

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

Pumping Apparatus DRIVER/OPERATOR Handbook 3rd edition. Oklahoma State University, Stillwater, OK. (800) 654-4055 or www.ifsta.org Chapters 2 5,7, 8, 9, 10, 11,14, 15, glossary.

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**

Fire pump manufacturer's repair manuals (Hale, Waterous, Darley, Trident) www.waterousco.com www.haleproducts.com
www.wsdarley.com

LEARNING OBJECTIVES FOR THE F-3 EXAM

1. **Hydraulic Principles:** Understand the hydraulic principles of water movement in pump operations.
 - a. Pressure
 - (1) Force per unit area
 - (2) Static pressure
 - (3) Measure of residual pressure
 - (4) Net pump pressure
 - (a) Friction loss
 - b. Vacuum
 - (1) inches of mercury
 - c. Drafting
 - (1) Effect of Atmospheric pressure on vacuum
 - (2) Lift
 - d. Venturi application
 - (1) eductor
 - e. Cavitation/Water hammer
 - (1) Symptoms
 - (2) Cause/Prevention
 - (3) Pump RPM to pressure relationship
2. **Mechanical Principles of Pumps:** Understand the theory and mechanical principles of pumps, pump controls and accessories:
 - a. Positive-displacement pumps
 - (1) Vane Primers
 - (a) Sealing Lubricant
 - b. Centrifugal Pump
 - (1) Two-stage
 - (a) Route of water
 - (b) Transfer valve
 - (i) Volume/parallel
 - (ii) Pressure/series
 - (2) Packing/Mechanical seal
 - (a) Drip rate
 - (i) mechanical seal
 - (ii) packing
 - (b) Flinger/Slinger ring
 - (c) Stuffing box
 - (d) Purpose of packing adjustment
 - (e) Lantern rings
 - (3) Impeller Design
 - (a) Purpose of eye
 - (4) Housing stripping edge/cut water
 - (5) Priming methods
 - (a) Air Primer
 - (b) Exhaust Primer
 - c. Pressure control devices
 - (1) Relief valves
 - (a) Purpose
 - (b) Controls
 - (c) Pilot Valve
 - (2) Governors
 - (a) Controls
 - d. Intake and discharge valves
 - (1) Ball valve
 - e. Coolers
 - (1) Engine
 - (2) Pump
 - (a) Thermal relief valve
 - f. Foam system proportioning
 - g. Vernier throttle purpose
 - h. Gauges
 - (1) Compound Pressure gauge
 - (2) Liquid filled gauge
 - (a) Acceptable condition
 - i. Flow meters
 - (1) Mounting
 - (2) Paddle wheel
 - j. Water tank to pump check valve
3. **Fire Pump Operation:** Understand the operation of a fire pump and related accessories.
 - a. Pumping at Draft
 - (1) Two Stage
 - (a) Volume/Parallel
 - (b) Pressure/Series
 - (c) Transfer valve positioning
 - (d) Swing check valve
 - (2) Choosing a draft site
 - (a) Contamination
 - (b) Maximum allowable lift
 - (3) Vacuum
 - (a) Effect of Leaks
 - (b) Priming
 - (c) Vacuum readings when drafting
 - (d) Pump packing adjustment
 - (4) Reduced flow/losing prime - Cause & Effect
 - (a) worn impeller
 - (b) leak on intake
 - (c) aeration
 - (d) hoseliner collapse
 - (e) Transmission Lockup
 - (f) Relief Valve
 - (5) Pressure controlling systems
 - (a) Pressure relief valves
 - (b) Maximum pressure rise
 - (c) intake relief valves
 - (d) Pilot valves
 - b. Auxiliary Cooling system
 - c. Butt Tooth condition during pump shifting
 - d. Cause of cavitation

4. Preventive Maintenance, Checks & Inspection: Understand the periodic preventive maintenance and inspection requirements.

