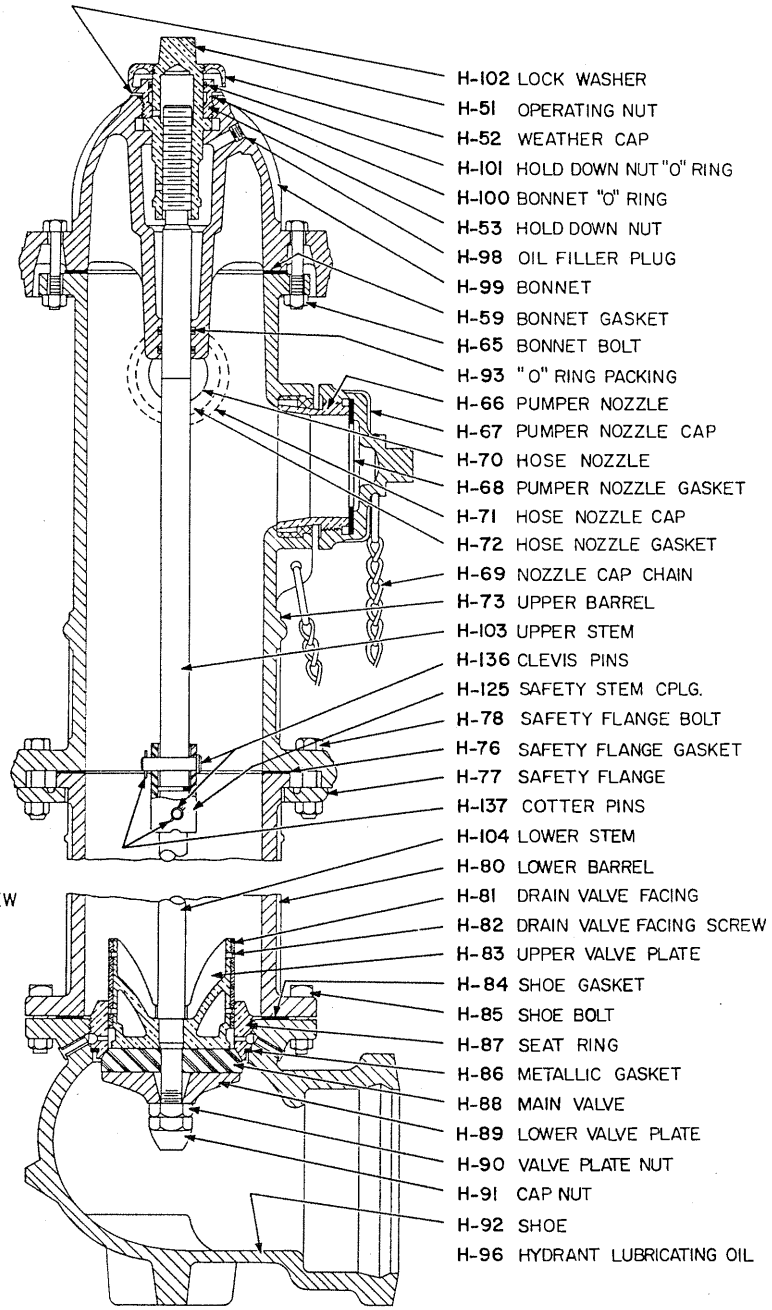
Disassembly Sequence

1. Shut off auxiliary valve & open hydrant.
2. Hold the operating nut with the spanner wrench and with the operating wrench, unthread the weather cap (H-52) - this is a left handed thread.
3. Using the operating wrench - remove the hold down nut (H-53) - right handed thread.
4. Using the spanner wrench unthread the operating nut - right handed thread.
5. Using the H-96 lubricant - lubricate the brass sleeve and slide over the threads.
6. Unbolt the bonnet.
7. Lift the bonnet from the hydrant - a brass hammer

IMPROVED HYDRANT WITH BRASS SAFETY STEM COUPLING



IMPROVED HYDRANT WITH STEEL SAFETY STEM COUPLING



may be necessary to loosen the bonnet - The brass sleeve should remain in the bonnet.

8. Pour the oil from the bonnet into a bucket by placing the bonnet over a bucket and removing the brass sleeve.
9. Insert the seat wrench - engage onto lugs.
10. Unscrew seat - counterclockwise.
11. Remove the seat wrench.
12. Remove main valve, seat and stem by lifting.
13. Place stem in a pipe vice.
14. Remove cap nut (H91), valve plate nut (H-90) and lower valve plate (H89), and main valve (H-88).
15. Remove upper valve plate - (H-83) - drive down with small brass hammer.
16. Inspect and clean:
    - Stem where upper valve plate connects for corrosion.
    - Threads on end of stem.
    - Operating nut threads.
    - Safety coupling for looseness.
    - Seat ring threads and surface.
    - Bonnet gasket surface.
    - Nozzle section gasket surface.
    - Bonnet where operating nut rests.
    - Operating nut.

Assembly Procedure

1. Remove & replace drain valve facings (H-81).
2. Install upper valve plate.
3. Insert upper valve plate into seat - Should fit tight but move smooth.
4. Install new main valve, replace lower valve plate and tighten valve plate nut until main valve is held firmly.
5. Install and tighten cap nut.
6. Place main valve in a open position.
7. Remove and replace Metallic gasket (H-86) - hold in place with a small amount of water resistant grease, place a small amount of grease on the seat threads.
8. Insert the valve assembly into the hydrant - lower slowly.
9. Using the valve seat wrench - tighten the valve assembly.
10. Open gate valve enough to allow water pressure to

build under the main valve - may have to pull up on the valve stem.

• The main valve should seal - If not shutdown and remove - locate the problem.

