F-4 Electrical Systems

Reference Materials:  Note: This exam also contains many handson-type questions you may not find in any reference material listed below
NFPA reference listed below - National Fire Protection Association, Quincy, MA, (800) 344-3555 or www.nfpa.org
NFPA 1901, Standard for Automotive Fire Apparatus Chapter 13
NFPA 1911, Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus
Chapters 3, 6, 9, 14, 20, 25
Any Heavy Truck Electrical Manual-- Suggestion for electrical reference material is listed below.
Fundamental Electrical Troubleshooting, by Dan Sullivan 800-227-1603 http://www.esitest.com/182.html or online retailers
Any emergency apparatus service and operator manual (OEM)

LEARNING OBJECTIVES FOR THE F-4 EXAM

1. Basic Principles of Electricity Define or identify:
   a. Principles of electron flow
      (1) Causes of resistance in circuits
      (2) Definitions and terms
      (3) Current flow in parallel circuits
      (4) Current flow in series circuits
      (5) Controlling current
      (6) Spike suppression
   b. Ohms Law as applied to electrical circuits
      (1) Relationship of volt, amp, resistance
      (2) Calculating resistance in parallel circuits
      (3) Units of measure for Ohm’s Law
      (4) Calculating resistance and voltage in series circuits
   c. Principles of electromagnetism
      (1) How an electromagnet is created
      (2) Uses of electromagnet
      (3) Straight conductor vs. coiled conductor
   d. Electrical symbols and schematics
      (1) Switch & relay symbol & terminal identification
      (2) General circuit & symbols, i.e. ground, motors, etc
   e. Power Formulas as applied to Electrical circuits
      (1) Relationship of volts, amps, & watts
      (2) Calculating power, amp, and voltage requirements
   f. Circuit types
      (1) Series & parallel
      (2) Combo series/parallel
      (3) Shielded Circuits

2. Basic Principles of Operation Describe or identify:
   a. Function & application of electrical components and accessories
      (1) relays & diodes
      (2) switches
      (3) solenoids
      (4) interlocks
      (5) interface
      (6) inverter & convertors
      (7) load managers & sequencer
      (8) electronic throttles
      (9) ECM/ECU
   b. Function and application of electronic components
      (1) diodes
      (2) capacitors
      (3) resistors
      (4) lighting-incandescent, halogen, L.E.D., & strobes
      (5) data buses
      (6) multiplexing
      (7) traffic preemption devices
   c. System requirements and performance evaluation
      (1) voltage drop, current draw, resistance
      (2) power consumption
      (3) efficiency
      (4) reliability
      (5) cost

3. Basic Use of Diagnostic Equipment/Tools
   a. Describe diagnostic equipment used to measure voltage, current, resistance & impedance
      (1) Interpretation of oscilloscopes
      (2) Proper diagnostic equipment/meter connections
         (a) Voltmeter
         (b) Ammeter
         (c) Ohmmeter
   b. Evaluate quality and application of diagnostic equipment
      (1) Applications of DVOM(DMM)
      (2) Applications of load testers
      (3) Applications of analog meters
      (4) Diagnostic equipment usage
         (a) Testing diodes
      (5) Inductive ammeters
      (6) Meter Impedance

4. Vehicle Batteries Describe or Identify:
   a. Battery construction and performance
      (1) Safety-jump starting
      (2) Components
         (a) spark arrester
      (3) Purpose-types-construction
         (a) lead-acid
      (4) Define a battery
      (5) Causes of battery failure
   b. How to evaluate battery requirements
      (1) Reserve capacity
      (2) C.C.A/C.A.
         (a) Battery cold cranking rating
      (3) BCI group identification
      (4) Operating temperature
   c. Proper battery maintenance procedures
      (1) Types of chargers
      (2) Charging rates
      (3) Battery maintenance
   d. Proper battery testing procedures
      (1) Replacement
      (2) Load Testing
      (3) Conductivity testing
      (4) Define surface charge
      (5) Determine state of charge w/DMM Continued
5. Starting Systems -- Understand the construction and operation of starting system components
   a. Describe starting system construction and operation
      (1) Circuit component
      (2) Mechanical components
         (a) Starter solenoid
      (3) Preventing starter motor over-speed
      (4) Field winding types
      (5) Pull in & hold in coils
   b. Proper cranking system & component testing procedure
      (1) Wiring and connections
      (2) Mechanical components/drive pinions
      (3) Current draw
      (4) Slow cranking engine
         (a) Voltage drop
      (5) Starter activation circuits
   c. Identify proper repair procedures
      (1) Connections
      (2) Solenoid switch contact
      (3) Starter interlock system
      (4) Armatures

6. Charging Systems--Understand construction and operation of the charging system and components
   a. Alternator construction and operation
      (1) Function of components
         (a) Alternator capacitor
         (b) Voltage regulator
      (2) Alternator output/operation
      (3) Alternator Design
      (4) Component recognition
         (a) Stator
      (5) Drive requirements
      (6) Noise suppression
   b. Alternator & Regulator diagnosis and testing
      (1) Unit testing
      (2) Component testing
      (3) On vehicle/off vehicle testing
         (a) Undercharge/overcharge condition
      (4) Battery isolator/isolated systems
      (5) Mounting hardware
      (6) Regulator adjustment procedure
      (7) Belt tension and wrap
      (8) Maintenance Free vs. Low Maintenance batteries
         (a) charge voltage
   c. Proper repair procedures
      (1) Component failures
      (2) Replacement of regulators and remote rectifier
      (3) Alternator failures
   d. Evaluate charging system requirements
      (1) Load analysis
      (2) Cable size
      (3) Set output requirements

7. Troubleshooting --Understand accepted practices used to diagnose and repair electrical circuits.
   a. Analyzing results
      (1) Interpretation of functional drawing reading
      (2) Circuit wiring/connection
      (3) Current draw
   b. Components
      (1) Relays/solenoids
      (2) Interlocks & Interfaces
      (3) Switches & proximity
      (4) Load managers
      (5) Sequencer
      (6) Proper ground connections
      (7) Terminals
      (8) Gauges
   c. Tools and equipment
      (1) DVOM/DMM
      (2) Induction meters
      (3) load tests
   d. Diagnostic tests
      (1) Voltage drop

8. NFPA 1911-Chapters 3, 6, 9, 14, 20, 25
   a. Low Voltage Electrical Systems
      (1) Inspection and Maintenance
         (a) Automatic electrical load management systems
      (2) Performance Testing
         (a) Battery testing
         (b) Alternator testing
            (I) Parameters
            (II) Electrical load
      (c) Total continuous electrical load test
         (I) Load Shedding
      (d) Solenoid and Relay Test
         (I) Voltage drop maximum
      (e) Conductivity Test
      (f) Starter wiring test
      (g) Regulator test
      (h) Voltage Drop Spec's
         (i) Lighting Tests
      (j) On Board Battery Charger/Conditioner Test
      (3) Out of Service Criteria
   b. Line Voltage Electrical Systems
      (1) Inspection and Maintenance
      (2) Performance Testing
      (3) Out of Service Criteria
      (4) Power Source Testing
         (a) Receptacle Testing