

Fundamentals of Air Conditioning and Repair

Crosswalk to HVAC Excellence Competencies

The following HVAC Excellence competencies (rev. 2007) are covered in this publication. Only the covered competencies are listed. The first column identifies the competency by name and number. The second column identifies the exact location in this MAVCC publication where that competency is covered.

HVAC Excellence Competencies	MAVCC Objectives and Tasks
Air Conditioning	
Fundamentals and Theory	
Describe the laws of Thermodynamics.	Unit 13, Objective 3—How laws of thermodynamics work in a refrigeration cycle
Explain condensation of a vapor, and its effect on heat.	Unit 13, Objective 3—How laws of thermodynamics work in a refrigeration cycle
Explain vaporization of a liquid, and its effect on heat.	Unit 13, Objective 3—How laws of thermodynamics work in a refrigeration cycle
Describe the three states of matter.	Unit 13—Basic Mechanical Refrigeration
Describe change of state.	Unit 13, Objective 3—How laws of thermodynamics work in a refrigeration cycle
Differentiate between absolute and gauge pressure.	Unit 16—Refrigerants
Define vacuum as it is used in the HVACR industry and describe how it is measured.	Unit 18, Objective 11—Pressure/temperature requirements for dehydration
Describe and define the following; BTU, latent heat, sensible heat, subcooled liquid, superheated vapor, dry bulb temperature, wet bulb, temperature, and dew point.	Located throughout the book
Refrigerants and Refrigerant Oils	
Describe the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters.	Unit 16, Objective 14—Characteristics and applications of ACR lubricants Unit 16, Objective 15—Guidelines for adding or changing lubricant Unit 16, Objective 16—Guidelines for working with synthetic oils
Describe the thermodynamics of refrigerants.	Unit 16, Objective 8—Characteristics of blended refrigerants Unit 16, Objective 9—Bubble point and dew point and what they mean
Identify and define; CFCs, HCFCs, and HFCs.	Unit 16, Objective 2—Types of refrigerants, their composition and identification

National Skills Crosswalk

HVAC Excellence Competencies	MAVCC Objectives and Tasks
Identify and define the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic	Unit 16, Objective 2—Types of refrigerants, their composition and identification Unit 16, Objective 3—Refrigerant identification colors and numbers Unit 16, Objective 4—Problems and challenges for an industry in transition Unit 16, Objective 5—The EPA SNAP program and its objectives Unit 16, Objective 6—Original refrigerants, their applications and possible alternatives Unit 16, Objective 7—“Drop-in” and “retrofit” refrigerants Unit 16, Objective 8—Characteristics of blended refrigerants Unit 16, Objective 9—Bubble point and dew point and what they mean Unit 16, Objective 10—Gauges, charts, and pressure/temperature relationships Unit 16, Objective 11—Why pressure/temperature readings and relationships are important Unit 16, Objective 12—Charging a system with a blend Unit 16, Objective 13—How to avoid potential problems with refrigerants
Describe fractionation and its potential causes.	Unit 16, Objective 8—Characteristics of blended refrigerants
Describe temperature glide.	Unit 16, Objective 8—Characteristics of blended refrigerants
System Components	
Describe and explain the function of the following components: evaporator accumulator suction line suction line filter compressor (reciprocating, scroll, rotary, screw, centrifugal)	Unit 13, Objective 2—Major refrigeration components and their functions Unit 13, Objective 11—Types of evaporators and their characteristics Unit 14, Objective 2—Refrigeration system accessories and their locations Unit 14, Objective 3—Suction line accumulators and their functions Unit 13, Objective 2—Major refrigeration components and their functions Unit 14, Objective 3—Suction line accumulators and their functions Unit 13, Objective 2—Major refrigeration components and their functions Unit 13, Objective 4—Compressor construction types and their applications

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<p>discharge line</p> <p>condenser</p> <p>liquid line</p> <p>receiver</p> <p>liquid line filter/drier</p> <p>sight glass</p> <p>head pressure controls</p> <p>low pressure controls</p> <p>metering device (capillary tube, thermostatic expansion valve, automatic expansion valve).</p>	<p>Unit 13, Objective 5—Reciprocating compressors and their applications</p> <p>Unit 13, Objective 6—Rotary compressors and their applications</p> <p>Unit 13, Objective 7—Scroll compressors and their applications</p> <p>Unit 13, Objective 8—Other compressor types and their applications</p> <p>Unit 13, Objective 2—Major refrigeration components and their functions</p> <p>Unit 13, Objective 2—Major refrigeration components and their functions</p> <p>Unit 13, Objective 10—Types of condensers and their characteristics</p> <p>Unit 13, Objective 2—Major refrigeration components and their functions</p> <p>Unit 14, Objective 2—Refrigeration system accessories and their locations</p> <p>Unit 14, Objective 4—Liquid receivers and their functions</p> <p>Unit 14, Objective 7—Filter-driers and their applications</p> <p>Unit 14, Objective 8—Monitoring moisture and liquid refrigerant in a system</p> <p>Unit 14, Objective 13—Pressure controls and their applications</p> <p>Unit 14, Objective 13—Pressure controls and their applications</p> <p>Unit 13, Objective 9—Types of metering devices and their applications</p>
<p>Describe the state of refrigerant, in each major component during normal operation.</p>	<p>Unit 13, Objective 2—Major refrigerant components and their functions</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p>
Recovery/Recycling/Reclamation	
<p>Define recover</p>	<p>Unit 17, Objective 2—Basic recovery processes</p> <p>Unit 17, Objective 3—Basic recovery devices</p> <p>Unit 17, Objective 4—EPA required evacuation practices during recovery</p> <p>Unit 17, Objective 5—Guidelines for effective recovery</p>

