PUMPER OPERATOR

Thirty-Two (32) Hours

THIS IS INTENDED TO BE A GENERIC PUMPER OPERATOR COURSE. AT THE CONCLUSION OF THIS COURSE THE STUDENT SHOULD BE ABLE TO WALK UP TO ALMOST ANY PIECE OF FIRE APPARATUS EQUIPPED WITH A PUMP AND, WITH A LITTLE TIME, BE ABLE TO EFFECTIVELY PUMP WATER THROUGH HOSE FROM POINT "A" TO POINT "B".

THE SUGGESTED COURSE SCHEDULE IS AS FOLLOWS:

<u>1st WEEKEND</u>

Four (4) Hours:	**Pump Operation • Part I (classroom)**
Four (4) Hours:	**Hydraulics • Part I (classroom)**
Two (2) Hours:	**Water Supply (classroom)**
Six (6) Hours:	**Practical Application (drill ground)**

<u>2nd WEEKEND</u>

Four (4) Hours:	**Pump Operation • Part II (classroom)**
Four (4) Hours:	**Hydraulics • Part II (classroom)**
Two (2) Hours:	**Sprinklers & Standpipes (classroom)**
Six (6) Hours:	**Practical Application (drill ground)**

IT IS ESSENTIAL FOR APPARATUS OPERATORS TO KNOW THE SPECIFIC CHARACTERISTICS OF ANY INDIVIDUAL PIECE OF APPARATUS THAT THEY COULD BE CALLED UPON TO OPERATE. THIS COURSE WILL NOT MEET THAT REQUIREMENT, BUT WILL HOWEVER, PROVIDE THE STUDENT WITH A GOOD BASIC FOUNDATION FROM WHICH TO START.

LESSON PLAN #PO-1

TITLE: **PUMP OPERATION (Part I)**

TIME REQ'D: Eight (8) hours

STANDARD: NFPA 1002 (1998 Edition)

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

MAT. NEEDED:
- Slide Projector
- Slide Program
- TV / VCR
- Media Resources Video "Fire Pumpers & Pump Operation"
- Span Gauge Video "Flowminders"
- Action Training Video "Foam Fire Streams"
- Elkhart Brass Video "No City or Community Without Risk"
- Student Handouts
- Fire Engine(s)
- Water Tender
- Water Supply
  - static
  - pressurized
- Monitor(s) equipped with non-automatic nozzles
  - portable
  - deck mounted
- Foam Producing Equipment
- Foam (Class "A")
- Flow Test Equipment

REFERENCE: IFSTA "Fire Department Pumping Apparatus", 7th Edition

OBJECTIVES: At the end of this class, each apparatus operator shall be able to:
SM Pg. 1

1. Identify three methods of power transfer from the vehicle engine to the pump

2. Identify the operating principles of single-stage and multiple-stage centrifugal pumps
3. Identify the major components and trace the flow of water through single-stage and multiple-stage centrifugal pumps
4. Identify corrective measures for the following conditions which may result in pump damage or unsafe operation:
    a. cavitation
    b. leaking fuel, oil or water
    c. overheating
    d. unusual noises
    e. vibrations
    f. water hammer
5. Recognize the theory and principles of priming the pump
6. Identify the characteristics and limitations of hard suction and soft suction pumper supply hose
7. Identify the percentages of rated capacity, rated pressures, and the capacity in gallons per minute at the rated pressures a fire department pumper is designed to deliver
8. Identify all gauges on a department pumper and demonstrate their use
9. Identify a remedy for each of the following malfunctions which may occur during pumping operations:
    a. fluctuating pressure
    b. insufficient pump capacity
    c. insufficient pump pressure
    d. pump will not prime or loses prime
10. Demonstrate how to operate (including engaging the pump) the various types of fire apparatus available in the employing department

SM Pg. 2

11. Demonstrate positioning and stabilizing a fire department pumper to operate at a fire hydrant and static supply source utilizing each existing pumper intake connection, given a pumper, a length of intake hose, and appropriate fittings or tools, so that the intake hose can be connected, without kinks, to the pump connection without repositioning the vehicle
12. Demonstrate production of effective hand streams, utilizing the sources specified below, so that the pump is safely engaged, all pressure control and vehicle safety devices are set, the rated flow of the nozzle is achieved, and the apparatus is continuously monitored for potential problems:

a. internal tank
b. pressurized source
c. static source

13. Demonstrate production of effective master streams, utilizing the sources specified below, so that the pump is safely engaged, all pressure control and vehicle safety devices are set, the rated flow of the nozzle is achieved, and the apparatus is continuously monitored for potential problems:
    a. internal tank
    b. pressurized source
    c. static source
14. Demonstrate procedures for pumping the following:
    a. maximum delivery rate from the apparatus water tank
    b. maximum rated capacity from a hydrant
    c. maximum rated capacity from draft
15. Demonstrate changing a water supply from the apparatus water tank to an external source, given a pumper with an operating fire attack line of 1-1/2 in. or larger, so that the flow of water to the attack line is not interrupted and the proper pressure is maintained
16. demonstrate the operations of fire apparatus pump pressure relief systems and pressure control governors
17. Demonstrate the operation of auxiliary cooling systems
19. Demonstrate the use of the volume/pressure transfer valve under actual pumping conditions (multi-stage pumps only)
20. The individual shall demonstrate connecting/engaging foam production system(s) and production of a foam fire stream.
21. Recognize the operating principles of the following types of apparatus foam systems:
    a. around the pump
    b. balanced pressure
    c. eductor
    d. electronically metered injection

SM Pg. 3

22. Identify the relationship of the four components of the foam tetrahedron in the production of an effective foam stream.
23. The individual shall match each of the following types of foam concentrates with their tactical application:
    a. Class A
    b. Class B - hydrocarbon type
    c. Class B - alcohol/polar solvent-resistant

d. Class B - hydrocarbon/alcohol/polar solvent-resistant

24. Match environmental and operational factors which may negatively affect foam quality with an appropriate corrective action.
25. Determine the water and foam concentrate requirements, given application time, application rate, and concentration.

Evaluation will be a written test requiring a minimum score of 70%, followed by several task performances which must be completed satisfactorily to receive credit for the class.

MOTIVATION: Although there are numerous models and types of fire pumps used on fire department apparatus, most are designed to perform the same general function. Because of this similarity, a pump operator can do an adequate job of operating any piece of apparatus by applying fundamental principles. These principles, along with proper training, practice, and a thorough knowledge of water supply, must be understood well before a firefighter can become a proficient and effective apparatus operator. (IFSTA)

OVERVIEW: In this presentation we shall cover:

1. Methods of power transfer
2. Pump construction
3. Pressure control devices
4. Priming systems
5. Auxiliary cooling systems
6. Pump operating procedures
7. Pump panel gauges
8. Flowmeters
9. Malfunctions which could occur during pump operation
10. Conditions which may lead to pump damage or unsafe operation and their remedies
11. Positioning apparatus
12. Rated pumping capacities
13. Foam fire streams

PRESENTATION: I. METHODS OF POWER TRANSFER

A. Three Types

1. Split Shaft

a. Midship

2. Direct Drive

a. Front mount

3. Power Take Off

a. Booster pumps

II. PUMP CONSTRUCTION

Slide #1

A. Split Shaft / Midship

1. Split shaft means:

a. To split original driveline and insert pump

(1) requires new front and rear drivelines

b. Shift is required to place pump gearbox into:

(1) road mode

(2) pump mode

NOTE

MIDSHIP TRANSFER DRIVE PUMPS USE A SPLIT-SHAFT GEAR CASE TO TRANSFER POWER FROM THE REAR AXLE TO THE FIRE PUMP.

2. Midship means:

a. Pump mounted behind cab, midway between front and rear axles

Slide #2

3. Midship pump before:

a. Piping

b. Tank

c. Panels

Slide #3

4. Two stage pump with typical panel arrangement

5. Midship pumps, both single and two stage

   a. Have capacities ranging from 500 to 2000 GPM

   b. Most popular pump in fire service today

Slide #4

6. Major components of midship pump

   a. Pump body

      (1) upper

      (2) lower

   b. Impeller assembly

   c. Gear box

Slide #5

7. Cross section of single stage pump showing:

   a. Double suction impeller

   b. Wrap-around clearance ring

   c. Double suction chamber

   d. Pump packing

Slide #6

8. Actual photo of single stage pump with lower half of pump body removed

Slide #7

9. Single stage pump water flow

   a. Double suction chamber supplies double suction impeller (lighter shading)

SM Pg. 4

   b. Discharge flow from impeller (darker shading)

Slide #8

10. Cross section of two stage midship pump showing:

   a. First stage impeller

   b. Second stage impeller

c. Center bearing

d. Pump packing

Slide #9

11. Actual photo of two stage pump with lower half of pump body removed

12. Two stage water flow

Slide #10

a. Volume (parallel) position

(1) check valves are open

(2) transfer valve allows second stage impeller to discharge directly to manifold

(a) light colors indicate suction

(b) darker shades indicate discharge

(3) each impeller pumps half of total volume

Slide #11

b. Pressure (series) position

(1) check valves are closed

(2) all water from first stage impeller diverted to second stage impeller through transfer valve

(a) light shading indicates suction

(b) light blue is first stage discharge

(c) dark blue is second stage discharge

Slide #12

13. Transfer valve (two stage pumps)

a. View on left shows:

(1) transfer valve in volume position

b. View on right shows:

(1) transfer valve in pressure position

Slide #13

14. Power train

a. Main cross section (pump position) shows:

(1) sliding gear disengaged from tail shaft and lined up with intermediate gear

(2) engine power directed through intermediate gear to pump shaft gear

b. Lower left cross section (road position) shows:

(1) sliding gear meshed with tail shaft and disengaged from intermediate gear

(2) engine power directed through pump gearbox to rear wheels

Slide #14

c. Exploded view of gearbox components

(1) sliding gear moves fore and aft on splined shaft

(2) power input from engine is to drive flange at left

Slide #15

B. Direct Drive / Front Mount

1. Direct drive means:

a. Pump driven directly from engine crankshaft pulley

2. Front mount means:

a. Installed on front of vehicle

Slide #16

3. Completed installation of front mount pump

   a. All controls located in same area

Slide #17

4. Schematic of front mount pump showing:

   a. Packing cooling line

      (1) provides water to lubricate and cool

   b. Clutch assembly

      (1) used to engage and disengage pump

   c. Power input shaft

      (1) connects to engine crankshaft

   d. Cooling line

      (1) circulates water from pump through copper coil in gearbox

      (2) draws heat from gearbox oil, cooling drive unit

   e. Packing gland adjusters

      (1) controls rate of water drip from packing

   f. Heating jacket

      (1) flows engine radiator water through water jacket in pump volute

         (a) prevents freeze-up in cold temperatures

5. Front mount pump allows:

   a. Better utilization of entire truck, especially for rural applications, due to:

(1) large booster tank

(2) easier access to water source

(3) pump and roll capabilities

Slide #18

C. Power Take Off (PTO)

1. Definition of:

a. Utilization of engine and truck transmission with power transmitted through gearbox on side of transmission

2. Allows for use of secondary equipment without interrupting power to main driveline

a. Provides pump and roll operation

Slide #19

3. Booster pump installed

a. Note PTO on right and shaft alignment from PTO to pump gearbox

Slide #20

4. Single stage booster pump

a. Volume pump

(1) up to 500 GPM @ 150 PSI

Slide #21

5. Two stage booster pump

a. Pressure pump

(1) up to 1000 PSI @ low volume

SM Pg. 5

III. INTAKE PRESSURE CONTROL DEVICES

NOTE

NFPA 1901 "PUMPER FIRE APPARATUS" STANDARD #4-5 READS, "AN ADJUSTABLE 2 1/2" OR LARGER INTAKE PRESSURE RELIEF SYSTEM SHALL BE PERMANENTLY INSTALLED. THE SYSTEM SHALL BE DESIGNED TO AUTOMATICALLY SELF-RESTORE TO A NONRELIEVING POSITION WHEN EXCESSIVE PRESSURE IS NO LONGER PRESENT ".

