
LESSON PLAN #FF1-11

TITLE: **WATER SUPPLY**

TIME REQ'D: Three (3) Hours

STANDARD: NFPA 1002 (1997 Edition)

INST. LEVEL: Level 1 - 2 - 3
Knowledge - Comprehension - Application

MAT. NEEDED: Overhead Projector, OHT's

REFERENCE: IFSTA Essentials of Firefighting, 4th Edition
IFSTA Water Supplies, 4th Edition

OBJECTIVE: At the end of this class, each firefighter shall be able to:

1. Describe a typical water distribution system
2. Identify water sources available in community
3. Define the following water main types:
 - a. primary feeders
 - b. secondary feeders
 - c. distributors
4. Identify the carrying capacity of various size water mains
5. Identify the causes of increased friction loss in water mains.
6. Describe the characteristics of wet-barrel and dry-barrel fire hydrants
7. Define the following water pressure terms and describe how to determine the pressure in each case:
 - a. flow pressure
 - b. head pressure
 - c. normal operating pressure
 - d. residual pressure
 - e. static pressure
8. Describe the following types of water main valves:
 - a. indicating
 - b. non-indicating
 - c. non-rising stem

- d. outside screw and yoke
9. List at least five items which should be part of a hydrant maintenance inspection
10. Describe how to properly operate a fire hydrant.
11. Understand how to use a pitot tube and record flow pressures from different size openings.
12. Identify basic procedures in tanker shuttle operation.
13. Understand how to assemble and connect hard suction line to draft from a static source.

Evaluation shall be a written test which requires a minimum score of 70% to pass.

MOTIVATION:

Water is the most widely used extinguishing agent in the fire service. When we respond to a structure fire we rely heavily on the available water supply. If any part of the water system fails due to lack of maintenance or fails to perform as expected due to lack of understanding, we place personnel in danger and face increased fire loss.

OVERVIEW:

In this presentation we will cover:

1. History of water supply systems
2. Components of a water supply system
3. Types of pressure
4. Hydrants
5. Tankers
6. Other sources of water
7. Drafting from static sources

PRESENTATION:

- I. HISTORY OF WATER SUPPLY SYSTEMS
 - A. Primitive communities built around natural water sources
 1. Lakes
 2. Rivers
 3. Ponds
 4. Springs
 5. Other

OHT #1 (IFSTA 9-1)

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- B. First Recorded Municipal Water System Developed By Roman Empire
 - 1. Water:
 - a. Carried by stone aqueducts
 - b. Stored in masonry cisterns
 - c. Delivered through:
 - (1) lead pipes
 - (2) bored stone pipes
 - C. Water system nearly vanished with decline of Roman Empire
 - D. First North American Water Supply System Put Into Service By Philadelphia Waterworks In 1800
 - E. New York City and Boston Developed Systems By Mid 1800's
 - 1. Utilized hollowed logs fed from elevated reservoirs
 - 2. When water needed for fire suppression:
 - a. Firefighters:
 - (1) dug hole in ground to put suction hose for hand pumper
 - (2) drilled hole in log water main allowing water to flow into hole in ground
 - (3) hole in water main filled with wooden plug
 - (a) allowed for quicker access if needed later
 - (b) modern fire hydrants still referred to as "fire plugs"
 - F. Hollow Logs And Elevated Reservoirs Replaced By:

1. Pumping stations
 2. Water towers
 3. Underground pipes
- G. Rural Areas Without Water Systems Require Alternate Means Of Water Supply
1. Two methods derived from old fashioned bucket brigades:
 - a. Relay pumping
 - b. Tanker shuttle

INSTRUCTOR NOTE

ASK STUDENTS: Who is responsible for water supply needs?

City Engineer

How is the water supply requirement calculated?

Normal operating requirements (industrial, business, residential) for area being served plus minimum required flow for fire suppression equals total amount of water system needs to furnish.

Who is responsible for quantity, location and types of fire hydrants?

Fire Department:

- ***Fire Chief***
- ***Fire Marshal***
- ***Other Designated Personnel***

How far apart should fire hydrants be placed in high-value areas?

Not more than 300'

What is the general rule of thumb for hydrant spacing?

- ***Near each intersection, but not exceed 350' to 400' between hydrants***

II. COMPONENTS OF WATER SUPPLY SYSTEM**INSTRUCTOR NOTE**

ASK STUDENTS: What are the four components of a modern water supply system?