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HVAC Excellence Competencies	MAVCC Objectives and Tasks
	Unit 17, Objective 6—Improperly mixed refrigerants and how to avoid them Unit 17, Objective 7—Recovery system characteristics and applications Unit 17, Objective 10—Recovery/recycling system characteristics and applications Unit 17, Objective 11—Recovery and recycling safety
Define recycle Define reclaim	Unit 17, Objective 9—Recycling equipment and processes Unit 17, Objective 10—Recovery/recycling system characteristics and applications Unit 17, Objective 11—Recovery and recycling safety Unit 17, Objective 12—The reclaiming process
Leak Detection/Testing	
Describe the six types of leak detectors	Unit 18, Objective 6—Leak testing with soap solution Unit 18, Objective 7—Leak testing with a halide torch Unit 18, Objective 8—Leak testing with refrigerant additives Unit 18, Objective 9—Leak testing with electronic leak detectors Unit 18, Job Sheet 17—Leak test a refrigeration system with an electronic leak detector
Explain the method of pinpointing a leak.	Unit 18, Objective 6—Leak testing with soap solution Unit 18, Objective 7—Leak testing with a halide torch Unit 18, Objective 8—Leak testing with refrigerant additives Unit 18, Objective 9—Leak testing with electronic leak detectors
Explain the proper use of each type of leak detector and their applicability.	Unit 18, Objective 6—Leak testing with soap solution Unit 18, Objective 7—Leak testing with a halide torch Unit 18, Objective 8—Leak testing with refrigerant additives Unit 18, Objective 9—Leak testing with electronic leak detectors
Explain the proper use and handling of nitrogen in the leak detection process.	Unit 18, Objective 5—Guidelines for pressurizing a system

HVAC Excellence Competencies	MAVCC Objectives and Tasks
Describe proper soldering and brazing techniques.	Units 9-12 throughout
Evacuation and Charging	
Describe the operation and use of a gauge manifold assembly.	Unit 16, Objective 18—The manifold gauge and its applications Unit 16, Job Sheet 1—Attach a manifold gauge set to service ports Unit 18, Objective 5—Guidelines for pressurizing a system
Identify the proper method of charging a blended refrigerant into an operating system.	Unit 16, Objective 12—Charging a system with a blend
Identify the proper method of charging a blended refrigerant into an empty system.	Unit 16, Objective 12—Charging a system with a blend
Identify the proper method of charging a compound refrigerant into an empty system.	Unit 18, Objective 16—Guidelines for charging a system Unit 18, Objective 17—Charging with a portable charging cylinder Unit 18, Objective 18—Charging with scales Unit 18, Objective 19—Using a sight glass for charging Unit 18, Objective 20—Charging with a superheat charging chart Unit 18, Objective 21—Special considerations for liquid and vapor charging
Identify the proper method of charging a compound refrigerant into an operating system.	Unit 18, Objective 16—Guidelines for charging a system Unit 18, Objective 17—Charging with a portable charging cylinder Unit 18, Objective 18—Charging with scales Unit 18, Objective 19—Using a sight glass for charging Unit 18, Objective 20—Charging with a superheat charging chart Unit 18, Objective 21—Special considerations for liquid and vapor charging
Describe charging using the superheat method.	Unit 18, Objective 16—Guidelines for charging a system Unit 18, Objective 20—Charging with a superheat charging chart
Describe charging using the subcooling method.	Unit 18, Objective 16—Guidelines for charging a system
Explain vacuum pump selection.	Unit 18, Objective 12—Use and care of vacuum pumps

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Describe the triple evacuation method.	Unit 18, Objective 10—Why refrigerate systems require evacuation Unit 18, Objective 11—Pressure/temperature requirements for dehydration Unit 18, Objective 12—Use and care of vacuum pumps Unit 18, Objective 13—Use and care of vacuum measuring equipment Unit 18, Objective 14—Using/reading a micron gauge Unit 18, Objective 15—Guidelines for evacuation Unit 18, Job Sheet 12—Triple evacuate a refrigeration system
Identify the types of micron gauges.	Unit 18, Objective 14—Using/reading a micron gauge
Explain the proper method of connecting a micron gauge to the system.	Unit 18, Objective 14—Using/reading a micron gauge
Air Conditioning Troubleshooting and Problem Solving	Located throughout this publication
Knowledge of the following test instruments and or tools is required to pass this test.	
Thermometers (wet and dry) Gauge manifold assembly Recovery equipment Vacuum pump Micron gauge Leak detector Nitrogen Cylinder Soldering and brazing equipment Charging scale and Charging cylinder Refrigerant throttling valve	Located through this publication