A. Integral Intake Relief Valve

1. Acts as safety valve

   a. Dumps excess pressure from inlet side of pump to:

      (1) atmosphere

      (2) booster tank

      (3) wherever:

         (a) fire department specifies

         (b) manufacturer decides

   b. Reduces potential of burst supply line due to water hammer

2. Allows discharge relief valve or governor system to properly control discharge pressure

3. Comprised of two (2) major components

   a. Pilot valve

   b. Main Valve

4. Pilot valve

   a. Controls operation of main valve

   b. May be mounted:

      (1) on pump panel for easy field adjustment to compensate for varying operating conditions

      (2) in compartment, preset for specific pressure

   c. For ease of maintenance, includes removable:

      (1) strainer

      (2) needle valve

5. Main valve

   a. Sliding piston type

   b. Mounted on pump inlet

   c. Discharges through 2 1/2" orifice

   d. Can go from closed to full open with minimal increase in intake pressure

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6. Operation

   a. To set operating pressure

      (1) align desired setting on calibration dial with arrow on top of panel plate

      (2) spanner wrench may be used to move dial

   b. Pilot valve will "dump" water through main valve when intake pressure exceeds set pressure

NOTE

THE PILOT VALVE VENT PORTS WILL MIST WHEN PRESSURE IS APPLIED TO PUMP INTAKE AS AIR IS AUTOMATICALLY BLED FROM THE SYSTEM.

SAFETY NOTE

DO NOT CAP RELIEF VALVE OUTLET. THIS SYSTEM IS DESIGNED TO HOLD VACUUM WHILE PRIMING AND OPERATING FROM DRAFT.

SAFETY NOTE

IF A HOSE IS CONNECTED TO THE INTAKE RELIEF OUTLET IT MUST BE SECURED. VIOLENT MOVEMENT OF THIS HOSE DURING RELIEF VALVE OPERATIONS MAY CAUSE SERIOUS INJURY OR DEATH. POSITION THIS HOSE TO AIM WATER AWAY FROM APPARATUS OR PEOPLE.

   c. After pumping:

      (1) open relief valve drain and flush system to remove all traces of impurities

(2) drain all water during cold weather (if applicable)

(3) close drain valve after flushing or draining

7. Maintenance

a. Remove and clean pilot valve strainer:

(1) once per month

(2) as needed

b. Remove and clean needle valve once per month

c. Test intake relief valve system once per month with pressurized water source (requires minimum flow of 250 gpm at pressures of 50 - 100 psi)

(1) set pilot valve slightly above source pressure

(2) apply source pressure to pump intake

(3) relief valve should remain closed

(4) reduce pilot valve setting to slightly below source pressure

(5) relief valve should open, "dumping" large volume of water

(6) reset pilot valve above source pressure

(7) relief valve should close

d. Perform dry vacuum test each month

(1) close:

(a) discharge valves

(b) drain valves

(c) all other valves and/or openings

(2) install vacuum gauge calibrated in "inches of mercury" (in. Hg)"

(3) operate priming device to create vacuum of 22 "inches of mercury" (in. Hg) in pump

(4) deactivate primer

(5) watch pressure gauge

(6) if vacuum drops more than 10 "inches of mercury" (in. Hg) in 10 minutes, listen for air leaks at:

(a) main valve outlet

(b) pilot valve "dump"

(c) vents

B. External Intake Relief Valve

1. Provides same basic function as integral intake relief valve, but differs in operation

2. External intake relief valve mounts on intake port

SM Pg. 7

3. Pressure setting adjusted with allen wrench

a. Adjust so normal intake pressures will not open relief valve

(1) reduce pressure setting on valve until water starts to flow from valve discharge

(2) increase pressure setting until water flow stops

4. Valve discharge opening:

a. Generally not threaded

b. Positioned to shot water downward when activated

Slide #22

IV. DISCHARGE PRESSURE CONTROL DEVICES

Slide #23

NOTE

NFPA 1901 "PUMPER FIRE APPARATUS" STANDARD #4-10.8 READS, "A MEANS SHALL BE PROVIDED FOR CONTROLLING THE DISCHARGE PRESSURE OF THE PUMP EITHER THROUGH AN AUTOMATIC RELIEF VALVE OR A PRESSURE REGULATOR THAT CONTROLS THE SPEED OF THE PUMP. THE DEVICE SHALL BE CAPABLE OF OPERATION OVER A RANGE OF 90 TO 300 PSIG DISCHARGE PRESSURE AND SHALL LIMIT THE PRESSURE RISE UPON ACTIVATION TO A MAXIMUM OF 30 PSI. A RELIEF VALVE SHALL BE EQUIPPED WITH AN AMBER LIGHT THAT INDICATES WHEN THE VALVE IS OPEN. A PRESSURE REGULATOR SHALL BE EQUIPPED WITH A GREEN LIGHT THAT INDICATES WHEN THE REGULATOR IS ACTIVATED. THE MEANS PROVIDED SHALL BE CONTROLLABLE BY ONE PERSON IN THE PUMP OPERATOR'S POSITION".

A. Midship Relief Valve (closed position)

1. Variable pressure relief valve required by NFPA 1901

2. Comprised of two (2) major components

a. Relief valve

(1) designed into midship pump

b. Control valve

3. Setting control valve allows variable setting of pressure requirements throughout complete pumping range

4. Opens into discharge pressure, therefore kept closed by same discharge pressure

Slide #24

B. Midship Relief Valve (open position)

1. Once pressure setting made on control valve, any pressure exceeding set pressure will open control valve, allowing continuation of flow to relief valve (broken blue line)

2. This pressure builds instantly on piston, which has larger surface area than valve

3. Valve opens and allows return of water to suction side of pump

C. Pressure relief valves are designed to operate with pressure differential

1. When operating with negative pressure on suction side of pump, relief valve will have rated capacity of pump, ie:

a. Closing discharges / hoselines when pumping at rated capacity will result in no more than 30 PSI increase

2. When operating with positive pressure on suction side of pump, values of relief valve system are altered, ie:

a. Relief valve could not open at 90 PSI pump pressure if there was 90 PSI hydrant pressure on suction side of pump

3. Pressure differential of at least 50 PSI required before relief valve will open, ie:

a. 115 PSI pump pressure with 65 PSI hydrant / suction pressure

b. Reaction time may also be affected

Slide #25

4. Exploded view of relief valve and control valve

a. Upper

(1) control valve

b. Lower

(1) relief valve

Slide #26

D. In-Line Relief Valve (closed position)

1. Operates same as midship system

2. Independent of pump

   a. Designed with threaded suction and discharge ports allowing it to be piped into almost any system

3. Should be sized to match capacity of pump, up to 2000 gpm

Slide #27

E. In-Line Relief Valve (open position)

1. Valve opens into discharge pressure and dumps into suction

   a. Broken blue line indicates water flow through control valve to relief valve

2. Has external spring and switch area

3. Warning light is "on" ONLY when relief valve is open

Slide #28

4. Cutaway of actual in-line relief valve in closed position

Slide #29

5. Explosion of all component parts of in-line relief valve

Slide #30

F. Pressure Control Governors

1. Definition of:

   a. Air / spring pressure control device

2. Installed independent from pump

   a. Exception:

      (1) sensing discharge pressure line

3. Pressure variations within given pumping range either increase or decrease engine speed

4. Right side of slide indicates governor in "off" position

a. Throttle control connected to engine operates through governor

(1) allows manual control of engine speed

b. Note actuator is "in"

5. Left side of slide shows actuator pulled out, system is now automatic

a. By moving actuator, we have separated pressures within governor sections "A" & "B"

(1) "A" side of governor (speckled blue) has trapped pressures into Air Tank

(2) air tank becomes air spring or reference pressure

b. Reference pressure is reacted upon by pump pressure

(1) imbalance will result in higher or lower engine RPM to bring system back into balance

Slide #31

V. PRIMING SYSTEMS

Slide #32

A. Rotary Vane System

1. This priming system utilizes:

SM Pg. 8

a. Electric motor

b. Rotary vane pump

c. Priming valve

d. Oil Tank

2. Pulling handle / Pushing button:

a. Opens valve

b. Energizes solenoid

(1) starts motor and pump

3. Internal recovery spring in priming valve closes valve automatically when released

a. Stops motor and pump

4. As rotary vane pump starts to turn, oil is drawn from priming oil tank

a. Creates better vacuum by sealing off close tolerances in pump

b. Lubricates pump components

Slide #33

5. Rotary vane priming pump is positive displacement pump

a. Equipped with four (4) fibre vanes

b. Vanes are forced outward by centrifugal force as rotor travels in eccentric path

c. Reduces air pressure within suction lines

(1) allows water to be forced into them from water source

6. Most popular type and industry standard

Slide #34

B. Rotary Gear System

1. Components are:

a. Priming valve

b. Priming pump

(1) driven by air or vacuum from truck

c. Priming control valve

d. Oil tank

Slide #35

2. Although activated by air or vacuum from engine, it is powered by pump gearbox through internal gearing

3. Oil coated gears mesh together, removing air from pump intake lines

a. Reduces atmospheric pressure inside of pump intake lines

(1) allows water to be forced into them from water source

Slide #36

VI. AUXILIARY COOLING SYSTEMS

A. Pump water flows through copper coil from discharge side back to suction side

Slide #37

B. Cooler mounted by cutting radiator hoses and installing cooler in line

C. Radiator water passes over coil

1. Lowers temperature of radiator water before it returns to engine

Slide #38

VII. PUMP OPERATING PROCEDURES

A. Apparatus Preparations

1. Spot in desired location

2. Set park brake

3. Operational sequence for engaging pump and getting water will vary according to:

a. Local department S.O.P.'s

(1) engage pump dry

(2) prime before engaging

NOTE

TO REDUCE THE POTENTIAL FOR PUMP FAILURE, SOME PUMP MANUFACTURERS RECOMMEND PRIMING THE PUMP BEFORE ENGAGING IT. INTERNAL WEAR OCCURS EVERY TIME THE PUMP IS ENGAGED. THIS WEAR IS

INCREASED WHENEVER THE PUMP IS ENGAGED WITHOUT INTERNAL LUBRICATION (WATER). LUBRICATION OF THE IMPELLER SHAFT, PUMP PACKING (MECHANICAL SEAL), IMPELLER, AND WEAR RING BEFORE OPERATION WILL EXTEND THE LIFE OF THE PUMP.

b. Apparatus design

(1) midship pumps require engagement before exiting cab

(2) front mount pumps require operator to go to front of engine to engage

(3) steps required to engage pump depend on pump:

(a) location

(b) type

c. Type of priming device

(1) electric

(2) vacuum / air

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B. Engaging Pump

1. Power takeoff (PTO):

a. Spot apparatus in desired location, disengage clutch

b. Set park brakes

c. With engine idling, put transmission in neutral

d. Operate PTO shift lever, meshing gears

e. Engage clutch slowly

f. Now ready for operation

g. May be operated while driving apparatus

2. Mid-ship pump:

   a. Spot apparatus in desired location, disengage clutch

   b. Set park brakes

   c. With engine idling, operate pump shift lever

      (1) transfers engine power from rear wheels to pump drive

   d. Shift and lock transmission into proper gear for pumping

   e. Engage clutch slowly

   f. Pump is now ready for operation

   g. Midship pumps do not have pump and roll capabilities

NOTE

THE ALLISON NEW WORLD TRANSMISSIONS HAVE POWER TAKEOFF CONNECTIONS WHICH ARE CAPABLE OF DRIVING PUMPS UP TO 1250 GPM WHILE PROVIDING POWER TO THE REAR WHEELS ALLOWING NEW APPARATUS EQUIPPED WITH MIDSHIP PUMPS TO HAVE PUMP AND ROLL CAPABILITIES.