- ***Source of Water***
- ***Means of Moving Water***
- ***Treatment Facility***
- ***Distribution System***

OHT #2 (IFSTA 9-2)

- A. Sources of Water
 - 1. Surface Water
 - a. River
 - b. Lake
 - c. Stream
 - d. Pond
 - 2. Ground Water
 - a. Well
 - b. Spring

OHT #3 (IFSTA 9-3)

- B. Means To Move Water
 - 1. Three methods used:
 - a. Pumps
 - b. Gravity
 - c. Combination

INSTRUCTOR NOTE

ASK STUDENTS: What advantage does a gravity or combination system have over a pump system?

They are not totally dependent upon a power supply to provide the distribution system with adequate supply of water for fire suppression.

What can we do to prevent a total breakdown of the system?

Nothing!!! We have no control over the water system, but we can and should make some contingency plans to cover any such occurrence.

- 2. Direct Pumping System
 - a. Used in communities where water source located at elevation lower than city
 - b. May supply water to:

- (1) water treatment facility or;
- (2) directly into distribution system
- c. Has little or no elevated water storage
- d. Failure of just one electrical / mechanical component could cause entire system to fail
 - (1) provisions to minimize consequences of component failure could include:
 - (a) multiple supply lines from water source
 - (b) automatic auxiliary power supplies for all primary pumps
 - (c) auxiliary pumping stations with independent power supplies

3. Gravity System

- a. Used in communities where water source located at elevation higher than city
- b. Water used from natural or man-made reservoir may run to:
 - (1) water treatment facility or;
 - (2) directly into distribution system
- c. Pressure created is directly proportional to difference in elevation between source and water distribution system
 - (1) one (1) foot elevation creates .434 pounds of pressure
 - (2) One (1) pound of pressure created for every 2.3 feet increase in elevation

- d. To create 65 psi (approx) static pressure, elevation difference would need to be 150'
 - e. Factors to consider when developing gravity system
 - (1) reservoir capacity
 - (a) sufficient to meet needs in emergency situations
 - (2) refill capability
 - (a) sufficient to meet maximum consumption demands
 - (3) elevation differences
 - (a) provide adequate pressures at all points of system
4. Combination System
- a. Most common type of system
 - b. Gravity flow provided by water pumped into elevated storage tanks
 - c. Tanks provide water storage as well as pressure
 - d. Ensures adequate supply of water at sufficient pressure to meet demands if mechanical side of system goes down
- C. Treatment Facility
- 1. Required by current regulations
 - 2. Might not be in use at all times
 - a. Depends upon water quality
 - 3. Methods of treatment:

- a. Coagulation
- b. Sedimentation
- c. Filtration
- d. Chemicals
- e. Bacteria
- f. Other

D. Distribution System

1. Definition:

- a. "that part of the system which receives the water from the pumping station and delivers it throughout the area"

2. Types of distribution systems:

a. Tree system

(1) definition:

- (a) "formed by branch lines running off from main line"

(2) creates many dead-end fire hydrants

(3) dead-end fire hydrants

(a) definition:

- "hydrant that receives water from only one direction"

OHT #4

b. Circle / Belt / Loop system

(1) definition:

- (a) "system which encircles area to be fed with branch lines running into area"

OHT #5

- OHT #6 (IFSTA 9-4)
- (b) except for those hydrants coming directly off loop, creates dead-end hydrants
 - c. Grid system
 - (1) definition:
 - (a) “distribution system which provides circulating water feed from several mains”
 - (2) components:
 - (a) primary feeders
 - large pipes with relatively wide spacing that carry large quantities of water to various points of system for distribution to smaller mains
 - (b) secondary feeders
 - network of intermediate size pipe that reinforces grid by forming loops that interlock primary feeders
 - (c) distributors
 - smaller internal grid arrangements that serve consumer blocks and individual fire hydrants
 - (3) promotes circulating feed hydrants
 - (4) circulating feed hydrant:
 - (a) definition:

- “hydrant which receives water from two or more directions”

- OHT #7 (IFSTA 9-5)
- E. Water Main Sizes
1. Industrial areas:
 - a. 12” minimum
 2. Business districts:
 - a. 8” minimum
 3. Residential areas
 - a. 6” minimum

NOTE

FIRE HYDRANTS SHOULD NOT BE INSTALLED ON ANY WATER MAIN SMALLER THAN 8”. ANYTHING SMALLER DOESN’T ALLOW FOR MAXIMUM FLOW FROM HYDRANT.