Crosswalk to PAHRA/NATE Competencies and Tasks

The following PAHRA/NATE competencies and tasks are covered in this publication. Only the covered competencies tasks are listed. The first column identifies the competency or task by name and number. The second column identifies the exact location in this MAVCC publication where that competency or task is covered.

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
I. Introduction	
Subtopic I.A. Introduction to Refrigeration	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain the history of air-conditioning and refrigeration 2. Define air-conditioning and refrigeration. 3. Explain the differences between air-conditioning and refrigeration. 4. Determine career opportunities in the HVACR industry. <ol style="list-style-type: none"> 5. Describe the role of Trade Association 	<p>Unit 1, Objective 2—Brief history of heating, ventilation, air conditioning and refrigeration (HVACR)</p> <p>Unit 1, Objective 3—HVACR industry areas</p> <p>Unit 1, Objective 3—HVACR industry areas</p> <p>Unit 1, Objective 5—ACR manufacturing jobs and their training requirements</p> <p>Unit 1, Objective 6—ACR wholesaling jobs and their training requirements</p> <p>Unit 1, Objective 7—HVACR retailing jobs and their training requirements</p> <p>Unit 1, Objective 8—HVACR building maintenance jobs and their training requirements</p> <p>Unit 1, Objective 11—Future opportunities for HVACR employment</p> <p>Unit 1, Focus Assignment—Access the Internet to find job descriptions</p> <p>Unit 1, Assignment Sheet 2—Find facts on skill and education levels required in HVACR</p> <p>Unit 1, Objective 9—Licensing and certification requirements for ACR employment</p>
Subtopic I.B. Introduction to Air Conditioning	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Understand the historical development of air-conditioning 2. Define “air-conditioning” and relate to human comfort conditions. 3. Discuss differences between air-conditioning and heating 4. Discuss the various systems of air-conditioning: <ol style="list-style-type: none"> a. mechanical compression cycle b. evaporative cooling c. desiccant dehumidification d. absorption cycle 	<p>Unit 1, Objective 2—Brief history of heating, ventilation, air conditioning and refrigeration (HVACR)</p> <p>Unit 1, Objective 3—HVACR industry areas</p> <p>Unit 1, Objective 3—HVACR industry areas</p> <p>Unit 13—Basic Mechanical Refrigeration</p> <p>Unit 16—Refrigerants</p>

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PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
II. Principles of Thermodynamics and Heat Transfer	
Subtopic II.A. Matter and Heat Behavior	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain the direction and rate of heat flow. 2. Describe the three methods of heat transfer. 3. Explain the difference between heat and temperature 4. Explain the difference between latent and sensible heat. 5. Explain the change of state of matter. 6. Define sensible heat. 7. Define latent heat of fusion. 8. Define latent heat of vaporization. 9. Define saturation temperature (dew point temperature) 10. Define water vapor pressure. 11. Explain the direction and rate of moisture transfer 	<p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Located throughout the publication</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p>
Subtopic II.B. Fluids and Pressures	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain the relationship of pressures and fluids at saturation temperatures. 2. Identify the relationship between temperatures and pressure using the P/T charts. 3. Define pressure 4. Explain atmospheric pressure 5. Explain compound gauges. 	<p>Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 16, Student Supplement 1—Pressure Temperature Chart</p> <p>Unit 16—Refrigerants</p> <p>Unit 16—Refrigerants</p> <p>Unit 16, Objective 8—Characteristics of blended refrigerants</p>