- a. Lubricant
 - (1) Types
 - (2) Primer pumps
 - (3) Fluid level check
 - (4) Hale Auto-lube front bearing
- b. Documentation
 - (1) PM
 - (2) Schedule responsibility
 - (3) Fluid analysis
- c. Frequency / Required monthly checks
 - (1) Flushing/Back Flushing
- d. Pump Packing
 - (1) Reason for Adjustment
 - (2) Cause/Effect of Incorrect Adjustment
 - (3) Maintenance
- e. Mechanical pump seals
 - (1) Acceptable leak rate
- f. Transfer Valve Maintenance
- g. Pump transmission
 - (1) Maintenance intervals
 - (2) Incorrect fluid levels
 - (3) Drain plug function
- (4) Water Contamination
- (5) Leaks
 - (a) Class 3
- (6) Primer Maintenance
- (7) Oiled Primer leaks
- h. Pressure relief system
 - (1) Checks
 - (2) Maintenance
- i. Valve maintenance
- j. Gauges and instruments
 - (1) Flow meter Paddle wheel inspection
- k. Pump assembly
 - (1) Waterous Out board bearing Lubrication
- l. Anodes/Intake strainer inspection
- m. Water and foam tank maintenance
- n. Out of service
 - (1) Pressure Control system
 - (2) Water Tank
 - (3) Fire Pump engagement

5. Repair and Overhaul: Understand the necessary procedures to repair and overhaul a fire pump

- a. Probable Causes and Effects of defects
 - (1) Pump components
 - (a) Galvanic corrosion
 - (b) Impeller damage from Cavitation
 - (c) Shaft damage from packing
 - (d) Primer systems
 - (i) Primer Valve stuck open
 - (ii) Oiled primer leaks
 - (iii) Primer will not engage
 - (e) Pump transmission Fluid analysis
 - (f) Drive line out of phase
 - (g) Relief valve delayed response
 - (h) Valves
 - (i) leakage
 - (ii) locking
 - (i) Worn clearance ring effect
 - (j) Missing flinger / slinger ring
 - (k) Pump component specifications
 - (2) Pump Controls and accessories
 - (a) Transmission Lockup
 - (b) Gauge problems
 - (c) Improper operation
- b. Out of Service criteria
 - (1) Pump out of service requirements
 - (2) Pump out of service signage / warning
- (3) Water tank level indicator
- (4) Class 2 valve leak
- c. Procedures
 - (1) Proper impeller assembly
 - (2) Transfer valve removal
 - (3) Intake Valve installation
 - (4) Packing
 - (a) Installation
 - (5) Replacing mechanical seal
 - (6) Gauge troubleshooting
 - (7) Worn or Damaged parts
 - (a) Pump packing
 - (b) Impeller shaft
 - (8) Determining condition
 - (a) Pump performance
 - (b) Out of Service
 - (c) Safety - Reliability
 - (9) Special tools
 - (10) Workplace safety and cleanliness
- d. Reference material
 - (1) Pump info needed
 - (2) Utilizing technical/repair manuals

6. Pump Performance Testing: Understand the procedures of conducting a pump performance test.

- a. Repair and overhaul testing requirements
- b. Documentation
 - (1) Purpose of maintaining records
 - (2) Records retention
- c. Frequency of tests
- d. Setup and equipment
 - (1) Conditions
 - (a) Required Electric load during test
 - (b) Ambient air
 - (c) Water temperature
 - (d) Hydraulic Generator
 - (e) Salt water testing
 - (2) Required equipment
 - (a) Pitot gauge
 - (b) Equipment to take RPM readings
 - (c) Required Test gauge Accuracy and Calibration
 - (3) Parallel/series
- e. Required Performance Tests
 - (1) Primer Test
 - (2) Vacuum test
 - (3) Overload pump test
 - (4) No load governor test
 - (5) Flow meter test
 - (6) Tank to pump flow test
 - (7) Pressure controlling device test
 - (8) Flow test
 - f. Calculating net pump pressure
 - g. Re-rating/de-rating pump
 - h. Troubleshooting
 - (1) Stuck swing check valves
 - (2) Draft problems / RPM not maintainable
 - (3) test pit aeration
 - (4) Causes for failing flow test
 - (5) Failed vacuum test
 - i. Out of Service
 - (1) Failure of test
 - (2) gauges
 - (3) signage
 - (4) inoperable pressure controlling device
 - (5) Engine overheat during test
 - (6) Leaks
 - (a) Class 3