3. Front mount pump:

   a. Spot apparatus in desired location, disengage clutch

   b. Set parking brake

   c. Put transmission in neutral

Slide #39
(One Type of Neutral Lock)

   d. Engage neutral lock

Slide #40
(Second Type of Neutral Lock)

   e. Dismount from cab and set wheel chocks

Slide #41
SM Pg. 10

   f. Close all drains

   g. Operate pump shift lever

   h. Now ready for operation

i. Has pump and roll capabilities

C. Getting Water to Pump

1. Water enters from intake / suction side of pump

2. Supplied by:

a. Gravity pressure from tank

b. Distribution system under pressure

c. Drafting from static water source

3. To get water from tank:

a. Open tank to pump valve(s)

(1) valve(s) located in various areas

(a) dependent upon apparatus:

(1) type

(2) manufacturer

Slide #42

b. Pump may need primed if:

(1) pump is dry

(2) piping is small

(3) tank mounted low on chassis

(4) departmental SOP's say to

Slide #43
(Engine Connected to Hydrant)
Slide #44
(Engine Connected to Hydrant)

4. To get water from distribution system:

a. Use hydrant and supply hose

5. To get water from static source:

a. Use hard suction hose and strainer

b. Pump must be primed

Slide #45
(Blank)

D. Pumping from Tank

1. Open tank-to-pump valves

2. Prime pump

a. With engine idling

(1) pull primer handle to engage

(2) prime until pump chamber is full of water

(3) push firmly in to disengage

3. Engage pump

4. Open appropriate discharge valves

a. Slowly to prevent water hammer

5. Increase engine RPM's

a. Open throttle until desired discharge pressure reached

6. Set relief valve to desired discharge pressure

a. Normal relief valve settings may be designated by departmental SOP's

NOTE

RELIEF VALVE PRESSURE MAY BE SET JUST OVER OPERATING PRESSURE WHICH KEEPS RELIEF VALVE CLOSED DURING NORMAL OPERATIONS, OPENING ONLY TO ALLOW PRESSURE RELIEF WHEN FLOWING LINES ARE SHUT DOWN OR AT THE OPERATING PRESSURE WHICH KEEPS RELIEF VALVE OPEN DURING NORMAL OPERATIONS. WHEN THE RELIEF VALVE IS OPEN DURING NORMAL OPERATIONS, ENGINE SPEED CAN BE INCREASED TO PROVIDE ADDITIONAL WATER AND PRESSURE FOR ANOTHER HOSELINE WITHOUT AN ADJUSTMENTS BY THE APPARATUS OPERATOR. THE LATTER DOES NOT PROVIDE THE SAME MARGIN OF SAFETY SINCE IT ALLOWS THE APPARATUS OPERATOR TO BE AWAY FROM OR NOT BE ATTENTIVE TO THE APPARATUS PUMP.

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7. If preparing for pump and roll:

a. Return engine to idle

b. Remove wheel chocks and enter cab

c. Remove neutral lock and release parking brake

d. Use accelerator to control engine RPM

e. Select proper transmission gear for slow ground speed and adequate pump pressure

8. If preparing for stationary pumping:

a. Open desired discharge valves

b. Make necessary adjustments to engine speed

c. If no water is being used, open tank fill valve to allow cool water to circulate through pump

(1) allowing water to overheat in pump can cause damage

9. To shut down pump

a. Slowly reduce engine speed to idle

b. Close all open valves slowly to prevent water hammer

c. Disengage pump

d. Close all tank-to-pump valves

e. Open all drains

E. Pumping from hydrant using 2 1/2" suction

1. Follow all stationary pumping from tank procedures and establish water to hose lines

a. This allows more time to set up at hydrant

2. Connect soft suction to pump and hydrant

3. Open hydrant fully

4. Bleed trapped air from supply line

    a. Use drain valve located on hydrant side of suction valve

5. Open suction valve slowly

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6. Close tank-to-pump valves

F. Pumping from hydrant using large diameter hose

1. Connect soft suction to pump and hydrant

2. Open hydrant fully

3. Bleed trapped air from pump

    a. If discharge lines are connected and ready for use, open discharge valve slowly and allow air from pump to be discharged through hoseline

    b. If not, use bleeder valve or unused discharge port

4. Slowly open all appropriate discharge valves

5. Engage pump

6. Set discharge and relief valve pressures as previously stated

G. Pumping From Draft

1. Connect airtight hard suction / strainer assembly to pump

    a. Size of hard suction (large or small) will be determined by:

        (1) manpower

(2) static source available

(3) amount of water needed

(a) if manpower and source are adequate for large diameter hose to be utilized, do so

(b) allows for expansion of delivery rate if needed

2. Situate suction and strainer in water

a. Tie off strainer so it does not rest on bottom

(1) if pumping large quantities of water have two (2) feet of water over top of strainer

(a) minimizes swirling and reduces chance of pump cavitation

b. Use of floating strainer will eliminate tying off, but may reduce water flow

(1) floating strainer only has suction holes on bottom side

3. Prime pump

a. Pumps, up to 1250 gpm, should prime in 30 seconds or less, 45 seconds or less in pumps 1500 gpm and larger

(1) if pump hasn't primed in prescribed time, disengage primer and check for air leaks

(a) open drains

(b) loose connections

(c) bad pump packing

(d) ask for other ideas

4. When pump is primed, engage pump

NOTE

SIMPLE LOGISTICS (THE PROXIMITY OF THE PUMP ENGAGEMENT DEVICE TO THE PRIMER ACTUATOR) AS WELL AS DEPARTMENTAL POLICIES AND PROCEDURES WILL DICTATE WHETHER THE PUMP IS PRIMED BEFORE BEING ENGAGED OR ENGAGED BEFORE BEING PRIMED.

a. May need to keep primer engaged while engaging pump

(1) water could flow out of suction leaving air pocket in pump

b. Engaging unprimed pump could result in seizing of impeller

5. Follow rest of instructions as stated above in pumping from tank to deliver water to hoselines

VIII. PUMP PANEL GAUGES

A. Tachometer

Slide #46

1. Function:

a. Register speed in revolutions per minute (RPM)

b. Measures turning rate of:

(1) motor

(2) pump

2. Provides information to apparatus operator

a. Allows for operation of equipment within design specifications

(1) equipment operated within these limits are less apt to fail

B. Fuel Gauge

Slide #47

1. Registers quantity of fuel left in reserve

   a. Should be monitored to allow for refueling or replacement before fuel supply exhausted

C. Oil Pressure Gauge

Slide #48

1. Registers oil pressure of motor during operation

   a. Drops in oil pressure should be noted

      (1) apparatus should be shut down if drop is sudden and large

D. Engine Temperature Gauge

1. Registers water temperature of motor during operation

   a. Raises in engine temperature should be noted and steps taken to return to normal

      (1) equipment failure could result if overheated motor allowed to operate

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E. Water Level Gauge

Slide #49

1. Registers water level in tank

2. Helps eliminate problem of pumping tank dry

F. Compound Gauge

Slide #50

1. Connected to suction side of pump

2. Registers:

   a. Positive pump intake pressure supplied when drafting from pressurized source such as:

      (1) hydrant

      (2) tanker

(3) engine

Slide #51

b. Negative intake pressures (vacuum) created when drafting from static source such as:

(1) port-a-tank

(2) lake

(3) pond

(4) ditch

3. NFPA 1901 requires:

a. One (1) 4 1/2" diameter gauge with minimum capacities of:

(1) 300 psi

(2) 30" vacuum

G. Pressure Gauge

Slide #52

1. Connected to discharge side of pump

2. NFPA 1901 requires:

a. One (1) 4 1/2" diameter main gauge

(1) minimum 300 psi capacity

b. Individual 3" diameter gauges on all discharge ports 2 1/2" or larger

(1) minimum 300 psi capacity

Slide #53
(Blank)

IX. FLOWMETERS

NOTE

NFPA 1901 "PUMPER FIRE APPARATUS" STANDARD #4-12.2 READS, "A FLOWMETER OR A PRESSURE GAUGE SHALL BE PROVIDED FOR EACH DISCHARGE OUTLET 1 1/2" OR LARGER IN SIZE AND SHALL BE LABELED AS TO THE OUTLET TO WHICH IT IS CONNECTED".

A. Provide accurate reading of water flow

1. May be calibrated to read in:

   a. Gallons Per Minute (GPM)

   b. Liters Per Minute (LPM)

2. Only way to accurately determine water flow at any given time

3. Automatic nozzles mechanically maintain nozzle pressure at predetermined level

   a. If flow is below rated nozzle capacity, nozzle will reduce orifice size, which

      (1) decreases flow

      (2) increases pressure

   b. Pressures can be artificially increased and mislead operator into believing nozzle capacity is being delivered

4. Friction loss coefficients of hose vary

   a. Hydraulics coefficients for friction loss are based on average coefficient for specific size of hose

   b. Hoses manufactured by various companies will generally have different friction loss coefficients

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   c. Flowmeter set at specific discharge gallonage will provide that quantity of water at nozzle regardless of friction loss coefficient of hose

5. Eliminates need for hydraulic calculations

   a. Shows exact flow through discharge valve

   b. Quantity will not diminish before it reaches nozzle unless there are leaks and/or breaks in hoses or appliances

B. Components

1. Linear flow-rate indicator

2. Primary sensor (self-averaging)

a. Four (4) basic types

(1) differential

(2) turbine

(3) spring probe

(4) paddlewheel

b. Differential

(1) utilizes small pair of tubes placed in opposite directions within flow

(2) each tube measures pressure

(3) pressure difference between tubes translated electronically to linear readout calibrated in:

(a) gallons per minute (GPM)

(b) liters per minute (LPM)

(4) tube orifices clogged by silt or mineral deposits are basic problem with sensors of this type

(5) not practical for fire service use, found primarily in chemical industry

c. Turbine

(1) common in farming areas where low-volume flows required

(2) very accurate

(3) mounted in center of flow and rotates as water passes through blades

(4) turbine revolutions translated mechanically into flow rates expressed in:

(a) gallons per minute (GPM)