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>6. Explain absolute pressure 7. Explain gauge pressure. 8. Explain micron.</p> <p>Tasks:</p> <p>1. Relate temperature and pressure using the P/T chart.</p> <p>2. Measure a vacuum using a micron gauge.</p>	<p>Unit 16—Refrigerants Unit 16—Refrigerants Unit 18, Objective 14—Using/reading a micron gauge</p> <p>Unit 16, Objective 11—Why pressure/temperature readings and relationships are important Unit 16, Assignment Sheet 1—Compute pressure/temperature relationships Unit 18, Job Sheet 5—Evaluate a refrigeration system and verify with a micron gauge</p>
Subtopic II.C. Refrigeration Cycle/Diagrams	
<p>Knowledge:</p> <p>1. Identify the four major components of the vapor compression refrigeration system. 2. Describe the state and conditions of the of the refrigerant during a cycle 3. Explain the effects of: a. superheating the suction gases b. increasing the condensing pressure c. subcooling the liquid 4. Explain the importance of superheat and subcooling. 5. Define refrigeration. 6. Explain the functions of the four major components of a refrigeration system: a. compressor b. condenser c. metering device d. evaporator 7. List the components which separate the high side from the low side of the system.</p>	<p>Unit 13, Objective 2—Major refrigeration components and their functions Unit 13, Objective 3—How laws of thermodynamics and gases work in a refrigeration cycle</p> <p>Unit 13, Job Sheet 2—Observe refrigeration trainer or system and explain superheat and subcooling Unit 13, Job Sheet 2—Observe refrigeration trainer or system and explain superheat and subcooling Unit 13, Job Sheet 2—Observe refrigeration trainer or system and explain superheat and subcooling Unit 13, Job Sheet 2—Observe refrigeration trainer or system and explain superheat and subcooling Unit 1, Objective 3—HVACR industry areas Unit 13, Objective 2—Major refrigeration components and their functions</p> <p>Unit 13, Assignment Sheet 1—Identify components of a basic mechanical refrigeration system and identify conditions in different parts of the system Unit 14, Assignment Sheet 1—Identify components of a mechanical refrigeration system with accessories and identify conditions in different parts of the system</p>

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PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>Tasks:</p> <ol style="list-style-type: none"> 1. Draw a simple refrigerant cycle diagram and label each of the basic components as well as the refrigerant lines. Place arrows on the diagram to show the direction of the refrigerant flow. 	<p>Unit 13, Objective 2—Major refrigerant components and their functions Unit 13, Assignment Sheet 1—Identify components of a basic mechanical refrigeration system and identify conditions in different parts of the system</p>
Subtopic II.D. Measurement Systems	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Identify U.S. and S.I. units. <p>Tasks:</p> <ol style="list-style-type: none"> 1. Convert from U.S. to metric units. 	<p>Unit 5, Objective 4—U.S. conventional units of linear measurement Unit 5, Objective 5—SI Metric units of measurement and associated prefixes</p> <p>Unit 5, Assignment Sheet 18—Use the English metric conversion chart</p>

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
III. Safety	
Subtopic III.A. Personal Safety and Work Practices	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain clothing and safety equipment. 2. Review OSHA standards. <p>Tasks:</p> <ol style="list-style-type: none"> 1. Wear appropriate clothing. 2. Use safety equipment (e.g., footwear, hearing protection, hardhat, goggles, gloves). 3. Demonstrate good housekeeping practices in the lab. 4. Demonstrate proper ladder safety: <ol style="list-style-type: none"> a. wooden b. aluminum c. fiberglass d. scaffolding 5. Demonstrate proper lifting procedures. 6. Use appropriate fire extinguishers. 7. Conduct routine safety inspections. 	<p>Unit 2, Objective 2—Dress safety on the job Unit 2, Objective 6—Facts about OSHA’s role in workplace health and safety Unit 2, Objective 12—What you should know about OSHA’s Hazard Communication Standard Unit 2, Objective 15—What you should know about OSHA’s Bloodborne Pathogen Standard Unit 2, Objective 16—Other items related to the Bloodborne Pathogen Standard</p> <p>Located throughout the publication. Located throughout the publication.</p> <p>Located throughout the publication.</p> <p>Unit 2, Objective 25—Rules for using ladders safely Unit 2, Objective 26—Safety guidelines for using scaffolds Unit 2, Objective 27—Safety guidelines for using power lifts Unit 2, Job Sheet 3—Place and climb a ladder safely</p> <p>Unit 2, Objective 22—Contributing factors and causes of back injuries Unit 2, Objective 23—Guidelines for lifting and moving items safely Unit 2, Job Sheet 2—Lift a heavy object properly</p> <p>Unit 2, Objective 20—Types of fires and their classifications Unit 2, Objective 21—General types of fire extinguishers and their uses Unit 2, Student Supplement 2—Using portable fire extinguishers Unit 2, Assignment Sheet 3—State portable fire extinguisher types, symbols, and operating instructions Unit 2, Job Sheet 1—Operate a fire extinguisher Unit 2, Assignment Sheet 4—Identify and correct safety violations</p>

