

### F-3 Fire Pumps & Accessories

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**Reference Materials:** Note: This exam also contains "accepted practice" type questions not found in the reference material listed below.

**Pumping Apparatus DRIVER/OPERATOR Handbook**, 2nd edition, Oklahoma State University, Stillwater, OK. (800) 654-4055 or www.ifsta.org ; Chapters 3, 6, 9, 10, 11, 12, 15, 16, glossary, & appendix a-e

NFPA reference listed below - National Fire Protection Association, Quincy, MA, (800) 344-3555 or www.nfpa.org

NFPA 1901, **Standard for Automotive Fire Apparatus**

NFPA 1911 **Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus**

Any fire pump manufacturer's repair manual (such as Hale, Waterous, etc.)

#### LEARNING OBJECTIVES FOR THE F-3 EXAM

1. **Hydraulic Principles:** The Fire Apparatus Technician shall understand the hydraulic principles of water movement in pumping operations.
  - 1.1 Identify the factors which affect water movement in pumping operations
    - a. Physical characteristics of water
    - b. Principles of pressure
      - (1) Definition
      - (2) Effect water surface
    - c. Rules of friction loss
    - d. Elevation influence
    - e. Velocity of water
      - (1) Effect of impeller speed
    - f. Atmospheric pressure influence
      - (1) Pump priming
  - 1.2 Identify the following terms that relate to the basic hydraulic principles used in the fire service:
    - a. Pressure
    - b. Atmospheric pressure
    - c. Negative pressure
    - d. Vacuum
      - (1) Definition
    - e. Static pressure
      - (1) Definition
    - f. Flow pressure
    - g. Residual pressure
      - (1) Measurement
    - h. Pump discharge pressure
    - i. Head pressure (back pressure)
      - (1) Definition
    - j. Friction loss
    - k. Net pump pressure
      - (1) Friction loss
    - l. Capacity
    - m. Drafting
      - (1) Effect of atmospheric pressure on vacuum
    - n. Venturi
      - (1) Definition
      - (2) Application
    - o. Water hammer
  - 1.3 Describe the physical development of cavitation in a fire pump.
  - 1.4 Conditions when cavitation occurs
    - a. Symptoms of cavitation
      - (1) Relationship-pump RPM to pressure
    - b. Methods of preventing cavitation
  - 1.5 Condition when water hammer occurs
    - a. Methods of preventing
    - b. Results of water hammer
2. **Mechanical Principle of Pumps:** Understand the mechanical principles of pumps, pump controls and accessories such as:
  - 2.1 Identify the operating principles and uses of the positive-displacement pumps
    - a. Vane Primers
      - (1) Sealing lubricant
  - 2.2 Identify the components of a centrifugal pump
    - a. Packing/mechanical seal
      - (1) Flinger/Slinger ring
      - (2) Stuffing box
      - (3) Purpose
      - (4) Lantern rings
    - b. Design of impeller
      - (1) Purpose of eye
    - c. Impeller housing
      - (1) Stripping edge/cut water
  - 2.3 Identify the operating principles of centrifugal pumps
    - a. Two-stage pumps
      - (1) Route of water
      - (2) Effect of staging
    - b. Single stage pumps
    - c. Advantage of centrifugal
      - (1) Impeller design
  - 2.4 Define the following terms as they relate to staging in a centrifugal pump:
    - a. Single-stage
    - b. Two-stage
    - c. Volume/parallel
    - d. Pressure/series
  - 2.5 Describe the theory, principles of operation and components of the following pump accessories:
    - a. Priming centrifugal pumps
      - (1) Positive displacement pumps
    - b. Pressure control devices
      - (1) Pressure relief valves
        - A. Purpose for
        - B. Controls
        - C. Pilot valve
      - (2) Pressure governors
        - A. Controls
        - B. Purpose for
    - c. Coolers
      - (1) Engine
      - (2) Aux/pump
    - d. Foam systems
      - (1) Flow rate injection
      - (2) Eduction
  - 2.6 Identify the pump controls, gauges and instruments associated with a fire pump, such as:
    - a. Cooler
      - (1) Engine
      - (1) Aux/pump
    - b. Pump intake & discharge valves
      - (1) Components
    - c. Vernier throttle purpose of
    - d. Compound pressure gauge
      - (1) Definition
    - e. Pressure gauge
      - (1) Types of gauges
      - (2) Acceptable condition
    - f. Engine gauges
    - g. Pump test gauges
    - h. Mechanical RPM counter connection
      - (1) Purpose
    - i. Snubber Valve
      - (1) Effect of
    - j. Flow meters & components
3. **Fire Pump Operation:** Understand the operation of a fire pump and related accessories during pumping operations.
  - 3.1 Identify the principle of drafting
    - a. Single Stage
    - b. Two Stage
      - (1) Transfer valve positioning
    - c. Choosing a draft site
      - (1) Maximum allowable lift
    - d. Effects of vacuum leak

