

E-3 Ambulance Heating, Air Conditioning, and Ventilation

February 2018

Reference Materials: Note: This exam may contain some "accepted practice" type questions not found in the reference material listed below.**Motor Age T7 Heating & A/C Self-Study Guide**, call 800-240-1968 order online www.PassTheASE.com**Motor Age A7 Heating & A/C Self-Study Guide**, call 800-240-1968 order online www.PassTheASE.com**NFPA 1917**, Standard for Automotive Ambulances, including annexes**NFPA 1911**, Standard for the Inspection, Maintenance, Testing and Retirement of In-Service Emergency VehiclesNational Fire Protection Association (800) 344-3555 or www.nfpa.org**Mobil Air Conditioning Society (MACS) Worldwide Certification Training Manual** can be downloaded for no charge at:http://www.macsw.org/web/MACS/Certification/Section_609_Certification.aspx?WebsiteKey=d89ff0bc-ce9d-41d9-a243-d885ad993b37&hkey=a4bf82fe-9db6-4507-8ddd-27fd9b9153f6&Technician_Panel=2#Technician_Panel**RedDot Heavy-Duty HVAC Service Manual** <https://www.btrac.com/documents/svc-manual-revision-i-feb-2011.pdf>**Haynes Automotive Heating & AC Chapter 1** <http://www.volkspage.net/technik/manuaisecatalogos/01/AutomotiveHeatingandAirConditioning.pdf>**OSHA Bloodborne Pathogens** - https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10051**OSHA Global Harmonized System of Classification and Labeling of Chemicals (GHS)** <https://www.osha.gov/dsg/hazcom/ghsguideoct05.pdf>**LEARNING OBJECTIVES FOR THE E-3 EXAM****1. Definitions or Terms**

- | | | |
|--|---------------------------------|-----------------------------------|
| a. Heat exchanger | i. FFOT-Ford Fixed Orifice Tube | r. British Thermal Unit (B.T.U.) |
| b. Evacuate | j. Evaporator | s. Latent heat |
| c. Conduction | k. Condenser | (1) Evaporation |
| d. Convection | l. Refrigerants | (2) Condensation |
| e. Radiation | m. Receiver-dryer | t. In-Line filter |
| f. Orifice tube | n. Accumulator-dryer | u. Diagnostic codes |
| g. CCOT-Cycling Clutch Orifice Tube | o. Desiccant bag | v. Compressor head pressure |
| h. FOTCC-Fixed Orifice Tube Cycling Clutch | p. Ambient temperature | w. Supplemental coolant additives |
| | q. Compressor | x. Law of heat transfer |
| | (1) types | |

2. Specification and Design

- | | | |
|---|--|---|
| a. Environmental systems | c. Auxiliary A/C condenser | h. Patient compartment insulation |
| (1) Controls | d. Sound level requirements | (1) rates and specifications |
| (2) Electrical wiring | (1) Interior Levels, 1917 Standard | i. Electronic/computer controlled systems |
| b. Heating and cooling criteria | e. Windshield defrosting | j. Compressor design types |
| (1) Sufficient capacity | f. Component installation & routing | k. Paint effect of temperature |
| (2) Temperature ranges | (1) Hoses and lines | l. Special Design Considerations (1917) |
| (a) out of service criteria | (2) Accessibility | m. Driver's compartment |
| (3) Performance test | (3) Securing hoses | (1) air box blend doors |
| (a) HVAC Settings during electrical load test | g. Ventilation requirements & criteria | n. Condenser |
| (4) Patient Compartment Requirements | (1) Ambient air exchange | (1) contaminated (cleaning) |
| (5) NFPA 1917 | | |

3. Heating and air conditioning theory

- | | | |
|---------------------------------|---|---------------------------------------|
| a. Heat & heat transfer | d. Pressure and temperature | e. Basic A/C theory of operation |
| (1) Movement/transfer of heat | (1) System performance | (1) Compressor controls |
| (2) Principles | (2) Function of compressor | (a) Variable displacement compressors |
| b. Matter | (3) Relationship between pressure and temperature | (2) Expansion device |
| (1) Compressibility | (4) Effect of air in refrigerant during recovery | a. Orifice tube |
| (2) Solid, liquids, and gases | (5) Effect of air in operation A/C system | b. TXV |
| (3) Physical states of matter | | (3) "Highside-Lowside" |
| c. Evaporation and Condensation | | f. Physical comfort |
| (1) B.T.U. | | g. Refrigerant control |
| (2) Desiccants | | |
| (a) When to replace | | |

