

Reference Materials: Note: This exam also contains "accepted practice" type questions not found in the reference material listed below. *Pumping Apparatus DRIVER/OPERATOR Handbook*, second edition, 2006, 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

Fire Department Pumping Apparatus Maintenance by Don Henry, Fire Protection Publications (800) 654-4055 or www.ifsta.org
NFPA reference listed below - National Fire Protection Association, Quincy, MA, (800) 344-3555 or www.nfpa.org

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2003 edition,

NFPA 1911 *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, 2007

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 centrifical 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
 - (1) Maximum allowable lift
 - b. Two Stage
 - (1) Transfer valve positioning
 - c. Choosing a draft site
 - d. Effects of vacuum leak

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