11. Replace bonnet "O" rings H-93.

12. Install brass sleeve over stem threads.

13. Place gasket (H-59) on nozzle section - use small amount of grease.

14. Install bonnet and insert bonnet bolts - do not tighten.

15. Remove brass sleeve.

16. Pour in one can of hydrant oil along side of stem.

17. Replace hold down nut and bonnet "O" rings.

18. Install operating nut and hold down nut.

19. Tight bonnet bolts - make sure operating nut moves easily.

20. Install weather cap.

21. Open auxiliary valve.

22. Fill out report.

MUELLER - CENTURION REPAIR

Introduction

The procedure described below references the individual part numbers as identified in the standard literature provided by Mueller. A copy of one of the Mueller drawings is provided as a convenience. We recommend that you request a wall poster from the supplier. The wall poster is much easier to read.

Lubrication

The operating nut on a Mueller fire hydrant is lubricated from an oil reservoir in the bonnet.

Check oil level by removing the oil plug. The level should be just at the bottom of file plug when the hydrant is closed.

Nozzle threads can be lubricated with a silicon based lubricant. The lubricant must be able to withstand low temperatures.

MAIN VALVE REPLACEMENT

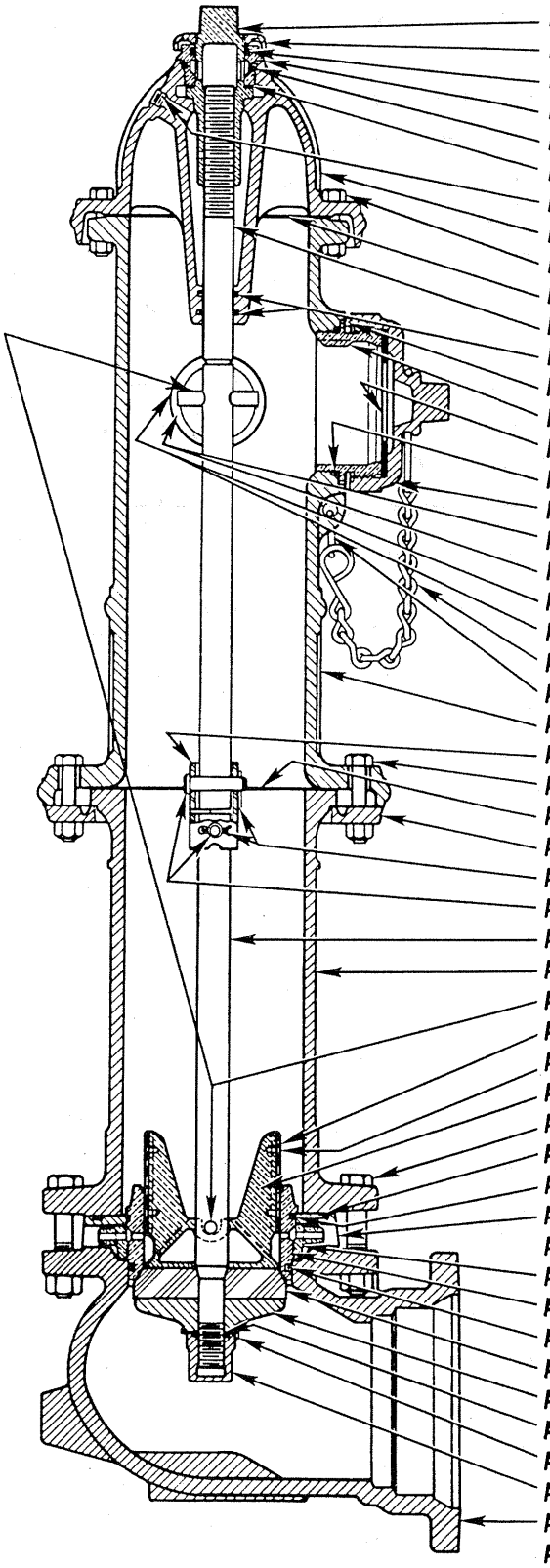
Tools & Parts

The following tools and spare parts should be available before you proceed with this task.

- A-311 Operating wrench
- A- 367 brass sleeve
- Seat wrench A-359
- Spanner wrench
- Hand tools
- Lubricants - oil for operating nut A-51 & silicon grease for nozzle caps
- Complete set of gaskets A-3, A-5, A-6, A-10, A-12, A-15, A-19 (2), A-39, A-44, A-47
- Drain valves, A-34 (2), A-35
- Main valve, A-45

Disassembly Sequence

1. Shut off auxiliary valve & open hydrant.
2. Hold the operating nut with the spanner wrench and with the operating wrench, unthread the weather cap (A-2) - this is a left handed thread.
3. Using the operating wrench - remove the hold down nut (A-4) - right handed thread.
4. Using the spanner wrench unthread the operating nut - right handed thread.
5. Using the A-51 lubricant - lubricate the brass sleeve and slide over the threads.
6. Unbolt the bonnet.
7. Lift the bonnet from the hydrant - a brass hammer may be necessary to loosen the bonnet - The brass sleeve should remain in the bonnet.