- 3.2 Describe the operation of the fire pump:
- a. When operating from a static and positive pressure water source
    - (1) Understand vacuum readings at draft
  - b. The use of the volume/pressure transfer valve
    - (1) Understand output in pressure & volume
  - c. The use of pressure relief or pressure governor systems
    - (1) When to use pressure relief valves
    - (2) Effect of pressure differential
    - (3) Effect of relief valve setting
    - (4) Max allowable pressure rise
    - (5) Intake relief valves
  - d. The use of the auxiliary cooling system
  - e. The use of priming systems
    - (1) Effect of priming system on pump
  - f. Automatic thermal protection
- 3.3 Describe the cause and remedies of problems encountered during pump operations, such as:
- a. Inability to prime the pump at draft
    - (1) Cause for poor vacuum conditions
  - b. Loss of prime
    - (1) Effect of system leaks
  - c. Reduction of intake pressure
  - d. Inability to obtain or maintain desired pump discharge pressures
    - (1) Effect of impeller speed
    - (2) Effect of water velocity
  - e. Inability to obtain or maintain desired g.p.m. discharge
    - (1) Effect of swing check valves on flow
    - (2) Cause & effect of reduced flow at draft
  - f. Malfunction of pump controls & accessories
    - (1) Pilot valve function
  - g. Malfunction of power train components
  - h. Pump Engagement
    - (1) Incomplete shift
  - i. Cavitation
- 4. Preventive Maintenance:** Understand the periodic preventive maintenance required for fire pumps, pumps controls and pump accessories.
- 4.1 Identify:
- a. Types of lubricant applications
    - (1) Primer pumps
    - (2) Auto lube
  - b. Records and reports needed for fire pump maintenance program
    - (1) Fluid analysis
    - (2) Result of incorrect fluid level
  - c. Tasks required to return the pumper apparatus to service after pumping operations
- 4.2 Describe the maintenance guidelines for pump, components and accessories, such as:
- a. Impeller shaft
    - (2) Result of incorrect fluid level
  - b. Pump packing
    - (1) Adjustment procedure
    - (2) Symptoms of incorrect adjustment
    - (3) Results of incorrect adjustment
  - c. Mechanical pump seals
    - (1) Acceptable conditions
  - d. Transfer valve actuator
    - (1) Procedure
  - e. Pump transmission
    - (1) Maintenance intervals
  - f. Transfer valve assembly
  - g. Priming pump system
    - (1) Procedure
  - h. Pressure relief systems
    - (1) Maintenance procedure
  - i. Valve assemblies
    - (1) Procedure
  - j. Gauges and instruments
    - (1) Flow meters & components
  - k. Clearance rings
  - l. Pump assembly
    - (1) Procedure
  - m. Anodes
  - n. Tanks
    - (1) water
    - (2) foam
- 5. Fire Pump Repair and Overhaul:** The Fire Apparatus Technician shall understand the procedures necessary to overhaul a fire pump.
- 5.1 Identify probable cause(s) of problems with:
- a. Pump components
    - (1) Galvanic action
    - (2) Cavitation
  - b. Pump controls
    - (1) Engine RPM indicator
  - (2) Improper operation
  - c. Pump accessories
    - (1) Priming system
    - (2) Speed measuring
  - d. Pump drive
    - (1) Fluid level
    - (2) mechanical failure
  - e. Symptoms
    - (1) Pressure Control Device
- 5.2 Describe procedures for:
- a. Repairing of the fire pump
  - b. Replacing the impeller assembly
    - (1) Proper assembly
  - c. Repairing transfer valve
    - (1) Removal procedure
  - d. Repairing priming system
  - e. Repairing pressure relief systems
  - f. Repairing pressure governor systems
  - g. Repairing valve assemblies
    - (1) Troubleshooting valve problems
    - (2) Proper valve repair procedure
  - h. Electronic controls
  - i. Repairing the packing
    - (1) Installation & Improper removal
  - j. Replacing the mechanical seal
  - k. Replacing instrumentation
    - (1) Troubleshooting gauge problems
- 5.3 Identify procedures for:
- a. Recognizing worn or damaged parts
    - (1) Clearance rings
    - (2) Acceptability criteria
  - b. Recognizing contaminated lubricants
    - (1) cause determination
  - c. Condition Determination
    - (1) Pump Performance
    - (2) Out of service criteria
    - (3) Safety - Reliability
- 5.4 Identify special tools and equipment required
- a. Hand and power tools
  - b. Diagnostic and measuring equipment
  - c. Technical manuals
    - (1) Obtaining information
  - d. Special hazards
    - (1) Work place safety
- 6. Pump Service Testing:** The Fire Apparatus Technician shall understand the procedures of performing a pump service test.
- 6.1 Identify data and certification records:
- a. Required of the pump and apparatus manufacturer
  - b. Service test records maintained by local authority
    - (1) Purpose of records
- 6.2 Identify the tests to be performed for a service test:
- a. Performance standards for the pump service test
    - (1) Pressure control device standard
  - b. Equipment required for the tests
    - (1) Calibration requirements
  - c. Methods of computing performance
    - (1) Speed measuring equipment
  - d. Records required for local authority
  - e. Tank-to-pump flow test
  - f. Re-rating pump
- 6.3 Identify the cause(s) and remedies of problems encountered while performing a pump service test
- a. Vacuum test
    - (1) Conditions preventing vacuum
  - b. Swing check valves on two stage pump
    - (1) Effect of stuck swing check valves
- 6.4 Describe the procedures for performing a pump service test
- 6.5 Identify procedures which require service testing afterwards