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PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
Subtopic III.B. Handling of Pressurized Fluids	
<p>Knowledge:</p> <ol style="list-style-type: none"> List safety requirements. Explain application of pressure relief devices. Explain proper storage and handling of refrigerants. Explain effect of temperature and hydraulic expansion. Explain proper storage and handling of oxygen, nitrogen, and acetylene bottles. Explain the effects of mixing oxygen and oil. Follow procedures specified on the Material Safety Data Sheet (MSDS). Store and dispose of hazardous material according to EPA specifications. Explain ASHRAE Refrigerant Safety Classification of Refrigerants for Toxicity and Flammability <p>Tasks:</p> <ol style="list-style-type: none"> Properly fill and label a refrigerant cylinder. Determine if a refrigerant cylinder needs retesting. 	<p>Units 16 and 17—Located throughout Unit 16, Objective 14—Characteristics and applications of ACR lubricants Unit 17, Objective 14—Guidelines for using refillable refrigerant cylinders Unit 17, Objective 14—Guidelines for using refillable refrigerant cylinders Unit 9—Soldering and brazing equipment</p> <p>Unit 16, Objective 16—Guidelines for working with synthetic oils Unit 2, Student Supplement 1—Guidelines for interpreting Material Safety Data Sheets Unit 2, Objective 13—Storage of hazardous materials Unit 18, Objective 2—Preparing a refrigeration system for operation</p> <p>Unit 17, Job Sheet 1—Use scales and a calculator to determine how much refrigerant can be added to a refillable refrigerant cylinder Unit 18, Job Sheet 6—Fill a charging cylinder Unit 17, Objective 14—Guidelines for using refillable refrigerant cylinders</p>
Subtopic III.C. Handling Hazardous Substances	
<p>Knowledge:</p> <ol style="list-style-type: none"> Explain use of Material Safety Data Sheets (MSDS). Define differences between hazardous materials, substances, and wastes. <p>Tasks:</p> <ol style="list-style-type: none"> Locate MSDS and identify particular effect. Demonstrate use of proper clothing and equipment. Demonstrate basic first aid procedure. 	<p>Unit 2, Student Supplement 1—Guidelines for interpreting Material Safety Data Sheets Unit 2, Assignment Sheet 2—Interpret a Material Safety Data Sheet Unit 2, Objective 13—Storage of hazardous materials Unit 2, Assignment Sheet 2—Interpret a Material Safety Data Sheet</p> <p>Unit 2, Focus Assignment—Locate Material Safety Data Sheets Unit 2, Assignment Sheet 2—Interpret a Material Safety Data Sheet Located throughout the publication</p> <p>Unit 2, Student Supplement 3—Descriptions of basic first aid procedures for various situations</p>

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Subtopic III.D. Electrical Safety	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain the use of power tools and accessories. 2. Discuss work habits. 3. Explain environmental safety practices. 4. Explain proper procedures when working with hands-on live equipment. 	<p>Unit 2, Objective 4—Guidelines for general electrical safety Unit 2, Objective 5—Safety guidelines for using electrical tools Unit 4, Objective 1—Guidelines for working with drills and power screwdrivers Unit 4, Objective 2—Caring for drilling tools Unit 4, Objective 2—Caring for drilling tools Unit 4—Located throughout</p>
IV. Tools and Equipment	
Subtopic IV.A. Hand Tools and Accessories	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Identify basic tools: 2. Identify power tools: 	<p>Unit 3—Hand Tools Unit 4—Special Tools</p>

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PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>3. Identify pipe and tubing tools:</p> <ul style="list-style-type: none"> a. benders b. flaring tools c. pipe cutters, reamers, and threaders d. pipe vises e. swaging tools f. tubing cutters and reamers <p>Tasks:</p> <ul style="list-style-type: none"> 1. Show the proper use of a pipe cutter. 2. Show the proper use of a threader. 3. Demonstrate how to make a flaring tubing joint. 	<p>Unit 8, Objective 16—Guidelines for bending tubing Unit 8, Objective 14—Guidelines for flaring tubing Unit 8, Objective 13—Guidelines for cutting and reaming tubing Unit 4, Objective 3—Use and care of grinders, vises, and presses Unit 3, Objective 9—Tubing tools and their uses Unit 3, Objective 9—Tubing tools and their uses</p> <p>Unit 7, Objective 12—Tools for cutting and threading iron pipe Unit 7, Job Sheet 1—Cut and ream PVC pipe and join it to a fitting Unit 7, Job Sheet 2—Cut, ream, and thread iron pipe</p> <p>Unit 7, Objective 12—Tools for cutting and threading iron pipe Unit 7, Objective 13—The pipe threading chart Unit 7, Job Sheet 2—Cut, ream, and thread iron pipe</p> <p>Unit 8, Job Sheet 1—Make a single flare with a compression-type flaring block Unit 8, Job Sheet 2—Make a single flare with a Rol-Air®-type flaring block</p>
<p>Subtopic IV.B. Refrigeration: Servicing and Testing Equipment</p>	
<p>Tasks:</p> <ul style="list-style-type: none"> 1. Measure pressures with the refrigeration gauge manifold. 2. Evacuate systems with a two-stage vacuum pump. 	<p>Unit 16, Job Sheet 1—Attach a manifold gauge set to service ports Unit 16, Job Sheet 2—Pressure check a refrigeration system Unit 16, Job Sheet 3—Pressure check an air conditioner Unit 16, Job Sheet 4—Pressure check a commercial refrigeration system Unit 17, Job Sheet 2—Use a hand-operated pump to recover refrigerant from a small AC or refrigeration system Unit 17, Job Sheet 3—Use a recovery machine to recover refrigerant from an AC or refrigerant system Unit 17, Job Sheet 4—Use a recovery/recycling machine to recover/recycle refrigerant from an AC or refrigeration system</p>

