

Reference Materials: Note: This exam also contains many hands-on 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-- Suggestions for electrical reference material are listed below.

Fundamental Electrical Troubleshooting, by Dan Sullivan 800-227-1603 www.esitest.com or online retailers

OR **Heavy Duty ProClinic Manual**, by Interstate Battery call Jeff Barron at 469-221-4655 for local interstate dealer ordering info
 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
- d. Evaluation of wire size, insulation, and circuit protection
 - (1) Fuses and circuit breakers-types
 - (2) insulation ratings
 - (3) wire gauge size
- e. Proper wire repair procedures and proper routing techniques
 - (1) Solder techniques
 - (2) wire termination, terminal & crimping tool
 - (3) wire loom ratings
 - (4) corrosion protections
- f. Equipment and component protection
 - (1) welding precautions
 - (2) spike protections
 - (3) static discharge
- g. Function, operation, & testing of gauges & warning devices
 - (1) ammeters, voltmeters
 - (2) gauges
 - (3) Temperature gauge
 - (a) instrument voltage regulators
 - (4) electric speedometers & tachometer

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
 - (5) Battery pack combinations
- 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

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, 8, 13, 17, 22

- 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 wiring