(b) liters per minute (LPM)

(5) major disadvantages for use in fire service applications

(a) presents significant barrier to water flow making it difficult for large volume flows to push through turbine blades

(b) turbine blades susceptible to damage by stones and other foreign objects picked up by pump in drafting operations

(c) units tend to be bulky and are difficult to install in fire apparatus plumbing

d. Spring probe

(1) uses stainless steel, spring-type probe to sense water movement in discharge piping

(2) greater flows of water increase spring movement

(3) electronically translates spring movement to digital display unit

(4) relatively maintenance free due to spring probe being only moving part

e. Paddlewheel

(1) operates on same principal as turbine sensor, ie. translating revolutions per minute into:

(a) gallons per minute (GPM)

(b) liters per minute (LPM)

(2) paddlewheel mounted in top of pipe

(3) very little of paddlewheel blade extends into flow

(4) this placement eliminates problems caused by:

(a) impeded flow

(b) damage by foreign objects

(5) due to it being located on top of pipe, no sediment will collect on paddlewheel

C. Accuracy

1. Properly calibrated and in good working condition, flowmeters should be accurate to within plus or minus three (3) percent

NOTE

THIS MEANS THAT FOR EVERY 100 GPM OF WATER FLOW, THE FLOWMETER SHOULD NOT BE MORE THAN 3 GALLONS HIGH OR LOW (97 to 103 GPM) IN ITS READING. THIS TRANSLATES INTO A FLOW ACCURACY OF 30 GALLONS HIGH OR LOW (970 to 1030 GPM) IN FLOWS OF 1000 GPM. ACCURACY OF THIS TYPE WOULD BE DIFFICULT TO ACHIEVE USING PRESSURE GAUGES AND HYDRAULICS FORMULAS DUE TO THE CALIBRATION OF PRESSURE GAUGES USUALLY BEING NO FINER THAN 5 TO 10 PSI.

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D. Installation

1. Flowmeters may be installed at:

a. Factory

(1) new installation

b. Fire department

(2) retro-fit

2. Sensors must be mounted in straight pipe runs in apparatus plumbing to ensure accuracy

a. Must be free of turbulence to allow for uniform flow of water past sensor

b. Turbulence caused by fittings such as:

(1) elbows

(2) valves

(3) tees

(4) other

3. Sensors operate electronically and may be located remotely within apparatus plumbing

4. Connected to analog gauges and/or digital LCD's located at pump panel by watertight wires and circuitry

5. If properly installed , flowmeters require little maintenance and are highly reliable

INSTRUCTOR NOTE
SHOW SPAN "FLOWMINDERS" VIDEO HERE IF TIME ALLOWS.

X. VOLUME / PRESSURE TRANSFER VALVE

NOTE
THE TWO-STAGE, SERIES / PARALLEL CENTRIFUGAL PUMP HAS LONG BEEN THE STANDARD OF THE FIRE SERVICE. THE TWO-STAGE PUMP PROVIDES A WIDE RANGE OF CAPACITIES OVER A RANGE OF PRESSURE ROUGHLY TWICE THAT POSSIBLE WITH A SINGLE STAGE PUMP. IN ORDER TO USE A SERIES / PARALLEL PUMP TO ITS MAXIMUM POTENTIAL, THE OPERATOR MUST KNOW WHEN TO USE EACH MODE, SERIES (PRESSURE) OR PARALLEL (VOLUME).

A. Best "mode" (transfer valve position) depends on:

1. Characteristics of pump / engine combination

2. Whether pump being supplied from:

   a. Static (non-pressurized) source

      (1) portable tank

      (2) pond

      (3) stream

      (4) other

   b. Pressurized source

      (1) hydrant

      (2) tanker

      (3) relay pumping operation

      (4) other

NOTE

A GENERAL RULE OF THUMB IS THAT IF POSITIVE SUCTION PRESSURE CAN BE MAINTAINED, THE PUMP CAN USUALLY HANDLE UP TO 75% OF ITS RATED CAPACITY WHEN IN THE SERIES (PRESSURE) MODE WITHOUT A SERIOUS LOSS OF EFFICIENCY, HOWEVER, WHEN PUMPING FROM A STATIC (NON-PRESSURIZED) WATER SOURCE THERE IS DANGER OF CAVITATION IF THE PUMP TRIES TO PRODUCE MORE THAN 50% OF ITS RATED CAPACITY.

B. Mode (transfer valve position) selection

1. Series (Pressure) mode

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   a. Less than 50% of rated capacity

   b. All pressures

2. Parallel (Volume) mode

   a. More than 50% of rated capacity

   b. Less than 200 psi

NOTE

IF IT IS NECESSARY TO PUMP MORE THAN 50% OF RATED PUMP CAPACITY AT PRESSURES OVER 200 PSI, THE OPERATOR SHOULD FIRST TRY TO PUMP IN PARALLEL (VOLUME), IF DRAFTING FROM A NON-PRESSURIZED SOURCE, OR IN SERIES (PRESSURE), IF PUMPING FROM A PRESSURIZED SOURCE. IF ENGINE POWER IS INSUFFICIENT TO REACH THE DESIRED PERFORMANCE, THE OTHER MODE SHOULD BE TRIED AND THE BEST MODE FOR THE CONDITIONS SHOULD BE USED.

C. Changing mode (transfer valve position) while pumping

1. Power actuators will move transfer valve when pump pressures are high

2. Manual operation of transfer valve difficult unless pump pressure decreased (below 100 psi)

3. Under normal circumstances, no pump damage will occur when changing transfer valve position at any pressure

SAFETY NOTE

CHANGING OPERATIONAL MODES WHILE PUMPING AT HIGH PRESSURES OR LARGE VOLUMES COULD HAVE AN IMPACT ON THE HOSELINE OPERATOR. THE APPARATUS OPERATOR SHOULD ALWAYS FOLLOW ESTABLISHED STANDARD OPERATING PROCEDURES DEVELOPED BY THE EMPLOYING FIRE DEPARTMENT WITH SAFETY BEING THE FOREMOST CONSIDERATION.

XI. MALFUNCTIONS WHICH COULD OCCUR DURING PUMP OPERATION

A. Problems Common To All Types Of Operation

1. Unable to get a reading on the pressure gauge when the pump is put in service

a. Possible causes:

(1) pump drive system not fully engaged

(2) vehicle clutch not engaged

(3) road transmission not in proper gear (midship pump)

(4) no water in pump

(5) defective gauge

(6) gauge snubber valve may be closed

2. Pump will not develop sufficient pressure

a. Possible causes:

(1) two-stage pump

(a) transfer valve in wrong position

(b) transfer valve only partially operated

(c) swing check valve may leak

(2) transmission not in proper gear

(3) relief valve activating too soon

(a) could be stuck, broken, or set improperly

(4) flow may exceed pump capacity

(5) not enough engine power

(6) excessive wear on impeller / clearance rings

3. Pump is unable to supply its rated capacity

a. Possible causes:

(1) two-stage pump

(a) transfer valve in wrong position

(b) swing check valve not opening completely

(2) blockage in:

(a) waterway of pump

(b) impeller

(c) suction hose

(d) strainer

(3) inadequate water supply / supply lines

4. Pump is overheating while in operation

a. Possible causes:

(1) inadequate water flow through pump

(2) excessive throttle on relief valve-equipped pumps

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5. Relief valve is inoperative or slow acting

a. Possible causes:

(1) strainer dirty

(2) relief valve dirty / corroded

(3) defective

B. Problems When Operating From The Tank

1. Unable to establish an adequate operating pressure or a loss of pressure occurs when the first discharge valve is opened

a. Possible causes:

(1) air trapped in pump

(2) clutch / transmission slippage

2. Fluctuation of the pressure gauge and a reduction of discharge pressure when additional lines are put in service

   a. Possible causes:

      (1) tank-to-pump valves not fully opened

      (2) tank-to-pump piping may be too small for flow required

3. While pumping, the discharge pressure drops to a very low value and water supply is interrupted

   a. Possible causes:

      (1) air leak in pump

      (2) water supply from tank almost consumed

C. Problems When Operating From A Hydrant

1. Suction line collapses when the discharge valve to a hoseline is opened

   a. Possible causes:

      (1) excessive friction loss in supply line

      (2) supply line too small for flow required

      (3) hydrant / hydrant gate not fully opened

2. While supplying water, the suction line collapses and the pump begins to cavitate

   a. Possible causes:

      (1) additional water demands made on pump

(2) additional demands made on water system

D. Problems When Operating From Draft

1. Pump will not prime

a. Possible causes:

(1) open drain

(2) open valves / caps not airtight

(3) relief valve may be leaking

(4) suction hose connections not airtight

(5) loose pump packing

(6) not operating primer long enough

(7) tank-to-pump valves leaking air

(8) no oil in primer pump reservoir (if applicable)

2. Pump loses its prime when the first discharge valve is opened and water begins to flow

a. Possible causes:

(1) valve opened too fast

(2) pump not completely primed

(3) pump not turning fast enough

(4) primer valve could be stuck open

(5) impeller clogged

3. Pump loses its prime during the course of a pumping operation

a. Possible causes:

(1) air leak on intake side of pump

(2) loose pump packing

(3) whirlpool over strainer

4. The pump goes into cavitation when the flow increases

   a. Possible causes:

      (1) flow exceeds supply

      (2) strainer partially blocked

      (3) inner liner of suction separates from rest of hose

XII. CONDITIONS WHICH MAY LEAD TO PUMP DAMAGE OR UNSAFE OPERATION AND THEIR REMEDIES

A. Cavitation

1. Definition of:

   a. Condition in which vacuum pockets form in pump and cause vibrations, loss of efficiency, and possible damage

2. Can happen in any pump when discharge flow starts to exceed intake flow

3. May be caused by:

   a. Partially clogged intake strainer

   b. Using intake hose that is too:

      (1) long

      (2) small

   c. Too high of lift

   d. Too warm of water

e. Trying to pump more water than hydrant can supply

4. Clues to pump cavitation are:

a. When increase in pump speed doesn't produce increase in pressure

b. When pump sounds like it has sucked rocks

5. Best cure is not to let happen, but, if it does:

a. Decrease output

b. Increase input

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B. Leaking Fluids (fuel, oil, water)

1. Some leakage normal

2. Excessive leakage should be checked

3. If unable to stop and it presents problem:

a. Call backup engine to replace operating engine

b. Shut down operating engine as soon as possible

c. Have repairs made before putting engine back in service

C. Engine Overheating

1. Remedies:

a. Open hood

b. Open auxiliary cooler

c. Use radiator fill as last resort

(1) check antifreeze after using to make sure it is not diluted too much

D. Pump Overheating

1. Any pump will overheat if run without discharging or circulating water

    a. Friction between impeller and water creates heat which must be dissipated

2. Pump temperature may be taken by placing back of bare hand against large diameter suction cover

3. If cap is hot or lines are shut down:

    a. Allow booster hose to discharge onto ground

    b. Open tank fill line and circulate water back to tank

4. Do not use pressure relief valve to prevent overheating

    a. Circulates water back to suction side of pump

        (1) cycles same water through pump with no way to dispel heat

E. Unusual Noises

1. Could be problem coming on

2. Locate sound and identify cause

3. If unable to identify:

    a. Call backup engine to replace operating engine

    b. Shut down operating engine as soon as possible

    c. Have repairs made before putting back in service

F. Vibrations

1. Increase in vibration generally means problems

2. If unable to identify:

   a. Call backup engine to replace operating engine

   b. Shut down operating engine as soon as possible

   c. Have repairs made before putting back in service

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G. Water Hammer

1. Definition of:

   a. Impact energy resulting from sudden closing of nozzles or valves on charged system