4. Operation Systems Components and Controls-Describe or identify:

- | | | |
|--|---|--|
| a. Types of clutch cycling systems | f. Electronic temperature control systems | j. A/C Performance Testing Methods |
| (1) CCOT | (1) High idle controls | (1) Using a Manifold Gauge Set |
| (2) FCCOT-FFOT | g. Refrigerant filter systems | (2) Diagnosis by "Sight, Sound, Smell & Touch" |
| b. Expansion Device | (1) Filter dryer | k. New Refrigerant Types (R-1234YF) |
| (1) TXV | (2) In-line filters | l. Refrigerant oils |
| (2) Orifice tube | a. Service life length | (1) Type |
| c. A/C pressure cycling controls | b. Installatin location | (2) Quantity |
| (1) Low pressure cut off controls | (3) Accumulator | m. Windshield defrosting |
| (2) High pressure cut off controls | h. Compressor clutch | n. Refrigerant recovery |
| d. Rear HVAC system | i. Electric cooling fans | o. Out of Service Criteria |
| (1) Auxiliary condensers | | (1) HVAC |
| e. Patient compartment air distribution system | | (2) Engine Coolant System |
| (1) Purpose of blower motor function | | |

continued next page

5. Troubleshooting, Repair and Service

- a. Identify types and use of leak detectors
- b. Describe the use of gauges and test equipment used in troubleshooting A/C systems
 - (1) Compound gauge
- c. Reclaiming/recycling & recharging units
 - (1) Certification and specification
 - (2) Describe the use of reclaiming/recycling & recharging units
- d. Hoses, fittings, belts, and components
 - (1) Hose fitting and connections
 - (2) Identify visual checks of
 - (3) Refrigerant identifier
- e. Compressor & clutch
 - (1) Service valves/isolation valves
 - (2) Other necessary component replacement
 - (3) Identification
 - (4) repair & replacement
- f. Diagnosis/repair of expansion valve/orifice tube system
- g. Condenser & evaporator diagnosis and replacement
- h. Engine cooling/heater - defrosting systems
 - (1) Preventative maintenance
 - (a) Inspections per NFPA 1911
 - (2) diagnosis, repair and replacement of components
 - (3) ATC control system
 - (4) SATC control system
 - a. Locate N.T.C. sensor
 - (5) EATC control system
- i. Evacuation and recharging of A/C systems
 - (1) Temperature/pressure ranges
 - (2) Describe evacuation and recharging
 - (a) Time required
 - (b) Amounts of refrigerants
- j. Diagnosis and repair of A/C cooling performance problems
 - (1) Air duct temperature ranges
 - (2) Blocked orifice tube
 - (3) Ambient temperature switch
 - (4) TXV controlled system
 - (5) Passenger compartment
 - (6) Air flow duct filters
 - (7) Air flow doors
 - (8) Engine coolant assemblies
- k. Electrical system repair and troubleshooting
 - (1) Components and functions
 - (2) System limit controls
 - (3) Load manager/high idle control
 - (4) Reading electrical schematics
- l. Heating system troubleshooting and repair
 - (1) Control valves
 - (2) Performance
- m. Retrofit to R134A refrigerant systems
 - (1) Component replacement
 - (2) In-line filter
- n. Proper flushing of A/C systems
 - (1) Components
- o. Identify proper use of refrigerants
 - (1) contaminants
 - (2) OEM requirement
- p. Refrigerant oils
 - (1) 134a
 - (2) Checking and adding oil (compatibility)
 - (a) OEM requirements
 - (3) Desiccant material compatibility
- q. Engine coolant systems
 - (1) Types of coolant
 - (a) OEM requirements
 - (2) Frequency of change
 - (3) Altitude variations - pressurized systems
- r. Disable air bag system
- s. Refrigerant dye for leaks
- t. Out of Service Criteria
 - (1) HVAC
 - (2) Engine Coolant System

6. Safety and Environmental Concerns

- a. Refrigerant recovery and recycling
- b. Federal Clear Air Act
 - (1) Technician Certification requirements
 - (2) Equipment certification requirements
- c. Equipment and tool specifications
 - (1) Charging hoses, manifolds, and connections
 - (2) Refrigerant container
 - (3) Recovery & recharging machines
- d. Refrigerant compatibility
- e. Use & maintenance of recharging station
- f. Leak detector safety
 - (1) Flame leak detector
 - (2) Electronic leak detector
 - (a) Probe tip damage and safety
 - (b) Explosive atmosphere
 - (3) Best practices & equipment
 - (4) UV leak detectors
- g. Personal protective equipment
 - (1) Refrigerants
 - (2) Oils
- h. Refrigerant safety and handling
 - (1) Container capacity
 - (2) Container specifications
 - (3) Flamibility of R-134a
 - (a) relative to atmospheric pressure
 - (b) introduction of compressed air
 - (4) Container disposal
- i. Environmental awareness
 - (1) Refrigerants
 - (2) Coolants
 - (a) disposal
 - (3) Carbon monoxide levels and detector (NFPA 1917)
- j. Engine Cooling - Heater - Defroster Safety
 - (1) Radiator Cap
- k. Environment system filters
 - (1) Pathogens
- l. Patient compartment windows & doors
 - (1) Tinting
 - (2) Seals for carbon monoxide
- m. Safety Data Sheets
 - (1) Suppliers responsibility
 - (2) Users responsibility
- n. Medical waste in ambulances
 - (1) Shop procedures
- o. European refrigerant rules
- p. Automatic cooling fan
- q. R-1234YF
 - (1) Equipment & tools
 - (2) Flamibility