A-1 OPERATING NUT
A-2 WEATHER CAP
A-3 HOLD DOWN NUT "O" RING
A-4 HOLD DOWN NUT
A-5 BONNET "O" RING
A-6 ANTI-FRICTION WASHER
A-7 OIL FILLER PLUG
A-8 BONNET
A-9 BONNET BOLT & NUT
A-10 BONNET GASKET
A-11 UPPER STEM
A-12 STEM "O" RINGS
A-13 NOZZLE LOCK
A-14 PUMPER NOZZLE
A-15 PUMPER NOZZLE GASKET
A-16 PUMPER NOZZLE "O" RING
A-17 PUMPER NOZZLE CAP
A-18 HOSE NOZZLE
A-19 HOSE NOZZLE GASKET
A-20 HOSE NOZZLE "O" RING
A-21 HOSE NOZZLE CAP
A-22 CHAIN
A-23 CHAIN CONNECTOR RING
A-24 UPPER BARREL
A-25 SAFETY STEM COUPLING
A-26 SAFETY FLANGE BOLT & NUT
A-27 SAFETY FLANGE GASKET
A-28 SAFETY FLANGE
A-29 COTTER PINS
A-30 CLEVIS PINS
A-31 LOWER STEM
A-32 LOWER BARREL
A-33 STEM PIN
A-34 DRAIN VALVE FACING
A-35 DRAIN VALVE FACING SCREW
A-36 UPPER VALVE PLATE
A-37 SHOE BOLT & NUT
A-38 DRAIN RING HOUSING GASKET
A-39 TOP SEAT RING "O" RING
A-40 DRAIN RING HOUSING
A-41 DRAIN RING HOUSING BOLT & NUT (NOT SHOWN)
A-42 DRAIN RING
A-43 SEAT RING
A-44 BOTTOM SEAT RING "O" RING
A-45 MAIN VALVE
A-46 LOWER VALVE PLATE
A-47 CAP NUT SEAL
A-48 LOCK WASHER
A-49 CAP NUT
A-50 SHOE
A-51 HYDRANT LUBRICATING OIL

8. Pour the oil from the bonnet into a bucket by placing the bonnet over a bucket and removing the brass sleeve.
9. Slide the slotted end of the seat wrench over stem and engage the pin on the stem with the slot.
10. Tighten the "T" handle firmly.
11. Lower the wrench support arms onto the top flange of the nozzle section.
12. Tighten the thumb screw on top of the seat wrench to hold the main valve closed.
13. Unscrew the main valve counterclockwise.
14. Remove the seat wrench and lift the valve assembly from the hydrant.
15. Remove main valve, seat and steam by lifting.
16. Place stem in a pipe vice.
17. Remove cap nut (A-49), lock washer (A-48), cap nut seal (A-47) lower valve plate (A-46), and main valve (A-45).
18. Remove the upper valve plate from the valve seat.
19. Remove upper valve plate - (A-36) - drive down with small brass hammer.
20. Inspect and clean:
    - Stem where upper valve plate connects for corrosion.
    - Threads on end of stem.
    - Operating nut threads.
    - Safety coupling for looseness.
    - Seat ring threads and surface.
    - Bonnet gasket surface.
    - Nozzle section gasket surface.
    - Bonnet where operating nut rests.
    - Operating nut.

Assembly Sequence

1. Remove & replace drain valve facings (A-34).
2. Install upper valve plate.
3. Insert upper valve plate into seat - Should fit tight but move smooth.
4. Install new main valve, replace lower valve plate, install new cap nut seal A-47 & lock washer A-48.
5. Install and tighten cap nut.
6. Place main valve in an open position.
7. Remove and replace the set of "O" rings (A-39 & A-44)-

place a small amount of grease on the "O" rings and seat threads.

8. Insert the valve assembly into the hydrant - lower slowly.
9. Using the valve seat wrench, snug up the valve seat.
10. Raise the main valve until it touches the seat - you may have to reach through the pumper nozzle in order to raise the valve.
11. Tighten the thumb screw on the seat wrench.
12. Tighten the main valve with the seat wrench.
13. Remove the seat wrench.
14. Open gate valve enough to allow water pressure to build under the main valve - may have to pull up on valve stem.

    • The main valve should seal - If not shutdown and remove - locate the problem.
15. Replace bonnet "O" rings (A-12).
16. Install brass sleeve over stem threads.
17. Place gasket (A-10) on nozzle section - use small amount of grease.
18. Install bonnet and insert bonnet bolts - do not tighten.
19. Remove brass sleeve.
20. Pour in one can of hydrant oil along side of stem.
21. Replace hold down nut and bonnet "O" rings.
22. Install operating nut and hold down nut.
23. Tight bonnet bolts - make sure operating nut moves easily.
24. Install weather cap.
25. Open auxiliary valve.
26. Fill out report.

REPAIRING CLOW HYDRANTS

Introduction

The procedure described below references the individual part numbers as identified in the standard literature provided by Iowa Valve, the makers of Clow fire hydrants. A copy of one of the Clow drawings is provided as a convenience. We recommend that you request a manufacturer's drawing from the supplier. It will be easier to read than the one provided in this module.

Lubrication

The operating nut on a Clow fire hydrant is lubricated from grease on the operating stem.

In order to grease the threads on this stem this procedure is described below in steps 2 through 4.

Nozzle threads can be lubricated with a silicon based lubricant. The lubricant must be able to withstand low temperatures.