INSTRUCTOR NOTE

SHOW IFSTA OHT #9-6 AND COMPARE THE QUANTITIES OF WATER WHICH FLOW THROUGH THE DIFFERENT SIZES OF PIPES.

- OHT #8 (IFSTA 9-6)
- F. Valves
1. Function:
 - a. Control flow of water through distribution system
 2. Spacing
 - a. Located at frequent intervals so only small sections of water system out of service when area shut down for maintenance and/or repair
 - b. Water department should have map with all valve locations marked
 3. Operation

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- a. Valves used little during normal water system operation
- (1) only used when system has malfunction
- b. Valves should be exercised minimum of once per year to keep in good operating condition
4. Types
- OHT #9 (IFSTA 9-7)
- a. Indicating
- b. Non-indicating
- c. Indicating valve
- (1) visually shows position of gate or valve seat
- (a) open
- (b) closed
- (c) partially open
- (2) common types
- (a) outside screw and yoke (OS&Y)
- has yoke on outside with threaded stem which controls gate / valve seat
 - valve stem out shows valve open
 - valve stem in shows valve closed
- (b) post indicator valve (PIV)
- hollow metal post attached to valve housing

- valve stem inside housing has OPEN and SHUT to show position of gate / valve seat

d. Non-indicating valves

- (1) usually buried or installed in manholes
- (2) correctly installed, valve operated from aboveground through valve box with valve key
- (3) types:
 - (a) non-rising stem gate valve
 - should be marked to show number of turns to fully open or close valve
 - lets operator know if valve working properly
 - (b) butterfly valve
 - tight closing with rubber or rubber composition seat bonded to valve body
 - valve disc rotates 90° from completely closed to fully open

G. Water Pipe

1. Types:
 - a. Cast iron
 - b. ductile iron
 - c. concrete-asbestos
 - d. steel

- e. plastic
- f. concrete
- 2. Must be proper type for:
 - a. soil conditions
 - b. pressure requirements
- 3. Internal surface of pipe offers resistance to water flow
 - a. Some materials offer substantially less resistance than others
 - b. This resistance called friction loss
 - (1) friction loss defined as:
 - (a) "that part of the total pressure lost as water moves through a hose or piping system, caused by water turbulence and the roughness of interior surfaces of hose or pipe"
 - c. Friction loss further increased by
 - (1) incrustation of minerals on interior surface of pipe
 - (2) sedimentation

OHT #10 (IFSTA 9-8)

III. TYPES OF PRESSURE

OHT #11

A. Flow Pressure

1. Definition:

- a. "Pressure created by the rate of flow or velocity of water coming from a discharge opening"

OHT #12

B. Head Pressure

1. Definition:

- a. "That pressure exerted by a stationary column of water, directly proportional to its height."
 - OHT #13
 - C. Normal Operating Pressure
 - 1. Definition:
 - a. "That pressure found on a water distribution system during normal consumption demands"
- OHT #14
 - D. Residual Pressure
 - 1. Definition:
 - a. "That part of the total pressure not used to overcome friction or gravity while forcing water through fire hose, pipe, fittings, and adapters"
- OHT #15
 - E. Static Pressure
 - 1. Definition:
 - a. "Stored or potential energy available to force water through pipes, fittings, fire hose, and adapters"
- IV. HYDRANTS
- OHT #16 (IFSTA 9-10)
 - A. Two Types
 - 1. Dry barrel
 - 2. Wet barrel
 - B. Dry Barrel
 - 1. Used in cold climates (below 40° F)
 - 2. Valve located below frost line
 - 3. Valve type may be:
 - a. Compression

- b. Gate
 - c. Knuckle-joint
 - 4. Valve may open with or against pressure
 - 5. When hydrant closed, barrel should be empty
 - a. Drain holes located just above valve
 - 6. Hydrant should either be fully opened or fully closed
 - a. Partially opened hydrant will flow water out drain holes, eroding ground around hydrant
 - 7. When you close hydrant , look down barrel before putting cap back on
 - a. Water should drain down if operating properly
- C. Wet Barrel
- 1. Used in warm climates (above 40° F)
 - 2. Has compression type valve on each outlet
 - 3. Entire hydrant always full of water

NOTE

OPEN AND CLOSE FIRE HYDRANTS SLOWLY TO PREVENT WATER HAMMER.