2. All valves and nozzles should be opened and closed slowly

   a. Eliminates water hammer

XIII. POSITIONING APPARATUS

A. Determining Factors

1. Water

   a. Amount needed

   b. Availability

2. Hose

   a. Size

   b. Length

3. Pump capacity

4. Safety concerns

5. Positioning apparatus to supply hoselines from tank differs from locating engine to draft from hydrant or static source

B. Positioning to Supply Hoselines from Tank

1. Locate as close to fire as safety / need permit

2. Considerations:

a. Wind direction

b. Exposures

c. Terrain

d. Obstructions

e. Manpower

f. Other

3. Permits preconnects to be utilized to best advantage

a. Provides quick attack on fire

4. Limitations:

a. Limited water supply

(1) supplemental water supply must be established

(a) hydrant

(b) tanker

(c) engine

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b. Full pump capacity unused

(1) engines with abundant water sources supply large volume lines

C. Positioning to Supply Water from Draft

1. Connect to water source with hose large enough to allow pump to supply maximum rated capacity

2. Two types of suction hose:

Slide #54

a. Hard

(1) must be used when drafting from static source

(2) may be used to draft from hydrant, but:

(a) heavier

(b) stiffer

(c) requires additional:

[1] manpower

[2] time

(d) risk of collapsed water mains

Slide #55

b. Soft

(1) requires pressurized water source

(a) hydrant

(b) tanker

(c) engine

(2) flexible

(a) apparatus position not as critical

(3) lighter

(a) requires less:

[1] manpower

[2] setup time

3. Apparatus operators must be able to position engines for either

D. Positioning to Draft from Static Source

1. Place apparatus as close to water source as safety permits

a. Apparatus should be located so that:

(1) vehicle weight is supported

(2) personnel have room to work

(3) water can be reached with:

(a) 20' of suction line

(b) 10' or less of lift

Slide #56

2. Suction hose may be connected to pump either before or after positioning

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3. Hose end strainers must be used

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a. Prevents objects from being introduced into pump that might cause:

Slide #59

(1) reduced capacities

(2) internal damage

b. Two (2) types:

(1) floating

(a) reduces flow

[1] has holes only on bottom side

(2) non-floating

Slide #60

(a) must be kept off bottom:

[1] tied with rope

[2] float device

[3] ladder

[4] other

Slide #61

(b) have minimum of 2' of water above and below strainer

Slide #62
(Blank)

E. Positioning to Draft from Hydrant

1. Hard suction

NOTE

MOST WATER DEPARTMENTS DO "NOT" WANT THE FIRE DEPARTMENT CONNECTING A HARD SUCTION TO THEIR WATER DISTRIBUTION SYSTEM. USING A HARD SUCTION TO DRAFT FROM A HYDRANT COULD RESULT IN COLLAPSE OF THE WATER MAINS OR OTHER PROBLEMS. FOR THIS AND OTHER REASONS MANY FIRE DEPARTMENTS DO NOT MAKE IT A PRACTICE TO CONNECT TO A HYDRANT WITH HARD SUCTION. WE TALK ABOUT IT HERE ONLY TO LET PEOPLE KNOW THAT IT CAN BE DONE IF ABSOLUTELY NECESSARY. IT SHOULD NOT BE ATTEMPTED BY SOMEONE WITHOUT EXPERIENCE IN DRAFTING FROM HYDRANTS.

a. Stop engine with suction port short of being in line with hydrant

b. Connect intake hose to engine first

(1) saves finish on pump panel and engine

c. Move engine forward, bending hose to make hydrant connection

2. Soft suction

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a. Stop proper distance from hydrant

(1) depends upon length of hose

Slide #64

(a) 10' - 25'

(2) judged from hydrant, not curb line

(a) hydrants tend to be at different distances from curb

(3) direction of hydrant outlet must be considered

b. Turn front wheels of apparatus at 45° angle

(1) allows easy adjustment of distance from hydrant

Slide #65
Slide #66
(Shows Proper Set-Up)
Slide #67
Slide #68
(Shows Kinked Line)

c. Connected supply hose should be slightly curved, with one or two complete twists

(1) prevents kinks

XIV. RATED PUMPING CAPACITIES

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(Blank)
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A. Capacity

1. Definition of (for this class):

a. Volume of water that pump can discharge from static source draft at certain pressure each minute

B. Rated Capacity is:

1. One means of identifying pump capabilities

2. Determined by testing

3. Not necessarily maximum capacity of pump

4. Actual capacity of centrifugal pumps limited by design features

a. Intake diameter

b. Impeller eye diameter

c. Outside diameter of impeller

d. Width of impeller

e. Shape and number of impeller vanes

f. Design of volute chamber

5. Capacity of positive displacement pump limited by:

a. Pump displacement

b. Pump speed

(1) revolutions per minute

6. To pass test and be rated, fire pumps must meet following capacity and pressure requirements:

Slide #70 (Performance Tag)

a. 100% of rated capacity @ 150 PSI

Slide #71 (Performance Tag)

b. 70% of rated capacity @ 200 PSI

Slide #72 (Performance Tag)

c. 50% of rated capacity @ 250 PSI

7. Insurance Services Office requires pumps be tested annually

INSTRUCTOR NOTE

SHOW MEDIA RESOURCES VIDEO "FIRE PUMPERS & PUMP OPERATION" HERE IF TIME ALLOWS.

XV. FOAM FIRE STREAMS

A. Terminology

1. Foam concentrate

a. Definition of:

(1) "the raw foam liquid as it sits in its storage container, usually a 5 gallon bucket, 55 gallon barrel, or an apparatus storage tank"

2. Foam proportioner

a. Definition of:

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(1) "a device that injects the correct amount of foam concentrate into the water stream to make the foam solution"

3. Foam solution

a. Definition of:

(1) "a mixture of foam concentrate and water that is discharged from the proportioner and passed through the hoseline"

4. Finished foam

a. Definition of:

(1) "the completed product after the foam solution reaches the nozzle and air is introduced into the solution (aeration)"

B. Foam Tetrahedron

1. Four elements necessary to make high quality firefighting foam

a. Foam concentrate

b. Water

c. Air

d. Mechanical agitation (aeration)

2. Components must be blended in proper ratios

3. Removal of any one element will result in:

a. Poor quality foam

b. No foam at all

C. Foam Production

1. Two steps:

   a. Proportioning

   b. Aeration

2. Proportioning

   a. Foam concentrate mixed with water in proper proportions

      (1) class "A" foam might contain as little as .25% foam concentrate

      (2) class "B" foam might contain as much as 6% foam concentrate

   b. Foam concentrations should follow manufacturer's recommendations to assure maximum effectiveness

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NOTE

FOAM CONCENTRATES MUST BE COMPATIBLE WITH THE FUELS TO WHICH THEY ARE APPLIED

3. Aeration

   a. Injects air into foam solution to create bubbles which form effective foam blanket

      (1) bubbles must be of uniform size if blanket to be long lasting

   b. Foam nozzles must be matched to proportioner to produce highest quality foam

      (1) proportioner rated at 95 gpm must flow 95 gpm to introduce proper amount of concentrate into solution

INSTRUCTOR NOTE

SHOW ELKHART BRASS VIDEO "NO CITY OR COMMUNITY WITHOUT RISK" HERE IF TIME ALLOWS.

SHOW ACTION TRAINING VIDEO "FOAM FIRE STREAMS" HERE IF TIME ALLOWS.

APPLICATION: & SUMMARY:

In this class we have covered:

1. Methods of power transfer
2. Pump construction
3. Pressure control devices
4. Priming systems
5. Auxiliary cooling systems
6. Pump operating procedures
7. Pump panel gauges
8. Flowmeters
9. Malfunctions which could occur during pump operation
10. Conditions which may lead to pump damage or unsafe operation and their remedies
11. Positioning apparatus
12. Rated pumping capacities
13. Foam fire streams

giving you a better understanding of pump construction and operation so as to increase your capabilities on the fire ground. Are there any questions or comments?

CONCLUSION: & ASSIGNMENT:

If there are no further questions, I will now hand out a written test which requires a minimum score of 70% to pass. We will then go to the practice ground where we shall put to use the information discussed. Tasks must be satisfactorily completed to receive credit for this class.

NOTE

To become accredited as a Pumper Operator by the Department of Public Safety Standards and Training (DPSST), students must complete task performance evaluations within their own department. These task performances include:

~~**1. Supplying fire streams from a hydrant**~~
~~**2. Supplying fire streams from a draft**~~
~~**3. Supplying fire streams from a tanker support**~~

~~**If any students are interested in the accreditation certificate, set a time to meet with them and further explain the program.**~~

DRILL GROUND PREPARATIONS
FOR PUMPER OPERATOR
PUMP OPERATIONS
PRACTICAL EXERCISES

Materials Needed:

1. Four (4) engines with operators (different types if possible)
2. Supply Hoses (hard & soft suction - small & large diameter)
3. Water Supply (hydrants, pools, port-a-tanks, tenders, etc.)
4. Discharge Lines (hand lines & master stream lines)
5. Master Stream Device(s) with straight tips and adjustable fog nozzles
6. Foam Producing Equipment (Built-in and/or External)
7. Class "A" Foam Concentrate (NOTE: Class "A" foam concentrate costs less per gallon to purchase, requires smaller percentages to produce a good finished foam, and is biodegradable making it safer for the environment, than class "B" foam concentrate)
8. Flow Test Kit

Station 1: Engine connected to hydrant with 250' of 2 1/2" supply line. (NOTE: supply line length may need to be adjusted to compensate for the static hydrant pressure * do not have residual pump pressure fall below 20 psi for the initial set-up)

At this station, each student is to charge 150' of 1 1/2" hose equipped with a 100 GPM (approx) nozzle at 145 psi and 200' of 2 1/2" hose equipped with a 250 GPM (approx) nozzle at 125 psi using tank water. After lines are established, student will transfer to hydrant water (without using relief valve) without more than a 10 psi pressure fluctuation. The student then refills the booster tank. After booster tank has been filled, have student try to supply another 1 1/2" line (pay close attention to residual pump pressure).

Intent:
1. To emphasize the skills needed to change water supplies.
2. To demonstrate the impact water supply has on pumping operations
3. To demonstrate pumping operations when water demands exceed the water supplies.
4. To demonstrate the responsibilities of the apparatus operator relating to pressure fluctuations.

Station 2: Engine connected to hydrant with a large diameter (4" to 6") supply line (any length).

At this station, each student will, using hydrant steamer port, flow large quantities of water from a master stream device (portable, deck mounted, ladder tower, etc.). This station also keeps the port-a-tank filled at Station 3 (if applicable).

Intent:
1. To allow students to work with increased flows.
2. To demonstrate the use of the transfer valve.
3. To demonstrate the use of relief devices.

Station 3: Engine at draft from port-a-tank using small diameter hard suction.

At this station, each student will flow maximum amount of water available to pump through a master stream device (portable, deck mounted, ladder tower, etc.).