MAIN VALVE REPLACEMENT

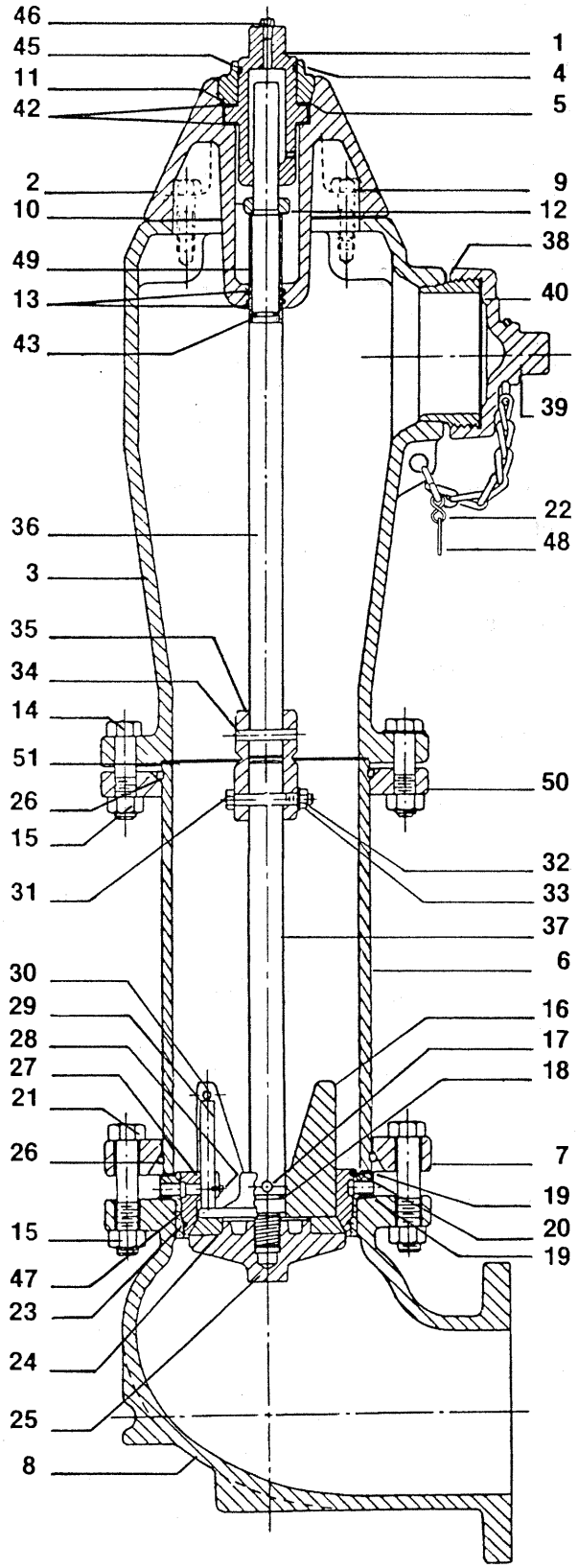
Tools & Parts

The following tools and spare parts should be available before you proceed with this task.

- Spanner wrench
- Seat wrench
- Hand tools
- Lubricants - Water resistant grease for operating nut & silicone grease for nozzle caps
- Complete set of gaskets , 45, 10, 11, 13 (2) , 43, 18, 20, 23
- Drain tube, 29
- Main valve, 24

Disassembly Sequence

1. Shut off auxiliary valve & open hydrant.
2. Using a spanner wrench hold the operating nut and unscrew the thrust nut (4) - left hand thread. (On hydrants with weather cap, the weather cap must be removed before the thrust nut can be removed.
3. Unthread the operating nut and remove.
4. Inset the hex end of the combination tool over the stem until it engages with the stop nut (12). Unthread the stop nut and remove.
5. Remove the bonnet bolts and the bonnet.
6. Insert the seat wrench over the stem - when inserted properly the wrench should rest on the nozzle section.
7. Insert the threaded end of the combination wrench into the hydrant wrench and tighten enough to pull the main valve into a closed position.



Part No.	Qty.	Description	Material
1	1	Operating Nut	Manganese Bronze ASTM B-584
2	1	Cover	Cast Iron ASTM A-126 Class B
3	1	Nozzle Section (2 Nozzle)	Cast Iron ASTM A-126 Class B
	1	Nozzle Section (3 Nozzle)	Cast Iron ASTM A-126 Class B
4	1	Thrust Nut	Bronze
5	2	Thrust Bearing Race	Hardened Steel
6	1	Standpipe	Ductile Iron ANSI A21.50, A21.51
7	1	Lower Flange	Cast Iron ASTM A-126 Class B
8	1	Bottom	Cast Iron ASTM A-126 Class B
		Bottom (Drain Ring Option)	Cast Iron ASTM A-126 Class B
9	4	Hex Hd. Capscrew $\frac{5}{8}$—11 NC x $1\frac{3}{4}$	Zinc Plated Steel
10	1	Cover Gasket	Neoprene
11	1	O-ring—152	Buna -N-
12	1	Hex Stop Nut 1"—8 NC	Steel
13	2	O-ring—218	Buna -N-
14	4	Hex Hd. Bolt $\frac{3}{4}$—10 NC x $3\frac{1}{4}$	Zinc Plated Steel
15	8	Hex Nut $\frac{3}{4}$—10 NC	Zinc Plated Steel
16	1	Upper Valve Plate	Cast Iron ASTM A-126 Class B
17	1	Hex Head Bolt $\frac{7}{16}$—14NX $2\frac{1}{2}$ with nut	18-8SS
18	1	O-ring—214	Buna -N-
19	2	Standpipe Gasket	Accopac
20	1	O-ring—259	Buna -N-
21	4	Hex Hd. Bolt $\frac{3}{4}$—10 NC x $4\frac{1}{2}$	Zinc Plated Steel
22	1	S-Hook 13 Ga. x 1"	Zinc Plated Steel
23	1	O-ring—258	Buna -N-
24	1	Valve Seat Rubber	ASTM D2000 AA915 A13 B13
25	1	Lower Valve Plate	Cast Iron ASTM A-126 Class B
26	2	Retaining Ring	300 Series SS
27	1	Valve Seat Ring	Bronze AWWA C502-80
28	1	Driv-Lok Stud #6 x $\frac{3}{8}$	Brass Plated Steel
29	1	Drain Tube	Brass Tubing
30	1	Driv-Lok Pin $\frac{1}{4}$ x $1\frac{1}{4}$ Type C	303 SS
31	1	Hex Hd. Bolt $\frac{7}{16}$—14 NC x 3	18-8 SS
32	1	Hex Nut $\frac{7}{16}$—14 NC	18-8 SS
33	1	Lock Washer $\frac{7}{16}$	18-8 SS
34	1	Pin $\frac{7}{16}$ x $2\frac{1}{4}$ Type E	303 SS
35	1	Stem Coupling	Cast Iron ASTM A-126 Class B
36	1	Upper Stem OL	1018 CRS
	1	Upper Stem OR	1018 CRS
37	1	Lower Stem	1018 CRS
38	1	Steamer Nozzle	Bronze AWWA C502-80
	2	Hose Nozzle	Bronze AWWA C502-80
39	1	Steamer Nozzle Cap	Cast Iron ASTM A-126 Class B
	2	Hose Nozzle Cap	Cast Iron ASTM A-126 Class B
40	1	Steamer Nozzle Gasket	Compressed Asbestos
	2	Hose Nozzle Gasket	Compressed Asbestos
41	3	Nozzle Cap Chain	Zinc Plated Steel
42	2	Bearing	Delrin or Celcon Acetal
43	1	O-ring—117	Buna -N-
45	1	O-ring—226	Buna -N-
46	1	Hex Hd. Capscrew $\frac{3}{8}$—16 NC x $\frac{1}{2}$ LG	Zinc Plated Steel
47	1	Drain Ring	Bronze AWWA C502-80
48	1	Trench Depth Tag	Cast Aluminum
49	1	Upper Stem Sleeve	Brass Tubing ASTM B-135 Alloy 3
50	1	Safety Flange (One piece or Split)	Cast iron ASTM A-126 Class B
51	1	Standpipe Gasket-Upper	Nigolet #225