- D. Hydrant Flow
- 1. Dependent upon:
 - a. Type of system
 - (1) tree
 - (2) loop / circle
 - (3) grid
 - b. Water main size

OHT #17

- c. Sedimentation / Encrustation
- 2. Color coding
 - a. Hydrant Class "AA"
 - (1) light blue bonnet and caps
 - (2) 1500 gpm or greater
 - b. Hydrant Class "A"
 - (1) green bonnet and caps
 - (2) 1000 - 1499 gpm
 - c. Hydrant Class "B"
 - (1) Orange bonnet and caps
 - (2) 500 - 999 gpm
 - d. Hydrant Class "C"
 - (1) red bonnet and caps
 - (2) less than 500 gpm

NOTE

THE NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RECOMMENDS THE BARREL OF ALL HYDRANTS BE PAINTED CHROME YELLOW.

OHT #18 (IFSTA 9-11)

- E. Hydrant Maintenance
 - 1. Check for obstructions
 - a. Sign posts
 - b. Utility poles
 - c. Fences
 - d. Shrubbery
 - 2. Check for outlet clearance
 - a. Ground

- b. Obstructions
 3. Check outlet direction
 - a. Are they facing right direction
 4. Check for damage from:
 - a. Traffic
 - b. Homeowners
 - c. Vandals
 5. Check for condition of paint
 6. Check for leaks
 7. Check for:
 - a. Rust
 - b. Sediment
 - c. Foreign materials
 - (1) rocks
 - (2) toys
 - (3) marbles
 - (4) other
 8. Check stem
 - a. Does it turn easily
 9. Check gaskets in caps
 10. Check threads
 11. Check hydrant drain (if dry-barrel type)

F. Hydrant Testing

OHT #19 (IFSTA 9-12)

1. Pitot tube used to read flow pressure of hydrant
 - a. Hold pitot so blade in center of water stream
 - b. Bleed air from pitot using petcock
 - c. Hold blade away from discharge orifice
 - (1) distance equal to one-half diameter of opening
 - d. Tube should be held parallel to opening
 - e. Read gauge
 - (1) if pressure fluctuates, use average

INSTRUCTOR NOTE

**SHOW IFSTA OHT 9-13 AND EXPLAIN TO STUDENTS HOW TO UTILIZE CHART.
OHT #20 (IFSTA 9-13)**

OHT #21 (IFSTA 9-14)

NOTE

WATER CAN BE MOVED FROM POINT "A" TO POINT "B" USING A SERIES OF ENGINES IN A RELAY PUMPING OPERATION. THE DISTANCE WE ARE ABLE TO RELAY IS DETERMINED BY THE NUMBER OF ENGINES AND THE SIZE AND QUANTITIES OF SUPPLY HOSE THAT ARE AVAILABLE. WHEN THE REQUIRMENTS EXCEED THE RESOURCES, THE USE OF TANKERS BECOMES NECESSARY.

V. TANKERS

NOTE

TANKERS MAY ALSO BE REFERED TO AS TENDERS OR MOBILE WATER SUPPLY APPARATUS

- A. Used to get water to fire in areas not equipped with fire hydrants
- B. Can be used individually for smaller water demands
- C. Tanker shuttle used when maximum water required
- D. Tanker shuttle

OHT #22 (IFSTA 9-15)

1. Defined as:
 - a. "The transporting of water from a supply source to a portable tank(s), where it can be used as needed by the attack engine."
2. Components:
 - a. Water source
 - (1) static
 - (2) pressurized
 - b. Transport equipment
 - (1) tankers
 - (2) pumpers
 - (3) tanker pumper
 - (4) pumper tanker
 - c. Dump site
 - (1) portable tanks
 - (2) nurse tanker
3. Factors affecting efficiency
 - a. Tank capacity
 - b. Off-load preparation time
 - c. Off-load time
 - d. Off-load breakdown time
 - e. Travel time empty
 - f. Fill preparation time
 - g. Fill time
 - h. Fill breakdown time

- i. Travel time full

NOTE

PORTABLE TANK CAPACITY AND THE ABILITY TO SIPHON FROM ONE TANK TO ANOTHER MAY ALSO HAVE A DIRECT IMPACT ON HOW MUCH WATER IS AVAILABLE FOR ATTACK ENGINES TO USE.

