

**E-3 Ambulance Heating, Air Conditioning, and Ventilation**

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**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](http://www.PassTheASE.com)

**Motor Age A7 Heating & A/C Self-Study** Guide, call 800-240-1968 order online [www.PassTheASE.com](http://www.PassTheASE.com)

**Ambulance Performance Standards**, AMD 001009, NTEA, AMD Division, 37400 Hills Tech Dr., Farmington Hills, MI 48331-3414 248-489-7090. Available for no charge at <http://www.ntea.com/content.aspx?id=3620>

KKK-A-1822F **Federal Specification for the Star-of-Life Ambulance**, download for no charge at

<http://www.ntea.com/content.aspx?id=3620>

**Automotive Air-Conditioning and Climate Control Systems:** order online at [www.amazon.com](http://www.amazon.com) or [www.books.elsevier.com](http://www.books.elsevier.com)

**Mobil Air Conditioning Society (MACS) Worldwide** Certification Training Manual can be downloaded for no charge at:

[http://www.macsw.org/AM/Template.cfm?Section=Section\\_609&Template=/CM/ContentDisplay.cfm&ContentID=5397](http://www.macsw.org/AM/Template.cfm?Section=Section_609&Template=/CM/ContentDisplay.cfm&ContentID=5397)

**Mobil Air Conditioning Society (MACS) Worldwide** Recommended service procedures can be download fo no charge at:

[http://www.macsw.org/AM/Template.cfm?Section=Service\\_Practices&Template=/CM/ContentDisplay.cfm&ContentID=1427](http://www.macsw.org/AM/Template.cfm?Section=Service_Practices&Template=/CM/ContentDisplay.cfm&ContentID=1427)

**LEARNING OBJECTIVES FOR THE E-3 EXAM****1. Definitions or Terms**

- |  |                                  |                                    |
|--|----------------------------------|------------------------------------|
| a. Heat exchanger                          | k. Condenser                     | u. Expansion valves & tubes        |
| b. Evacuate                                | l. Refrigerant                   | v. TXV valves                      |
| c. Conduction                              | m. Receiver-dryer                | w. VIR valves                      |
| d. Convection                              | n. Accumulator-dryer             | x. In-Line filter                  |
| e. Radiation                               | o. Desiccant bag                 | y. Diagnostic codes                |
| f. Orifice tube                            | p. Ambient temperature           | z. Compressor head pressure        |
| g. CCOT-Cycling Clutch Orifice Tube        | q. Compressor                    | aa. Supplemental coolant additives |
| h. FOTCC-Fixed Orifice Tube Cycling Clutch | (1) types                        | bb. A/C control sensors & switches |
| i. FFOT-Ford Fixed Orifice Tube            | r. British Thermal Unit (B.T.U.) | (1) Thermal limiter                |
| j. Evaporator                              | s. Material types                | (2) superheat switch               |
|  | t. Latent heat                   |                                    |

**2. Specification and Design--As stated in KKK-A-1822**

- |                                      |                                     |   |
|--------------------------------------|-------------------------------------|---|
| a. Environmental systems             | d. Sound level requirements         | g. Ventilation requirements & criteria    |
| (1) Controls                         | (1) AMD standard                    | (1) Air exchange rate                     |
| (2) Electrical wiring                | (2) Interior Levels, KKK Standard   | h. Patient compartment insulation         |
| b. Heating and cooling criteria      | e. Windshield defrosting            | (1) rates and specifications              |
| (1) Sufficient capacity              | f. Component installation & routing | i. Electronic/computer controlled systems |
| (2) Temperature ranges               | (1) Hoses and lines                 | j. Compressor design types                |
| (3) Performance test                 | (2) Accessibility                   | k. Paint effect of temperature            |
| (4) Patient Compartment Requirements | (3) Securing hoses                  | l. Environmental control storage cabinet  |
| a. Flow & Make-up air                |                                     | (1) types                                 |
| b. Drafts                            |                                     |   |
| c. Auxiliary A/C condenser           |                                     |   |

**3. Heating and air conditioning theory**

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

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

- |  |                               |
|--|-------------------------------|
| a. Types of clutch cycling systems             | (1) High idle controls        |
| (1) CCOT                                       | g. Refrigerant filter systems |
| (2) FCCOT-FFOT                                 | (1) Filter dryer              |
| b. TXV thermostatic controls                   | (2) In-line filters           |
| c. A/C pressure cycling controls               | a. Service life length        |
| (1) Low pressure cut off controls              | b. Installatin location       |
| d. Rear HVAC(heating, ventilation, A/C) system | h. Compressor clutch          |
| (1) Auxiliary condensers                       |                               |
| (2) Rear unit hot water controls (heating)     |                               |
| e. Patient compartment air distribution system |                               |
| (1) Purpose of blower motor function           |                               |
| f. Electronic temperature control systems      |                               |

continued next page

## 5. Trouble Shooting, 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
- 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
  - (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
- j. Diagnosis and repair of A/C cooling performance problems
  - (1) Air duct temperature ranges
  - (2) Blocked orifice tube
  - (3) Ambient temperature switch
  - (4) TXN controlled system
  - (5) Passenger compartment
  - (6) Air flow duct filters
- 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 & R-12
  - (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

## 6. Safety and Environmental Concerns

- a. Refrigerant recovery and recycling
- b. Federal Clean Air Act
  - (1) Technician Certification requirements
  - (2) Equipment certification requirements
- c. Equipment and tool specifications
  - (1) Charging hoses, manifolds, and connections
  - (2) Refrigerant container
- d. Refrigerant compatibility
  - (1) Retrofitting
- 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) Flammability 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 (AMD standard)
  - (4) Material safety data sheet
  - (5) Bio hazards & sharps container
  - (6) Performance tests
- 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. Material safety data sheets
  - (1) Suppliers responsibility
  - (2) Users responsibility
- n. Medical waste in ambulances
  - (1) Shop procedures
- o. European refrigerant rules