8. Unthread the seat ring - counterclockwise.
9. Remove the hydrant wrench from the stem.
10. Remove the valve assembly from the hydrant.
11. Place stem in a pipe vice.
12. Remove pin 30 from the upper valve plate and slide the seat ring upward.
13. Remove the drain tube - 29 from the seat ring.
14. Remove lower valve plate (25) - clockwise & remove main valve face.
15. Remove bolt (17) from the upper valve plate and remove the upper valve plate.
16. Inspect and clean:
    - Stem where upper valve plate connects for corrosion.
    - Threads on end of stem.
    - Operating nut threads.
    - Safety coupling for looseness.
    - Seat ring threads and surface.
    - Bonnet gasket surface.
    - Nozzle section gasket surface.
    - Bonnet where operating nut rests.
    - Operating nut.
    - O-ring surfaces on operating nut.
    - Bearings on operating nut.

Assembly Sequence

1. Install upper valve plate (16) onto the stem far enough to expose the O-ring groove.
2. Install the O-ring and lubricate with silicone lube.
3. Slide the upper valve plate down so that the bolt (17) can be installed. Install bolt and tighten nut.
4. Install main valve - lubricate stem threads with lock-tight and install lower valve plate. Tighten to 50 ft-lbs.
5. Install drain tube in seat ring.
6. Install seat ring down over main valve.
7. Install seat ring O-rings - Lubricate with silicone lube.
    - Top ring down from top.
    - Bottom ring up from bottom.
8. Install hydrant wrench on stem.
9. Carefully insert valve assembly into hydrant - start threads by hand.

- Tighten approximately 6 turns.
- Tighten to 100 - 150 ft-lbs.

10. Remove combination tool and hydrant wrench.

11. Install O-ring (43) in upper groove on stem - lube with silicone.

12. Install O-rings in bonnet (13) - lube with silicone.

13. Install cover gasket (10) over bolts on bonnet - hold in place with grease.

14. Carefully so as not to damage O-rings install bonnet.

15. Start the Stop Nut - Tighten with the combination tool.

16. Lubricate stem threads, inside of operating nut, and upper and lower Delrin bearing surfaces with water resistant grease.

17. Install a Delrin bearing on the bottom of the operating nut and install.

18. Install a Delrin bearing on the top of the operating nut followed by a thrust bearing race (5).

19. Install and lube with silicone lube the O-ring on the top of the operating nut and on the thrust nut.

20. Install the thrust nut and tighten to 150 ft-lbs.

21. Open and close hydrant a few times to check for ease of operation.

22. Open auxiliary valve.

23. Fill out report.

REPAIRING - AMERICAN DARLING MARK -73, 4 1/2 INCH

Introduction

The procedure described below references the individual part numbers as identified in the standard literature provided by American Darling. A copy of one of the American Darling drawings is provided as a convenience. We recommend that you request a drawing from the supplier. It will be much easier to read than the one supplied here.

Lubrication

The operating nut on an American Darling fire hydrant is lubricated from grease on the operating stem.

To lubricate the operating nut, remove the bonnet, housing cover and operating nut. Lubricate with a water resistant grease.

Nozzle threads can be lubricated with a silicone based lubricant. The lubricant must be able to withstand low temperatures.