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>3. Measure temperatures with electronic thermometers.</p> <p>4. Measure temperatures with bimetal, thermocouple or glass stem thermometer.</p> <p>5. Charge a system with a charging cylinder.</p> <p>6. Charge a system with an electronic charging scale.</p> <p>7. Check for leaks with electronic leak detector and halide torch.</p> <p>8. Use nitrogen with trace of R-22 for leak detection.</p> <p>9. Compare readings to manufacturers' specifications.</p> <p>10. Determine refrigerant amount and type.</p> <p>11. Charge a system to manufacturers' specifications.</p>	<p>Unit 18, Job Sheet 4—Leak check with a halide torch</p> <p>Unit 16, Job Sheet 2—Pressure check a refrigeration system</p> <p>Unit 16, Job Sheet 3—Pressure check an air conditioner</p> <p>Unit 16, Job Sheet 4—Pressure check a commercial refrigeration system</p> <p>Unit 16, Job Sheet 2—Pressure check a refrigeration system</p> <p>Unit 16, Job Sheet 3—Pressure check an air conditioner</p> <p>Unit 16, Job Sheet 4—Pressure check a commercial refrigeration system</p> <p>Unit 18, Job Sheet 7—Vapor charge a refrigeration system from a charging cylinder</p> <p>Unit 18, Job Sheet 13—Liquid charge a refrigeration system from refrigerant cylinder</p> <p>Unit 18, Job Sheet 18—Liquid charge using a charging cylinder</p> <p>Unit 18, Job Sheet 19—Vapor charge a refrigeration system from a refrigerant cylinder</p> <p>Unit 17, Job Sheet 1—Use scales and a calculator to determine how much refrigerant can be added to a refillable refrigerant cylinder</p> <p>Unit 18, Job Sheet 4—Leak check with a halide torch</p> <p>Unit 18, Objective 8—Leak testing with refrigerant additives.</p> <p>Unit 18, Job Sheet 11—Pressurize a refrigeration system with dry nitrogen and leak test</p> <p>Units 16 and 18—Located throughout</p> <p>Unit 16, Objective 13—How to avoid potential problems with refrigerants</p> <p>Unit 18, Job Sheet 7—Vapor charge a refrigeration system from a charging cylinder</p> <p>Unit 18, Job Sheet 13—Liquid charge a refrigeration system from refrigerant cylinder</p> <p>Unit 18, Job Sheet 18—Liquid charge using a charging cylinder</p> <p>Unit 18, Job Sheet 19—Vapor charge a refrigeration system from a refrigerant cylinder</p>

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PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
V. Piping and Piping Practices	
Subtopic V.A. Piping Material and Fabrication	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Identify types of pipe and tubing used in refrigeration work. 2. Identify various types of fittings. 3. Identify soldering and brazing alloys used in HVACR. 4. Explain applications of soldering and and brazing alloys. 5. Describe heat sink methods. 6. Describe heat exchange techniques. 7. Describe the applications and installation of vibration eliminators. 8. Identify types of torches. 	<p>Unit 7, Objective 2—Black iron pipe in HVAC applications Unit 7, Objective 3—Galvanized pipe in HVAC applications Unit 7, Objective 4—Polybutylene and polyethylene in HVAC applications Unit 8, Objective 2—Kinds of tubing and their applications Unit 8, Objective 3—Advantages of copper tubing in ACR applications Unit 8, Objective 4—Characteristics of Type K copper tubing and its applications Unit 8, Objective 5—Characteristics of Type L copper tubing and its applications Unit 8, Objective 6—Characteristics of Type M copper tubing and its applications Unit 7, Objective 5—Guidelines for using iron pipe fittings Unit 8, Assignment Sheet 1 — Identify selected fittings for copper tubing Unit 10, Objective 3—General characteristics of solder Unit 11, Objective 3—Basic silver brazing alloys Unit 11, Objective 4—Special silver brazing alloys and their characteristics Unit 10, Objective 7—Ways to control heat while soldering Unit 10, Objective 7—Ways to control heat while soldering Unit 14, Objective 2—Refrigeration system accessories and their locations Unit 14, Objective 6—Noise and vibration control with large compressors Unit 9, Objective 3—Characteristics and components of an air-acetylene torch Unit 9, Objective 4—Modern torch tip design for soldering and brazing Unit 9, Objective 5—Self-lighting torch designs for soldering and brazing</p>