Intent:
1. To show the impact that water supply has on flow.
2. To demonstrate the signs of cavitation and how to compensate accordingly.
3. To demonstrate the need to open the discharge valves slowly (so as not to lose prime).
4. Allow students to practice priming the pump, "back-priming" the pump (from booster tank), and trouble shooting drafting operations.

Station 4: Engine developing foam fire streams (water supply may be static or pressurized).

Intent:
1. To allow students to work with different foam producing equipment, such as discharge side foam proportioners, around the pump foam proportioners, foam eductors, etc., and produce an effective finished foam with the different types available. **NOTE: Around the pump proportioners do not function properly when using a pressurized water source. If using an around the pump proportioner use a static water source.**

NAME:____ **DATE:**_________________

OPERATIONS (Part I) EVALUATION

1. T F Positioning an engine to supply hoselines is identical to positioning an engine to obtain water from a hydrant or static source.

2. T F Never twist soft suction hose when connecting between the hydrant and engine, as it causes kinks.

3. T F If pump packing is too loose, air leaks will affect the pump's ability to draft water.

4. T F One advantage of the front mount and PTO pump is that they allow for "pump and roll" operation.

5. T F Midship transfer drive pumps use a split-shaft gear case to transfer power from the rear axle to the fire pump.

6. T F Aligning the transfer valve in a multi-stage centrifugal fire pump to the SERIES (PRESSURE) position will increase the maximum volume attainable.

7. T F Whenever a multi-stage centrifugal fire pump is used at more than one-half its rated capacity, the PARALLEL (VOLUME) position should be used.

8. T F Pressure relief valves dump excessive pressure automatically and never require adjustment.

9. T F The pressure gauge on an apparatus registers the pump discharge pressure.

10. T F The primary function of an auxiliary cooler is to control the temperature of the engine coolant during pumping operations.

11. T F The first means of water supply to apparatus operators is the hydrant.

12. T F When in good condition, flowmeters should be accurate to within ±1%.

13. T F Class "A" foam was developed to use on combustible liquid fires.

14. T F Changing operational modes with the transfer valve while pumping at high pressures or large volumes could have an adverse impact on the hoseline operator.

15. T F Turbine type flowmeters are the most common type used in the fire service today.

16. T F The pressure relief valve can be used to circulate water through the pump to keep it cool as well as relieve excess pump discharge pressures.

17. T F Water hammer is only a concern when opening a valve.

18. The first action apparatus operators should complete after positioning the apparatus is to ______________________.

    A. connect the hard suction hose
    B. set the parking brake and chocks
    C. report to command that apparatus is in position
    D. document time and location

19. The three (3) methods of power transfer are:

    ____________________ ____________________ ____________________

20. The main feature of the pressure governor is its ability to ____.

    A. detect and compensate pressure changes by activating the pressure relief valve
    B. switch a multistage centrifugal pump into the PARALLEL position if pressure builds to excessive levels during series operation
    C. regulate the power output of the engine to match set pump discharge requirements
    D. control and compensate for all pressure changes including intake, discharge, and internal pump pressures

21. Which of the following is NOT a function of the compound gauge.

    A. It indicates vacuum present at the pump intake during drafting.
    B. It indicates water flow from the pump.
    C. It indicates vacuum developed while the pump is operating from draft.
    D. It indicates the residual pressure when the pump is operating from a hydrant.

22. When positioning an apparatus for soft suction hose connection, the apparatus operator should turn the front wheels at a ________ degree angle to easily adjust the distance from the hydrant.

A. 30 B. 45 C. 60 D. 90

23. If the attack lines are not ready to be charged by the time the pump pressure has been built up, the apparatus operator should ___________________________.

A. reduce pressure and stand by to restore pressure upon demand
B. release all pressure and stand by to reprime
C. monitor the compound gauge and reduce engine rpm
D. partially open the tank fill valve to allow water to circulate

24. A compound gauge is normally used on the __________.

A. discharge side of the fire pump
B. the hydrant
C. suction side of the fire pump
D. primer intake valve

25. List the percentages of rated pumping capacity and at what pressures these need developed for a pump to be rated.

1.____

2.____

3.____

26. List three (3) things which could cause a pump not to prime.

1.____

2.____

3.____

27. What is the main cause of cavitation in a centrifugal pump?

<u>PUMP CONSTRUCTION AND OPERATION I EVALUATION</u>

ANSWER KEY

1. T ***<u>F</u>*** Positioning an engine to supply hoselines is identical to positioning an engine to obtain water from a hydrant or static source.

2. T ***<u>F</u>*** Never twist soft suction hose when connecting between the hydrant and engine, as it causes kinks.

3. ***<u>T</u>*** F If pump packing is too loose, air leaks will affect the pump's ability to draft water.

4. ***<u>T</u>*** F One advantage of the front mount and PTO pump is that they allow for "pump and roll" operation.

5. ***<u>T</u>*** F Midship transfer drive pumps use a split-shaft gear case to transfer power from the rear axle to the fire pump.

6. T ***<u>F</u>*** Aligning the transfer valve in a multi-stage centrifugal fire pump to the SERIES (PRESSURE) position will increase the maximum volume attainable.

7. ***<u>T</u>*** F Whenever a multi-stage centrifugal fire pump is used at more than one-half its rated capacity, the PARALLEL (VOLUME) position should be used.

8. T ***<u>F</u>*** Pressure relief valves dump excessive pressure automatically and never require adjustment.

9. ***<u>T</u>*** F The pressure gauge on an apparatus registers the pump discharge pressure.

10. ***<u>T</u>*** F The primary function of an auxiliary cooler is to control the temperature of the engine coolant during pumping operations.

11. T ***<u>F</u>*** The first means of water supply to apparatus operators is the hydrant.

12. T ***<u>F</u>*** When in good condition, flowmeters should be accurate to within ±1%.

13. T ***<u>F</u>*** Class "A" foam was developed to use on combustible liquid fires.

14. ***T*** F Changing operational modes with the transfer valve while pumping at high pressures or large volumes could have an adverse impact on the hoseline operator.

15. T ***F*** Turbine type flowmeters are the most common type used in the fire service today.

16. T ***F*** The pressure relief valve can be used to circulate water through the pump to keep it cool as well as relieve excess pump discharge pressure.

17. T ***F*** Water hammer is only a concern when opening a valve.

18. The first action apparatus operators should complete after positioning the apparatus is to ______________________.

    A. connect the hard suction hose
    B. set the parking brake and chocks
    C. report to command that apparatus is in position
    D. document time and location

19. The three (3) methods of power transfer are:

    Split Shaft (Midship) Direct Drive (Front Mount) Power Take Off (PTO)

20. The main feature of the pressure governor is its ability to ______________________________________.

    A. detect and compensate pressure changes by activating the pressure relief valve
    B. switch a multistage centrifugal pump into the PARALLEL position if pressure builds to excessive levels during series operation
    C. regulate the power output of the engine to match set pump discharge requirements
    D. control and compensate for all pressure changes including intake, discharge, and internal pump pressures

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A. 30 ***B.*** ***45*** C. 60 D. 90

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A. reduce pressure and stand by to restore pressure upon demand
B. release all pressure and stand by to reprime
C. monitor the compound gauge and reduce engine rpm
D. ***partially open the tank fill valve to allow water to circulate***

24. A compound gauge is normally used on the __________.

A. discharge side of the fire pump
B. the hydrant
C. ***suction side of the fire pump***
D. primer intake valve

25. List the percentages of rated pumping capacity and at what pressures these need developed for a pump to be rated.

1. ***100% @ 150psi***
2. ***70% @ 200psi***
3. ***50% @ 250psi***

26. List three (3) things which could cause a pump not to prime.

1. ***Loose pump packing***
2. ***Open drain***
3. ***Suction hose connections not airtight***
4. ***Open valves / Caps not airtight***
5. ***Relief valve may be leaking***
6. ***Tank-to-pump valves leaking air***
7 ***Not operating primer long enough***
8. ***No oil in primer pump reservoir***

27. What is the main cause of cavitation in a centrifugal pump?

Trying to discharge more water than the pump can take in.

STUDENT MANUAL
PUMP OPERATION (Part I)

STANDARD: DPSST PO #16-05.01, .02, .03, .04, .05, .06, .07, .08, .09, .10, .11, .12, .13, .14, .15, .16, .17, .19, .20, .21, .22, .23, .24, .25

REFERENCE: IFSTA "Fire Department Pumping Apparatus", 7th Edition

OBJECTIVES: At the end of this class, the apparatus operator shall:

1. Identify three methods of power transfer from the vehicle engine to the pump
2. Identify the operating principles of single-stage and multiple-stage centrifugal pumps
3. Identify the major components and trace the flow of water through single-stage and multiple-stage centrifugal pumps
4. Identify corrective measures for the following conditions which may result in pump damage or unsafe operation:
    a. cavitation
    b. leaking fuel, oil or water
    c. overheating
    d. unusual noises
    e. vibrations
    f. water hammer
5. Recognize the theory and principles of priming the pump
6. Identify the characteristics and limitations of hard suction and soft suction pumper supply hose
7. Identify the percentages of rated capacity, rated pressures, and the capacity in gallons per minute at the rated pressures a fire department pumper is designed to deliver
8. Identify all gauges on a department pumper and demonstrate their use
9. Identify a remedy for each of the following malfunctions which may occur during pumping operations:
    a. fluctuating pressure
    b. insufficient pump capacity
    c. insufficient pump pressure
    d. pump will not prime or loses prime
10. Demonstrate how to operate (including engaging the pump) the various types of fire apparatus available in the employing department

11. Demonstrate positioning and stabilizing a fire department pumper to operate at a fire hydrant and static supply source utilizing each existing pumper intake connection, given a pumper, a length of intake hose, and appropriate fittings or tools, so that the intake hose can be connected, without kinks, to the pump connection without repositioning the vehicle
12. Demonstrate production of effective hand streams, utilizing the sources specified below, so that the pump is safely engaged, all pressure control and vehicle safety devices are set, the rated flow of the nozzle is achieved, and the apparatus is continuously monitored for potential problems:
    a. internal tank
    b. pressurized source
    c. static source
13. Demonstrate production of effective master streams, utilizing the sources specified below, so that the pump is safely engaged, all pressure control and vehicle safety devices are set, the rated flow of the nozzle is achieved, and the apparatus is continuously monitored for potential problems:
    a. internal tank
    b. pressurized source
    c. static source
14. Demonstrate procedures for pumping the following:
    a. maximum delivery rate from the apparatus water tank
    b. maximum rated capacity from a hydrant
    c. maximum rated capacity from draft
15. Demonstrate changing a water supply from the apparatus water tank to an external source, given a pumper with an operating fire attack line of 1-1/2 in. or larger, so that the flow of water to the attack line is not interrupted and the proper pressure is maintained
16. demonstrate the operations of fire apparatus pump pressure relief systems and pressure control governors
17. Demonstrate the operation of auxiliary cooling systems
19. Demonstrate the use of the volume/pressure transfer valve under actual pumping conditions (multi-stage pumps only)
20. The individual shall demonstrate connecting/engaging foam production system(s) and production of a foam fire stream.
21. Recognize the operating principles of the following types of apparatus foam systems:
    a. around the pump
    b. balanced pressure

c. eductor
d. electronically metered injection

22. Identify the relationship of the four components of the foam tetrahedron in the production of an effective foam stream.
23. The individual shall match each of the following types of foam concentrates with their tactical application:
    a. Class A
    b. Class B - hydrocarbon type
    c. Class B - alcohol/polar solvent-resistant
    d. Class B - hydrocarbon/alcohol/polar solvent-resistant
24. Match environmental and operational factors which may negatively affect foam quality with an appropriate corrective action.
25. Determine the water and foam concentrate requirements, given application time, application rate, and concentration.