MAIN VALVE REPLACEMENT

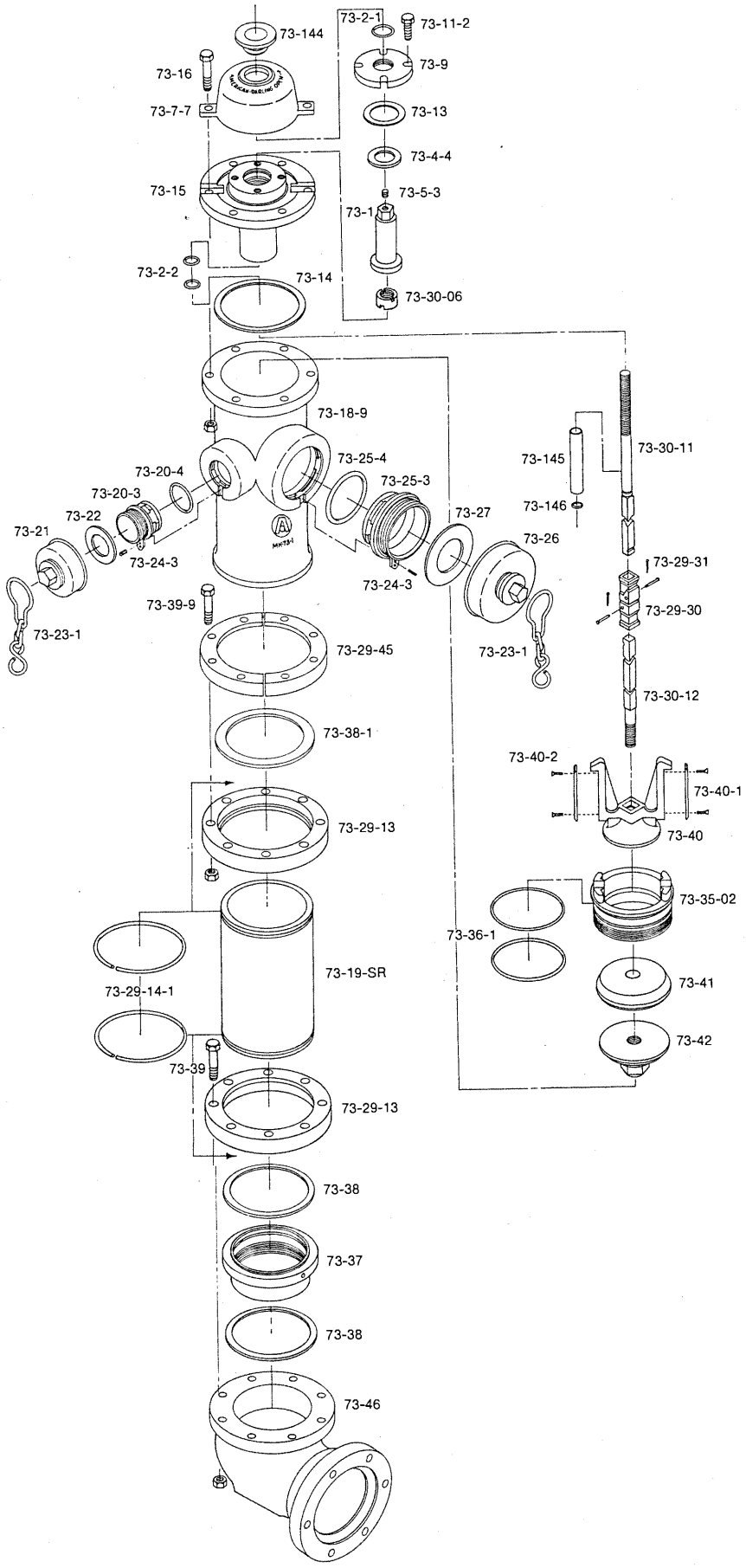
Tools & Parts

The following tools and spare parts should be available before you proceed with this task.

- Seat wrench - 73-147
- Spanner wrench
- Hand tools
- Lubricants - Lithium Soap Base Grease & silicone grease for nozzle caps
- Complete set of gaskets 73-2-1, 73-2-2, 73-13, 73-14, 73-146, 73-36-1
- Drain valves, 73-40-1 (2), 73-40-2 (4)
- Main valve, 73-41

Disassembly Sequence

1. Shut off auxiliary valve & open hydrant.
2. Remove bonnet bolts and bonnet (73-7-7).
3. Remove bolts and housing cover (73-9).
4. Unthread the operating nut.
5. Use top of hydrant valve wrench to unthread the Travel Stop Nut (73-30-06).
6. Unbolt and remove housing (73-15).
7. Insert seat wrench - turn counterclockwise to unthread valve seat.
8. Remove seat wrench & valve assembly.
9. Place stem in pipe vice.
10. Remove valve bottom (73-42) by unthreading counter-


73-144
73-2-1
73-11-2
73-16
73-9
73-7-7
73-13
73-4-4
73-15
73-5-3
73-1
73-2-2
73-14
73-30-06
73-18-9
73-145
73-30-11
73-20-4
73-25-4
73-25-3
73-20-3
73-146
73-22
73-27
73-21
73-26
73-24-3
73-24-3
73-29-31
73-39-9
73-29-30
73-23-1
73-23-1
73-29-45
73-30-12
73-38-1
73-40-2
73-40-1
73-29-13
73-40
73-35-02
73-36-1
73-19-SR
73-41
73-29-14-1
73-42
73-39
73-29-13
73-38
73-37
73-38
73-46

clockwise.

11. Remove main valve (73-41)
12. Remove upper valve plate from the valve seat. Slide the seat up or down.
13. Remove the upper valve plate (73-40) - Drive down with small brass hammer or hammer and wooden block.
14. Inspect and clean:
    - Stem where upper valve plate connects for corrosion.
    - Threads on end of stem.
    - Operating nut threads.
    - Safety coupling for looseness.
    - Seat ring threads and surface.
    - Bonnet gasket surface.
    - Nozzle section gasket surface.
    - Bonnet where operating nut rests.
    - Operating nut.

Assembly Sequence

1. Remove and replace drain valve facings (73-40-2).
2. Install upper valve plate.
3. Insert upper valve plate into seat - Should fit tight but move smooth.
4. Install new main valve.
5. Place lock-tight on center 3 or 4 threads of stem. Install lower valve plate & tighten - 100 ft-lbs.
6. Install new main valve seat O-ring - lube with silicone lube, lube seat threads.
7. Slowly and with care install main valve in hydrant.
    - Turn counterclockwise until a jar is felt.
    - Turn clockwise until threads are started.
8. Tighten with seat wrench - 100 to 150 ft-lbs.
9. Replace stem O-ring - 73-146 - lube with silicone.
10. Replace housing O-rings - 73-2-2 - lube with silicone lube.
11. Install gasket 73-14.
12. Carefully so as not to damage O-rings - install housing 73-15.
13. With the hydrant wrench - install and tighten the travel stop nut.
14. Place lithium grease on stem threads and in operating

nut - install operating nut.