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>Tasks:</p> <ol style="list-style-type: none"> 1. Flare copper tubing. 2. Swage copper tubing. 3. Bend copper tubing. 4. Solder and braze copper tubing. 5. Cut and thread steel/iron pipe. 6. Solder aluminum tubing. 	<p>Unit 8, Objective 14—Guidelines for flaring tubing Unit 8, Job Sheet 1—Make a single flare with a compression-type flaring block Unit 8, Job Sheet 2—Make a single flare with a Rol-Air®-type flaring block Unit 8, Objective 15—Guidelines for swaging tubing Unit 8, Job Sheet 3—Make a swage joint in copper tubing Unit 8, Objective 16—Guidelines for bending tubing Unit 8, Job Sheet 4—Make a 90° bend in copper tubing Unit 8, Job Sheet 5—Make a 180° bend in copper tubing Unit 8, Job Sheet 6—Make a 45° offset bend in copper tubing Unit 10, Job Sheet 1—Use an air-fuel torch to soft solder copper tubing/swage joints in upright, horizontal, and inverted positions Unit 10, Job Sheet 2—Use an air-fuel torch with a swirl top to solder copper tubing/swage joints in upright, horizontal, and inverted positions Unit 10, Job Sheet 3—Use an oxyfuel torch to solder copper tubing/swage joints in upright, horizontal, and inverted positions Unit 11, Job Sheet 1—Silver braze upright, inverted, and horizontal swage joints Unit 11, Job Sheet 2—Silver braze a copper-to-steel joint Unit 11, Job Sheet 3—Assemble a copper tubing project Unit 7, Job Sheet 2—Cut, ream, and thread iron pipe Unit 12, Job Sheet 1—Soft solder an aluminum tubing/swage joint with an air-fuel torch Unit 12, Job Sheet 2—Repair a hole in aluminum tubing with brazing and an air-fuel torch Unit 12, Job Sheet 3—Repair a hole in aluminum tubing with paste epoxy Unit 12, Job Sheet 4—Repair a pin-hole leak in aluminum tubing with a pre-mixed, two-part epoxy stick Unit 12, Job Sheet 5—Solder aluminum tubing to copper tubing</p>

Crosswalk

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
Subtopic V.C. Sheetmetal	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Explain use of bending tools. 2. Explain use of cutting tools. <p>Tasks:</p> <ol style="list-style-type: none"> 1. Demonstrate use of tin snips left, right and straight. 2. Identify the different types of connections. 	<p>Unit 8, Job Sheet 4—Make a 90° bend in copper tubing Unit 8, Job Sheet 5—Make a 180° bend in copper tubing Unit 8, Job Sheet 6—Make a 45° offset bend in copper tubing Unit 8, Objective 13—Guidelines for cutting and reaming tubing Unit 8, Job Sheet 1—Make a single flare with a compression-type flaring block Unit 8, Job Sheet 2—Make a single flare with a Rol-Air®-type flaring block Unit 8, Job Sheet 3—Make a swage joint in copper tubing Unit 8, Job Sheet 4—Make a 90° bend in copper tubing Unit 8, Job Sheet 5—Make a 180° bend in copper tubing Unit 8, Job Sheet 6—Make a 45° offset bend in copper tubing</p> <p>Unit 4, Job Sheet 3—Lay out, then cut centered circles from metal squares Unit 7, Objective 5—Guidelines for using iron pipe fittings Unit 7, Objective 7—Guidelines for using brass fittings Unit 7, Objective 8—Guidelines for using flexible plastic fittings Unit 8, Objective 7—Tubing fittings and their characteristics Unit 8, Objective 8—Flare fittings Unit 8, Objective 9—Flare-to-pipe fittings or half unions Unit 8, Objective 10—Compression fittings Unit 8, Objective 11—Sweat fittings Unit 8, Objective 12—Quick connect fittings and their applications Unit 8, Assignment Sheet 1—Identify selected fittings for iron, plastic, and PVC pipe</p>

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
X. Refrigerant System Components	
Subtopic X.A. Metering Devices	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Define types of metering devices: <ol style="list-style-type: none"> a. capillary tubes b. thermal expansion valve c. automatic expansion valve d. low side float e. high side float f. hand expansion valve g. restrictor orifices h. electronic expansion valve i. solid state expansion valve 	<p>Unit 13, Objective 9—Types of metering devices and their characteristics</p>
Subtopic X.B. Evaporators	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Identify types of evaporators: <ol style="list-style-type: none"> a. bare-tube b. finned <ul style="list-style-type: none"> • internal • external c. plate d. unit coolers e. chillers 	<p>Unit 13, Objective 11—Types of evaporators and their characteristics</p>
Subtopic X.C. Compressors	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Identify types of compressors: <ol style="list-style-type: none"> a. hermetic b. semi-hermetic c. open type 2. Identify types of compression: <ol style="list-style-type: none"> a. centrifugal b. rotary c. screw d. scroll e. reciprocating 	<p>Unit 13, Objective 4—Compressor construction types and their applications Unit 13, Objective 5—Reciprocating compressors and their applications Unit 13, Objective 6—Rotary compressors and their applications Unit 13, Objective 7—Scroll compressors and their applications Unit 13, Objective 8—Other compressor types and their applications Unit 13, Objective 4—Compressor construction types and their applications Unit 13, Objective 5—Reciprocating compressors and their applications Unit 13, Objective 6—Rotary compressors and their applications Unit 13, Objective 7—Scroll compressors and their applications Unit 13, Objective 8—Other compressor types and their applications</p>