I. METHODS OF POWER TRANSFER

A. Three types of power transfer

1. Split Shaft

2. Direct Drive

3. Power Take Off (PTO)

II. PUMP CONSTRUCTION

A. Split Shaft / Midship Pumps

1. Split shaft means:

a. To split original driveline and insert pump

NOTE

MIDSHIP TRANSFER DRIVE PUMPS USE A SPLIT-SHAFT GEAR CASE TO TRANSFER POWER FROM THE REAR AXLE TO THE FIRE PUMP.

2. Midship means:

a. Pump is mounted behind the cab, midway between the front and rear axles

3. Single-stage pump water flow:

a. Double suction chamber supplies double suction impeller

b. Discharge flow from impeller

4. Two stage pump water flow:

a. Volume (Parallel) position:

(1) check valves are open

(2) transfer valve allows second stage impeller to discharge directly to manifold

(3) each impeller pumps half of the total volume

b. Pressure (Series) position:

(1) check valves are closed

(2) all the water from the first stage impeller is diverted to the second stage impeller through the transfer valve

B. Direct Drive / Front Mount Pumps

1. Direct drive means:

a. Pump is driven directly from the engine crankshaft pulley

2. Front mount means:

a. Installed on front of vehicle

3. Front mount pump permits better utilization of entire truck, especially for rural applications, by allowing for:

a. Larger booster tanks

b. Easier access to the source of water

c. Pump and roll capabilities

C. Power Take Off (PTO)

1. Definition of PTO:

a. Utilization of the engine and truck transmission, with the power transmitted through a gearbox on the side of the transmission

2. By allowing the use of secondary equipment without interrupting the power to the main driveline, a PTO pump provides for pump and roll capabilities

III. INTAKE PRESSURE CONTROL DEVICES

NOTE

NFPA 1901 "PUMPER FIRE APPARATUS" STANDARD #4-5 READS, "AN ADJUSTABLE 2 1/2" OR LARGER INTAKE PRESSURE RELIEF SYSTEM SHALL BE PERMANENTLY INSTALLED. THE SYSTEM SHALL BE DESIGNED TO AUTOMATICALLY SELF-RESTORE TO A NONRELIEVING POSITION WHEN EXCESSIVE PRESSURE IS NO LONGER PRESENT ".

A. Integral Intake Relief Valve

1. Acts as safety valve

    a. Dumps excess pressure from inlet side of pump to:

    b. Reduces potential of burst supply line due to water hammer

2. Allows discharge relief valve or governor system to properly control discharge pressure

3. Comprised of two (2) major components:

4. Pilot valve

    a. Controls operation of main valve

    b. May be mounted:

    c. For ease of maintenance, includes removable:

5. Main valve

    a. Sliding piston type

    b. Mounted on pump inlet

    c. Discharges through 2 1/2" orifice

    d. Can go from closed to full open with minimal increase in intake pressure

6. Operation

   a. To set operating pressure:

   b. Pilot valve will "dump" water through main valve when intake pressure exceeds set pressure

NOTE

THE PILOT VALVE VENT PORTS WILL MIST WHEN PRESSURE IS APPLIED TO PUMP INTAKE AS AIR IS AUTOMATICALLY BLED FROM THE SYSTEM.

SAFETY NOTE

DO NOT CAP RELIEF VALVE OUTLET. THIS SYSTEM IS DESIGNED TO HOLD VACUUM WHILE PRIMING AND OPERATING FROM DRAFT.

SAFETY NOTE

IF A HOSE IS CONNECTED TO THE INTAKE RELIEF OUTLET IT MUST BE SECURED. VIOLENT MOVEMENT OF THIS HOSE DURING RELIEF VALVE OPERATIONS MAY CAUSE SERIOUS INJURY OR DEATH. POSITION THIS HOSE TO AIM WATER AWAY FROM APPARATUS OR PEOPLE.

   c. After pumping:

7. Maintenance

   a. Remove and clean pilot valve strainer:

   b. Remove and clean needle valve once per month

   c. Test intake relief valve system once per month with pressurized water source (requires minimum flow of 250 gpm at pressures of 50 - 100 psi)

   d. Perform dry vacuum test each month

B. External Intake Relief Valve

1. Provides same basic function as integral intake relief valve, but differs in operation

2. External intake relief valve mounts on intake port

3. Pressure setting adjusted with allen wrench

   a. Adjust so normal intake pressures will not open relief valve

4. Valve discharge opening:

   a. Generally not threaded

   b. Positioned to shot water downward when activated

IV. DISCHARGE PRESSURE CONTROL DEVICES

A. Relief Valve

1. Two (2) major components

   a. Relief valve

   b. Control valve

2. Setting the control valve allows for variable setting of the pressure requirements throughout the complete pumping range

3. Relief valve opens into the discharge pressure, therefore it is kept closed by that same pressure

4. Once the pressure setting is made, any pressure exceeding the set pressure will open the relief valve and dump excess pressure back into the suction side of the pump

5. Designed to operate with pressure differential

   a. Needs minimum of 50 psi to work effectively

B. Pressure Control Governors

1. Definition of:

   a. Air / spring pressure control device

2. Alternative to relief valve

3. Pressure variations within the given pumping range either increase or decrease engine speed

V. PRIMING SYSTEMS

A. Rotary Vane

1. Components are:

    a. Electric motor

    b. Rotary vane pump

    c. Priming valve

    d. Oil tank

2. Most popular type and the industry standard

B. Rotary Gear

1. Components are:

    a. Priming valve

    b. Priming pump

        (1) driven by air or vacuum from the truck

    c. Priming control valve

    d. Oil tank

VI. AUXILIARY COOLING SYSTEMS

A. Pump water flows through copper coil from the discharge side back to the suction side

B. Cooler is mounted by cutting the radiator hose and installing the cooler in-line

C. Radiator water passes over the coil, lowering the temperature of the radiator water before it returns to the engine

VII. PUMP OPERATING PROCEDURES

A. Apparatus Preparations

1. Depend on:

    a. Departmental Standard Operating Procedures (SOP's)

    b. Apparatus design

    c. Type of priming device

B. Engaging Pump

1. Power takeoff (PTO):

   a. Spot the apparatus in the desired location and disengage the clutch

   b. Set the park brakes

   c. With the engine idling, put the transmission in neutral

   d. Operate the PTO shift lever, meshing the gears

   e. Engage the clutch slowly

   f. Now ready for operation

   g. May be operated while driving the apparatus

2. Mid-ship pump:

   a. Spot the apparatus in the desired location and disengage the clutch

   b. Set the park brakes

   c. With the engine idling, operate the pump shift lever

   d. Shift and lock the transmission into the proper gear for pumping

   e. Engage the clutch slowly

   f. Pump is now ready for operation

   g. Midship pumps do not have pump and roll capabilities, so the wheel chocks should be set immediately upon exiting the cab

3. Front mount pump:

   a. Spot the apparatus in the desired location and disengage the clutch

   b. Set the parking brake

   c. Put the transmission in neutral

   d. Engage the neutral lock

e. Dismount from the cab and set the wheel chocks

f. Close all the drains

g. Operate the pump shift lever

h. Now ready for operation

i. Has pump and roll capabilities

C. Getting Water to Pump

1. Water enters from the intake or suction side of the pump

2. Supplied by:

a. Gravity pressure from the tank

b. Distribution system under pressure

c. Drafting from a static water source

3. To get water from the tank:

a. Open the tank to pump valve(s)

b. Pump may need to be primed

4. To get water from a distribution system:

a. Use a fire hydrant and supply hose

5. To get water from a static source:

a. Use hard suction hose and strainer

b. Pump must be primed

D. Pumping from Tank

1. Open the tank-to-pump valves

2. Prime the pump

3. Engage the pump

4. Open the appropriate discharge valves

5. Increase the engine RPM's

6. Set the relief valve to the desired pressure

7. If preparing for pump and roll:

    a. Return the engine to idle

    b. Remove the wheel chocks and enter the cab

    c. Remove the neutral lock and parking brake

    d. Use the accelerator to control the engine RPM

    e. Select the proper transmission gear for slow ground speed and adequate pump pressure

8. If preparing for stationary pumping:

    a. Open desired discharge valves

    b. Make necessary adjustments to engine speed

    c. If no water is being used, open the tank fill valve to allow cool water to circulate through the pump

        (1) allowing water to overheat in pump can cause damage

9. To shut down the pump

    a. Slowly reduce the engine speed to an idle

    b. Close all the open valves slowly to prevent water hammer

    c. Disengage the pump

    d. Close all the tank-to-pump valves

    e. Open all the drains

E. Pumping from a hydrant using a 2 1/2" suction

1. Follow all the stationary pumping from tank procedures and establish water to hose lines

2. Connect the soft suction to the pump and hydrant

3. Open the hydrant fully

4. Bleed the trapped air from the supply line

5. Open the suction valve slowly

6. Close the tank-to-pump valves

F. Pumping from a hydrant using a large diameter hose

1. Connect the soft suction to the pump and hydrant

2. Open the hydrant fully

3. Bleed the trapped air from the pump

4. Slowly open all the appropriate discharge valves.

5. Engage the pump

6. Set the discharge and relief valve pressures as previously stated

G. Pumping From Draft

1. Connect the airtight hard suction / strainer assembly to the pump

2. Situate the suction and strainer in the water

3. Prime the pump

4. When the pump is primed, engage the pump

5. Follow rest of instructions as stated above in pumping from tank to deliver water to hoselines

VIII. PUMP PANEL GAUGES

A. Tachometer

1. Registers the apparatus engine speed in revolutions per minute (RPM)

B. Fuel Gauge

1. Registers quantity of fuel left in reserve

C. Oil Pressure Gauge

1. Registers the oil pressure of the apparatus engine during operation

D. Engine Temperature Gauge

1. Registers water temperature of the apparatus engine during operation

E. Water Level Gauge

1. Registers the water level in the tank

F. Compound Gauge

1. Registers the positive pump intake pressure when drafting from a pressurized source and the negative pump intake pressure (vacuum) when drafting from a static source

G. Pressure Gauge

1. Registers the discharge pressure of the pump

IX. FLOWMETERS

NOTE

NFPA 1901 "PUMPER FIRE APPARATUS" STANDARD #4-12.2 READS, "A FLOWMETER OR A PRESSURE GAUGE SHALL BE PROVIDED FOR EACH DISCHARGE OUTLET 1 1/2" OR LARGER IN SIZE AND SHALL BE LABELED AS TO THE OUTLET TO WHICH IT IS CONNECTED".