15. Replace gasket 73-13 and install housing.
16. Install weather cover (bonnet).
17. Open and close hydrant several times to assure ease of operation.
18. Open auxiliary valve.
19. Fill out report.

COMMON HYDRANT PROBLEMS

The following descriptions do not include all of the possible problems associated with fire hydrants. These descriptions do, however, describe six of the most common hydrant problems and methods of resolving each.

HYDRANT WON'T OPEN EASILY

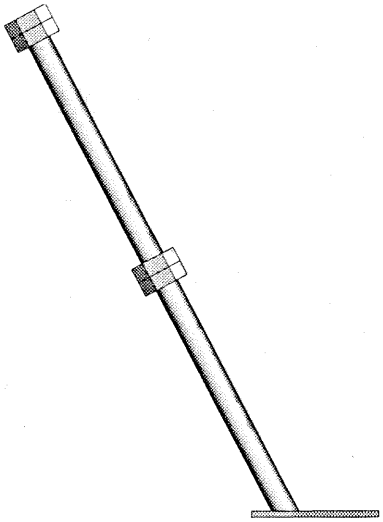
Causes	Cures
1. Lack of lubrication of the operating nut, operating lock nut or stem threads	Lubricate as needed
2. Bent operating stem	Replace stem
3. Corroded threads on toggle hydrants	Remove operating assembly, clean and lubricate the threads
4. The drain valve is stuck or damaged	Remove and replace
5. Too many extensions in operating stem	Disassemble and reduce the number of sections in the stem to 1 on standard hydrants and 2 on traffic models
6. Stuck packing or "O" rings in stuffing box	Remove and replace

LEAKING MAIN VALVE

Causes	Cures
1. Damaged by rocks or debris	Remove and replace
2. Toggle hydrant - main valve not centered in valve seat	Adjust position of stem collar

HYDRANT WILL NOT DRAIN

Causes	Cures
1. High water table	a. Plug drain valve openings and pump barrel after each use
2. Plugged drain valve	a. Pressurize hydrant with main valve only open 1 to 2 turns
	b. Toggle hydrants— use a rod through the drain hole. Use a 5/8" rod on Rennselear, Corey and Pacific States and 3/8" rod on Iowa
	c. Dig down and clear the hole from the outside
	d. Disassemble and use a tool as shown in the figure below



Hydrant drain hole punch (Gimmicks and Gadgets Opflow Feb. 1977)

HYDRANT WILL NOT SHUTDOWN AFTER USE

Causes	Cures
1. Bent or broken stem	Remove and replace stem
2. Improper adjustment of drain valve on toggle hydrant	Disassemble hydrant and adjust the drain valve
3. Damaged main valve	Remove and replace

HYDRANT VIBRATES DURING SHUTDOWN

Causes	Cures
Compression Hydrants	
1. Main valve loose on stem	Disassemble and tighten nuts below lower valve plate
2. Worn threads in operating nut or on stem	Replace either the operating nut or stem, which ever has the worn threads
Toggle Hydrants	
1. Loose pins on the operator arm	Disassemble the hydrant and remove and replace the pins
2. The nature of some toggle hydrants	Do not hesitate at shutdown. (This does not cure the vibration, but it does reduce the amount of time that the hydrant vibrates.) These hydrants should be marked

NO WATER FLOWS FROM THE HYDRANT WHEN IT IS OPENED

Causes	Cures
1. Auxiliary valve shut off	Open auxiliary valve
2. Broken stem	Remove and replace
3. Stripped threads on operating nut	Remove and replace
4. Broken arm on toggle type hydrant	May need to use a cutting torch to remove the broken arm Remove and replace broken arm

O & M OF FIRE HYDRANTS

WORKSHEET

1. The most common fire hydrants installed in Alaska are:

_____ a. Wet Barrel

_____ b. Dry Barrel

_____ c. Post type

_____ d. Flush type

_____ e. High pressure

2. Identify the hydrants below. If a hydrant is a dry barrel then identify if it is a toggle or compression type.

_____ a.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

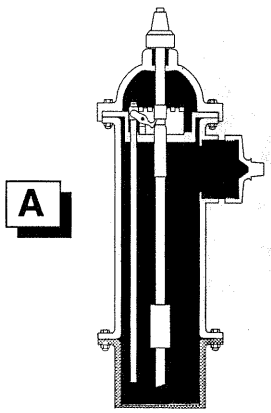
_____ b.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

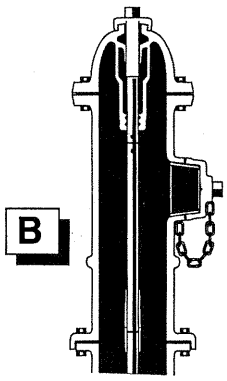
_____ c.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

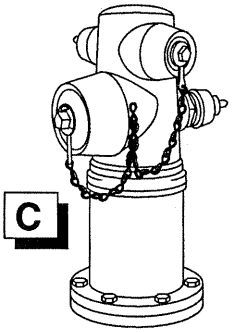
_____ d.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

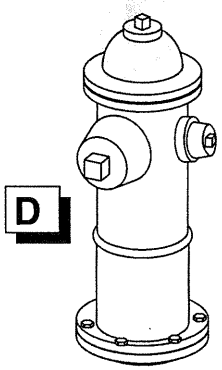
_____ e.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

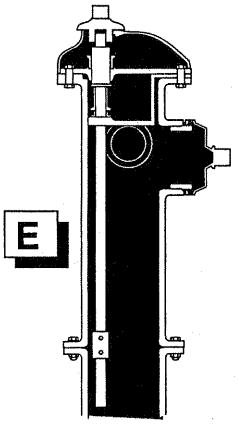
_____ f.❑ Wet or❑ dry barrel, ❑ compression or❑ Toggle

