

Reference Materials: Note: This exam may contain some "accepted practice" type questions not found in the reference material listed below.

Mobil Air Conditioning Society (MACS) Worldwide: <https://macsmobileairclimate.org/training-materials/>

Modern Automotive HVAC Systems: <https://www.macsw.org/ItemDetail?iProductCode=4428-0>

Modern Automotive HVAC: Electrical & Electronic Systems: <https://www.macsw.org/ItemDetail?iProductCode=4429-0>

OSHA Publications:

#3514 *Hazard Communication Standard: Safety Data Sheets - OSHA Brief*

<https://www.osha.gov/sites/default/files/publications/OSHA3514.pdf>

#3186 *Model Plans and Programs for the OSHA Bloodborne Pathogens and Hazard Communications Standard.*

<https://www.osha.gov/sites/default/files/publications/osha3186.pdf>

#3370 *Best Practices for Protecting EMS Responders*

<https://www.osha.gov/sites/default/files/publications/OSHA3370-protecting-EMS-respondersSM.pdf>

NFPA 1900: Standard for Aircraft Rescue and Firefighting Vehicles, Automotive Fire Apparatus, Wildland Fire Apparatus, and Automotive Ambulances (**NFPA 1917 Chapters**) 2024 edition (800) 344-3555 or www.nfpa.org

NFPA 1910: Standard for the Inspection, Maintenance, Refurbishment, Testing and Retirement of In-Service Emergency Vehicles and Marine Firefighting Vessels (**NFPA 1911 Chapters**) 2024 edition (800) 344-3555 or www.nfpa.org

LEARNING OBJECTIVES

1. Definitions or Terms

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

2. Specification and Design

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|--|--|---|
| 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 | | o. Electrical Systems |
| | | (1) Loads |
| | | (2) Testing |
| | | (3) Wiring Types |

3. Heating and air conditioning theory

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|---------------------------------|--|--|
| 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:

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

Continued on 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 unit identifiers
 - (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
- u. Condenser fan
- v. Service ports

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
 - (b) skin & eye irritant
 - (c) harmful to animals
 - (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
 - (3) Globally Harmonized System of Classification and Labeling of Chemicals (GHS)
- n. Medical waste in ambulances
 - (1) Shop procedures
- o. European refrigerant rules
- p. Automatic cooling fan
- q. R-1234YF
 - (1) Equipment & tools
 - (2) Flamibility