A. Provide accurate reading of water flow

1. May be calibrated to read in:

2. Only way to accurately determine water flow at any given time

3. Automatic nozzles mechanically maintain nozzle pressure at predetermined level

a. If flow is below rated nozzle capacity, nozzle will reduce orifice size, which:

b. Pressures can be artificially increased and mislead operator into believing nozzle capacity is being delivered

4. Friction loss coefficients of hose vary

a. Hydraulics coefficients for friction loss are based on average coefficient for specific size of hose

b. Hoses manufactured by various companies will generally have different friction loss coefficients

c. Flowmeter set at specific discharge gallonage will provide that quantity of water at nozzle regardless of friction loss coefficient of hose

5. Eliminates need for hydraulic calculations

a. Shows exact flow through discharge valve

b. Quantity will not diminish before it reaches nozzle unless there are leaks and/or breaks in hoses or appliances

B. Components

1. Linear flow-rate indicator

2. Primary sensor (self-averaging)

a. Four (4) basic types

(1) Differential

(2) Turbine

(3) Spring probe

(4) Paddlewheel

C. Accuracy

1. Properly calibrated and in good working condition, flowmeters should be accurate to within plus or minus three (3) percent

NOTE

THIS MEANS THAT FOR EVERY 100 GPM OF WATER FLOW, THE FLOWMETER SHOULD NOT BE MORE THAN 3 GALLONS HIGH OR LOW (97 to 103 GPM) IN ITS

READING. THIS TRANSLATES INTO A FLOW ACCURACY OF 30 GALLONS HIGH OR LOW (970 to 1030 GPM) IN FLOWS OF 1000 GPM. ACCURACY OF THIS TYPE WOULD BE DIFFICULT TO ACHIEVE USING PRESSURE GAUGES AND HYDRAULICS FORMULAS DUE TO THE CALIBRATION OF PRESSURE GAUGES USUALLY BEING NO FINER THAN 5 TO 10 PSI.

D. Installation

1. Flowmeters may be installed at:

2. Sensors must be mounted in straight pipe runs in apparatus plumbing to ensure accuracy

3. Sensors operate electronically and may be located remotely within apparatus plumbing

4. Connected to analog gauges and/or digital LCD's located at pump panel by watertight wires and circuitry

5. If properly installed , flowmeters require little maintenance and are highly reliable

X. VOLUME / PRESSURE TRANSFER VALVE

NOTE

THE TWO-STAGE, SERIES / PARALLEL CENTRIFUGAL PUMP HAS LONG BEEN THE STANDARD OF THE FIRE SERVICE. THE TWO-STAGE PUMP PROVIDES A WIDE RANGE OF CAPACITIES OVER A RANGE OF PRESSURE ROUGHLY TWICE THAT POSSIBLE WITH A SINGLE STAGE PUMP. IN ORDER TO USE A SERIES / PARALLEL PUMP TO ITS MAXIMUM POTENTIAL, THE OPERATOR MUST KNOW WHEN TO USE EACH MODE, SERIES (PRESSURE) OR PARALLEL (VOLUME).

A. Best "mode" (transfer valve position) depends on:

1. Characteristics of pump / engine combination

2. Whether pump being supplied from:

NOTE

A GENERAL RULE OF THUMB IS THAT IF POSITIVE SUCTION PRESSURE CAN BE MAINTAINED, THE PUMP CAN USUALLY HANDLE UP TO 75% OF ITS RATED CAPACITY WHEN IN THE SERIES (PRESSURE) MODE WITHOUT A SERIOUS LOSS OF EFFICIENCY, HOWEVER, WHEN PUMPING FROM A STATIC (NON-PRESSURIZED) WATER SOURCE THERE IS DANGER OF CAVITATION IF THE PUMP TRIES TO PRODUCE MORE THAN 50% OF ITS RATED CAPACITY.

B. Mode (transfer valve position) selection

1. Series (Pressure) mode

   a. Less than 50% of rated capacity

   b. All pressures

2. Parallel (Volume) mode

   a. More than 50% of rated capacity

   b. Less than 200 psi

NOTE

IF IT IS NECESSARY TO PUMP MORE THAN 50% OF RATED PUMP CAPACITY AT PRESSURES OVER 200 PSI, THE OPERATOR SHOULD FIRST TRY TO PUMP IN PARALLEL (VOLUME), IF DRAFTING FROM A NON-PRESSURIZED SOURCE, OR IN SERIES (PRESSURE), IF PUMPING FROM A PRESSURIZED SOURCE. IF ENGINE POWER IS INSUFFICIENT TO REACH THE DESIRED PERFORMANCE, THE OTHER MODE SHOULD BE TRIED AND THE BEST MODE FOR THE CONDITIONS SHOULD BE USED.

C. Changing mode (transfer valve position) while pumping

1. Power actuators will move transfer valve when pump pressures are high

2. Manual operation of transfer valve difficult unless pump pressure decreased (below 100 psi)

3. Under normal circumstances, no pump damage will occur when changing transfer valve position at any pressure

SAFETY NOTE

CHANGING OPERATIONAL MODES WHILE PUMPING AT HIGH PRESSURES OR LARGE VOLUMES COULD HAVE AN IMPACT ON THE HOSELINE OPERATOR. THE APPARATUS OPERATOR SHOULD ALWAYS FOLLOW ESTABLISHED STANDARD OPERATING PROCEDURES DEVELOPED BY THE EMPLOYING FIRE DEPARTMENT WITH SAFETY BEING THE FOREMOST CONSIDERATION.

XI. MALFUNCTIONS WHICH COULD OCCUR DURING PUMP OPERATION

A. Problems Common To All Types Of Operation

1. Unable to get a reading on the pressure gauge when the pump is put in service

2. Pump will not develop sufficient pressure

3. Pump is unable to supply its rated capacity

4. Pump is overheating while in operation

5. Relief valve is inoperative or slow acting

B. Problems When Operating From The Tank

1. Unable to establish an adequate operating pressure or a loss of pressure occurs when the first discharge valve is opened

2. Fluctuation of the pressure gauge and a reduction of discharge pressure when additional lines are put in service

3. While pumping, the discharge pressure drops to a very low value and water supply is interrupted

C. Problems When Operating From A Hydrant

1. Suction line collapses when the discharge valve to a hoseline is opened

2. While supplying water, the suction line collapses and the pump begins to cavitate

D. Problems When Operating From Draft

1. Pump will not prime

2. Pump loses its prime when the first discharge valve is opened and water begins to flow

3. Pump loses its prime during the course of a pumping operation

4. The pump goes into cavitation when the flow increases

XII. CONDITIONS WHICH MAY LEAD TO PUMP DAMAGE OR UNSAFE OPERATION AND THEIR REMEDIES

A. Cavitation

1. Definition of:

a. A condition in which vacuum pockets form in a pump and cause vibrations, loss of efficiency, and possible damage

b. Normally occurs when the output starts to exceed the input

2. May be remedied by:

   a. Decreasing output

   b. Increasing input

B. Leaking Fluids (Fuel, Oil, Water)

   1. Remedy:

      a. Call a backup engine to replace operating engine

      b. Shut down operating engine as soon as possible

      c. Have repairs made before putting back in service

C. Engine Overheating

   1. Remedies:

      a. Open hood

      b. Open auxiliary cooler

      c. Use radiator fill

D. Pump Overheating

   1. Remedy:

      a. Open tank fill valve to allow tank water to circulate through pump

E. Unusual Noises

   1. Remedy:

      a. Call a backup engine to replace operating engine

      b. Shut down operating engine as soon as possible

      c. Have repairs made before putting back in service

F. Vibrations

   1. Remedy:

      a. Call a backup engine to replace operating engine

      b. Shut down operating engine as soon as possible

c. Have repairs made before putting back in service

G. Water Hammer

1. Definition of:

a. Impact energy resulting from sudden closure of nozzles or valves on charged lines

2. Remedy:

a. Open and close valves and nozzles slowly

XIII. POSITIONING APPARATUS

A. Determining Factors

1. Water

2. Hose

3. Pump capacity

4. Safety concerns

5. Positioning the apparatus to supply hoselines from the tank differs from locating the engine to draft from a hydrant or static source

B. Positioning to Supply Hoselines from the Tank

1. Locate as close to the fire as safety and/or need permit

2. Considerations:

a. Wind direction

b. Exposures

c. Terrain

d. Obstructions

e. Manpower

f. Other

3. Permits the preconnects to be utilized to their best advantage

4. Limitations:

    a. Limited water supply

    b. Full pump capacity is unused

C. Positioning to Supply Water from Draft

1. Connect to the water source with a hose large enough to allow the pump to supply the maximum rated capacity

2. Two types of suction hose:

    a. Hard

    b. Soft

3. Apparatus operators must be able to position their engines for either type

D. Positioning to Draft from Static Source

1. Place the apparatus as close to the water source as safety permits

2. Suction hose may be connected to the pump either before or after positioning

3. Hose end strainers must be used

E. Positioning to Draft from Hydrant

1. Hard suction

    a. Stop the engine with the suction port short of being in line with the hydrant

    b. Connect the intake hose to the engine first

    c. Move the engine forward, bending the hose to make the hydrant connection

2. Soft suction

    a. Stop the proper distance from the hydrant

    b. Turn the front wheels of the apparatus at a 45° angle

c. Connected supply hose should be slightly curved, with one or two complete twists

XIV. RATED PUMPING CAPACITIES

A. Capacity

1. Definition of (for this class):

a. Volume of water that the pump can discharge from a static source draft at a certain pressure each minute

B. Rated Capacity is:

1. One means of identifying the pump capabilities

2. Determined by testing

3. Not necessarily the maximum capacity of the pump

4. Actual capacity of centrifugal pumps are limited by their design features

5. Capacity of a positive displacement pump is limited by:

a. Pump displacement

b. Pump speed

6. To pass the test and be rated, fire pumps must meet the following capacity and pressure requirements:

a. 100% of rated capacity @ 150 PSI

b. 70% of rated capacity @ 200 PSI

c. 50% of rated capacity @ 250 PSI

7. Insurance Services Office requires that pumps be tested annually

XV. FOAM FIRE STREAMS

A. Terminology

1. Foam concentrate

a. Definition of:

(1) "the raw foam liquid as it sits in its storage container, usually a 5 gallon bucket, 55 gallon barrel, or an apparatus storage tank"

2. Foam proportioner

   a. Definition of:

      (1) "a device that injects the correct amount of foam concentrate into the water stream to make the foam solution"

3. Foam solution

   a. Definition of:

      (1) "a mixture of foam concentrate and water that is discharged from the proportioner and passed through the hoseline"

4. Finished foam

   a. Definition of:

      (1) "the completed product after the foam solution reaches the nozzle and air is introduced into the solution (aeration)"

B. Foam Tetrahedron

1. Four elements necessary to make high quality firefighting foam

   a. Foam concentrate

   b. Water

   c. Air

   d. Mechanical agitation (aeration)

2. Components must be blended in proper ratios

3. Removal of any one element will result in:

   a. Poor quality foam

   b. No foam at all

C. Foam Production

1. Two steps:

2. Proportioning

   a. Foam concentrate mixed with water in proper proportions

   b. Foam concentrations should follow manufacturer's recommendations to assure maximum effectiveness

NOTE

FOAM CONCENTRATES MUST BE COMPATIBLE WITH THE FUELS TO WHICH THEY ARE APPLIED

3. Aeration

   a. Injects air into foam solution to create bubbles which form effective foam blanket

   b. Foam nozzles must be matched to proportioner to produce highest quality foam