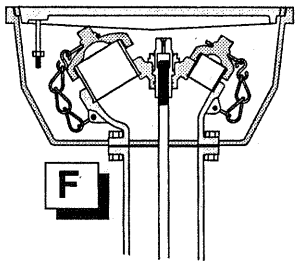












3. The major advantage to using a wet barrel hydrant is...

_____ a. Easier to repair

_____ b. Protected from freezing

_____ c. Easier to connect a second fire truck

_____ d. Easier to install and maintain, reducing maintenance cost

_____ e. There is no advantage

4. Identify the hydrant components indicated.

_____ a. Shoe

_____ b. Safety Flange

_____ c. Upper Barrel

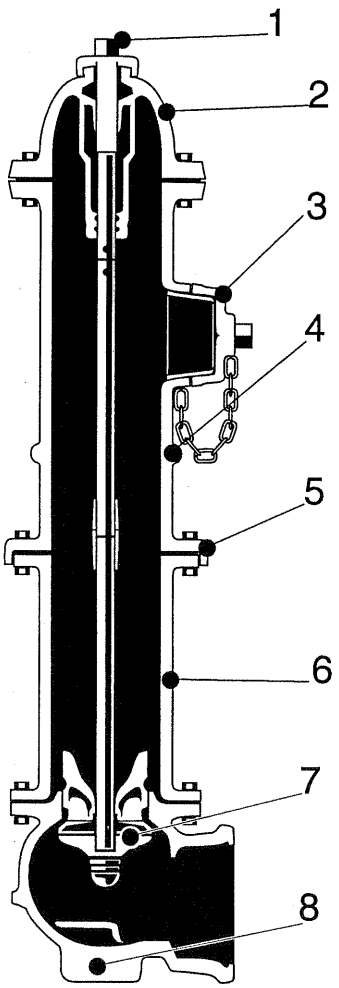
_____ d. Lower Barrel

_____ e. Bonnet

_____ f. Operating nut

_____ g. Pumper Nozzle cap

_____ h. Main valve



5. The most common hydrant inlet connection size is...

_____ a. 4 inch

_____ b. 2 inch

_____ c. 6 inch

_____ d. 3 inch

_____ e. 8 inch

6. The most common outlet connection for a fire hydrant is the ....

_____ a. 3 inch pumper nozzle

_____ b. 2.5 inch NST

_____ c. 2 inch IPT

_____ d. 3 inch IPT

_____ e. 4 inch NST

7. The bury of a hydrant is the distance between _____ and the _____.

_____ a. Bottom of the trench and just below the safety flange

_____ b. The invert of the pipe and a point 2 inches above the safety flange

_____ c. The invert of the pipe and a point 2 inches below the safety flange

_____ d. The bottom of the trench and the center of the safety flange

_____ e. The bottom of the trench and the top of the ground

8. When opening a compression hydrant the drain valve remains open during the first _____ to _____ turns.

_____ a. 1 - 10

_____ b. 5 -10

_____ c. 3 - 8

_____ d. 2 - 6

_____ e. 1 - 5

9. When the main valve of a compression fire hydrant is closed the drain valve is..

_____ a. Closed

_____ b. Open

10. How often should fire hydrants in an environment with freezing winter temperatures be inspected?

_____ a. 3 times each year

_____ b. Only after they are used

_____ c. Twice each year

_____ d. Once each year

_____ e. Only where there is expected problems

11. How is the operating nut on a Mueller hydrant lubricated?

_____ a. It is not lubricated

_____ b. An oil reservoir in the bonnet

_____ c. Water resistant grease

_____ d. Silicone lubricant

_____ e. By water flowing past the threads

12. On a fire hydrant what does MVO mean?

_____ a. Most Valuable Organization

_____ b. Main Valve Operation

_____ c. Most Variable Operation

_____ d. Main Valve Opening

_____ e. Many Variable Openings

13. Where would you look on a fire hydrant to find the year of manufacture?

_____ a. Lower barrel

_____ b. Bonnet

_____ c. It is not on the hydrant

_____ d. Base

_____ e. Nozzle section

14. The component used to separate the bonnet from the nozzle section is called the _____.

_____ a. "O" ring section

_____ b. Nozzle guard

_____ c. Packing plate

_____ d. Packing gland

_____ e. Upper bonnet plate

15. The drain valve on a compression hydrant is located in what component?

_____ a. Main valve

_____ b. Lower barrel

_____ c. Nozzle section

_____ d. Base

_____ e. Inlet connection

16. As a result of closing a fire hydrant rapidly ...

_____ a. Water hammer can be produced

_____ b. The flow is stopped quickly

_____ c. The operating nut can be damaged

_____ d. The stem may come unthreaded

_____ e. The main valve will be pushed away from the seat causing excessive leakage

17. When opening a compression hydrant that opens against the flow you would expect the stem to turn easiest.

_____ a. When first opening the hydrant

_____ b. After the hydrant is nearly completely open

_____ c. In the middle of the opening cycle

_____ d. There should be no change in the amount of effort to rotate the shaft regardless of the position.

_____ e. At the start and at the end of the opening cycle

18. A fire hydrant that uses a scissors-type action for its operating mechanism is called a _____ .

_____ a. Compression hydrant

_____ b. Toggle hydrant

_____ c. Slide gate hydrant

_____ d. High pressure hydrant

_____ e. Frost jacket hydrant

19. The NFPA suggest that fire hydrants that flow less than 500 gpm be color coded by painting some portion of the hydrant _____.

_____ a. White

_____ b. Red

_____ c. Yellow

_____ d. Green

_____ e. Orange