VI. OTHER SOURCES OF WATER

A. Natural Sources

1. Lakes
2. Streams
3. Ponds
4. Rivers
5. Ocean

- a. Rinse apparatus, pump, piping and hoses thoroughly with fresh water before putting back in service

6. Other

B. Man-made Sources

1. Stock tanks
2. Swimming pools
3. Cisterns
4. Irrigation ditches
5. Other

VII. DRAFTING FROM STATIC SOURCES

A. Components

1. Suitable water supply
2. Engine equipped and maintained to draft

- a. Appropriate size hard suction / strainer
 - b. Pump capable of pulling vacuum
- B. Operations
1. Position engine for draft
 2. Connect:
 - a. Hard suction to pump intake
 - b. Strainer to hard suction
 - (1) basket strainer
 - (2) floating strainer

NOTE

ALL CONNECTIONS MUST BE AIRTIGHT FOR DRAFT TO BE EFFECTIVE.

3. Place strainer in water
4. Operator activates primer to initiate lift

APPLICATION:
&
SUMMARY:

We have covered the elements of a water supply:

1. History of water supply systems
2. Components of a water supply system
3. Types of pressure
4. Hydrants
5. Tankers
6. Other sources of water
7. Drafting from static sources

to give you a basic understanding of how water gets from the ground to the fire hydrant. Are there any question or comments?

CONCLUSION:
&
ASSIGNMENT:

If there are no further questions, I will now hand out a written test which will require a minimum score of 70% to receive credit for this class.

NAME: _____ DATE: _____

WATER SUPPLIES QUIZ

1. Name three (3) alternate sources of water besides the city hydrant system.

2. T F Wet barrel fire hydrants are used primarily in the cold weather climates.

3. T F An OS&Y valve is an example of a non-indicating type valve.

4. List three (3) items which should be part of a hydrant maintenance inspection.

5. T F A non-rising stem gate valve and a butterfly valve are most commonly used underground.

6. T F Primary feeders consist of large pipes with widespread spacing which convey large quantities of water to various points of the water system.

7. T F A 6" water main will provide 1075 GPM to a dead-end hydrant at 50 PSI static and 20 PSI residual.

8. T F Distributors are smaller mains which serve individual fire hydrants and blocks of consumers.

9. T F The amount of water needed to supply a city is the sum of the fire flow and the industrial, business, and residential use.

10. Match the term to the definition:

- a. Flow Pressure b. Head Pressure c. Normal Operating Pressure
d. Residual Pressure e. Static Pressure

___ is that part of the total pressure not used to overcome friction or gravity while forcing water through fire hose, pipe, fittings, and adapters.

___ is the forward velocity pressure at a discharge opening that is recorded by a pitot tube and gauge while water is flowing.

___ is that pressure which is normally found on a water distribution system during normal consumption demands.

___ is stored potential energy that is available to force water through pipe, fittings, fire hose, and adapters.

___ is that pressure exerted by a stationary column of water and is directly proportional to its height.

**ANSWER KEY
WATER SUPPLIES QUIZ**

1. Name three (3) alternate sources of water besides the city hydrant system.
River, Pond, Lake, Swimming Pool, Cistern, Ocean, Irrigation Ditches, Tenders
2. T F Wet barrel fire hydrants are used primarily in the cold weather climates.
3. T F An OS&Y valve is an example of a non-indicating type valve.
4. List three (3) items which should be part of a hydrant maintenance inspection.
Check for: obstructions, clearance, direction, damage, leaks, foreign materials
Check: paint, stem, gaskets, threads, drain
5. I F A non-rising stem gate valve and a butterfly valve are most commonly used underground.
6. I F Primary feeders consist of large pipes with widespread spacing which convey large quantities of water to various points of the water system.
7. T F A 6" water main will provide 1075 GPM to a dead-end hydrant at 50 PSI static and 20 PSI residual.
8. I F Distributors are smaller mains which serve individual fire hydrants and blocks of consumers.
9. I F The amount of water needed to supply a city is the sum of the fire flow and the industrial, business, and residential use.
10. Match the term to the definition:

- | | | |
|----------------------|--------------------|------------------------------|
| a. Flow Pressure | b. Head Pressure | c. Normal Operating Pressure |
| d. Residual Pressure | e. Static Pressure | |

d is that part of the total pressure not used to overcome friction or gravity while forcing water through fire hose, pipe, fittings, and adapters.

a is the forward velocity pressure at a discharge opening that is recorded by a pitot tube and gauge while water is flowing.

c is that pressure which is normally found on a water distribution system during normal consumption demands.

e is stored potential energy that is available to force water through pipe, fittings, fire hose, and adapters.

b is that pressure exerted by a stationary column of water and is directly proportional to its height.