Crosswalk

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
3. Explain the methods of compression.	Unit 13, Objective 4—Compressor construction types and their applications Unit 13, Objective 5—Reciprocating compressors and their applications Unit 13, Objective 6—Rotary compressors and their applications Unit 13, Objective 7—Scroll compressors and their applications Unit 13, Objective 8—Other compressor types and their applications
Subtopic X.D. Condensers	
Knowledge: <ol style="list-style-type: none"> 1. Define the types of condensers: <ol style="list-style-type: none"> a. air-cooled b. water-cooled c. evaporative-cooled 2. Explain the operation and performance of a condenser. 	Unit 13, Objective 10—Types of condensers and their characteristics Unit 13, Objective 10—Types of condensers and their characteristics
Subtopic X.E. Accessories	
Knowledge: <ol style="list-style-type: none"> 1. Identify the proper location of all accessories: <ol style="list-style-type: none"> a. accumulators b. crankcase heaters c. crankcase pressure regulating valves d. defrost timers e. driers/filters f. evaporator pressure regulating valves g. head pressure controls h. heat exchangers i. hot gas bypass j. low pressure controls k. low ambient controls l. mufflers m. oil separators n. receivers o. solenoid valves p. suction filters q. unloaders r. vibration eliminators s. check valves t. water regulating valve u. liquid sight valve-refrigerant and oil v. relief valve 	Unit 14, Objective 2—Refrigeration system accessories and their locations Unit 14, Assignment Sheet 1—Identify components of a mechanical refrigeration system with accessories and identify conditions in different parts of the system Unit 14, Assignment Sheet 2—Select functions for refrigeration system accessories Unit 14, Assignment Sheet 3—Select operating positions for service valves Unit 14, Job Sheet 1—Find and identify refrigeration system accessories

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>2. Explain the operation of the above listed accessories (Item #1).</p> <p>Task:</p> <p>1. Replace a drier/filter.</p>	<p>Unit 14, Objective 3—Suction line accumulators and their functions Unit 14, Objective 4—Liquid receivers and their functions Unit 14, Objective 5—Oil separators and their functions Unit 14, Objective 6—Noise and vibration control with large compressors Unit 14, Objective 7—Filter-driers and their applications Unit 14, Objective 8—Monitoring moisture and liquid refrigerant in the system Unit 14, Objective 9—Service valves, their operating positions and functions Unit 14, Objective 10—Service valves and their applications Unit 14, Objective 11—Shut-off valves and their applications Unit 14, Objective 12—Access valves and ports and their applications Unit 14, Objective 13—Pressure controls and their applications</p> <p>Unit 18, Job Sheet 2—Install a filter-drier on a capillary tube</p>
<p>Subtopic X.F. Access Valves</p>	
<p>Knowledge:</p> <p>1. Identify front and back seat valves in the:</p> <ol style="list-style-type: none"> a. Operation and use of the suction and discharge service valves that service the compressor. b. Application and operation of the king valve at the outlet of the receiver. c. Application and operation of the queen valve where present, near the receiver. d. Small system high side and low side service ports. e. Front seating and Schrader valves, OEM and field installed. 	<p>Unit 14, Objective 9—Service valves, their operating positions and functions Unit 14, Objective 10—Service valves and their applications Unit 14, Objective 11—Shut-off valves and their applications Unit 14, Objective 12—Access valves and ports and their applications Unit 14, Assignment Sheet 3—Select operating positions for service valves</p>

Crosswalk

PAHRA/NATE Tasks, Competencies and Objectives	MAVCC Objectives and Tasks
<p>Tasks:</p> <ol style="list-style-type: none"> 1. Identify Schrader Type OEM and field installed in the: <ol style="list-style-type: none"> a. Installation and use of clamp on valves. b. Installation and use of solder (in) or (on) stem valves c. Use of A/C front seating/Schrader OEM service valves. d. Use of quick disconnects with Schrader-Based Valves. 	<p>Unit 14, Objective 12—Access valves and ports and their applications Unit 14, Assignment Sheet 3—Select operating positions for service valves</p>
XI. Air-Conditioning Systems	
Subtopic XI.A. Unitary Cooling	
<p>Knowledge:</p> <ol style="list-style-type: none"> 1. Describe the sequence of the basic refrigeration cycle and operation of the various types of air-conditioning systems. <p>Task:</p> <ol style="list-style-type: none"> 1. Use and read various tools and instrumentation needed for checking, testing, and operating air-conditioning systems 	<p>Unit 13—Basic Mechanical Refrigeration</p> <p>Located throughout the publication</p>