

**HVAC
HVAC/R TECHNICIAN
SKILLS STANDARDS**

OD33401



*ALIGNED WITH
PAHRA
Technical
Program
Requirements*

COMPETENCY-BASED EDUCATION: OKLAHOMA'S RECIPE FOR SUCCESS

BY THE INDUSTRY FOR THE INDUSTRY

Oklahoma's *CareerTech* system of competency-based education uses industry professionals and certification standards to identify the knowledge and abilities needed to master an occupation. This industry input provides the foundation for development of instructional materials that help prepare the comprehensively trained, highly skilled employees demanded by our workplace partners.

TOOLS FOR SUCCESS

CareerTech relies on three basic instructional components to deliver competency-based instruction: skills standards, curriculum materials, and competency assessments.

Skills standards provide the foundation for competency-based instruction in Oklahoma's *CareerTech* system. The skills standards outline the knowledge, skills, and abilities needed to perform related jobs within an industry. Skills standards are aligned with national skills standards; therefore, a student trained to the skills standards possesses technical skills that make him/her employable in both state and national job markets.

Curriculum materials contain information and activities that teach students the knowledge and skills outlined in the skills standards. In addition to complementing classroom instruction, curriculum resources provide supplemental activities to enhance learning and provide hands-on training experiences.

Competency Assessments test the student over material outlined in the skills standards and taught using the curriculum materials. When used with classroom performance evaluations, written competency assessments provide a means of measuring occupational readiness.

Although each of these components satisfy a unique purpose in competency-based education, they work together to reinforce the skills and abilities students need to gain employment and succeed on the job.

MEASURING SUCCESS

Written competency assessments are used to evaluate student performance. Results reports communicate competency assessment scores to students and provide a breakdown of assessment results by duty area. The results breakdown shows how well the student has mastered skills needed to perform major job functions and identifies areas of job responsibility that may require additional instruction and/or training.

Group analysis of student results also provides feedback to instructors seeking to improve the effectiveness of career and technology training. Performance patterns in individual duties indicate opportunities to evaluate training methods and customize instruction.

TRUE TO OUR PURPOSE

"Helping Oklahomans succeed in the workplace" defines the mission of Oklahoma *CareerTech* and its competency-based system of instruction. Skills standards, curriculum, and assessments that identify and reinforce industry expectations provide accountability for programs and assure *CareerTech*'s continued role in preparing skilled workers for a global job market

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Oklahoma Department of Career and Technology Education
Stillwater, Oklahoma

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**HVAC
HVAC/R TECHNICIAN
SKILLS STANDARDS
Frequency & Criticality Ratings**

- Duty A: Demonstrate Knowledge of the HVAC/R Industry
- Duty B: Demonstrate Knowledge of Thermodynamics and Heat Transfer Principles
- Duty C: Demonstrate Safety Skills
- Duty D: Demonstrate Knowledge of Tools and Equipment
- Duty E: Demonstrate Knowledge of Piping and Piping Practices
- Duty F: Demonstrate Knowledge of Electricity
- Duty G: Demonstrate Knowledge of Controls
- Duty H: Demonstrate Knowledge of Solid State Electronics
- Duty I: Demonstrate Knowledge of Load Calculations
- Duty J: Demonstrate Knowledge of Refrigerant System Components
- Duty K: Demonstrate Knowledge of Air-Conditioning Systems
- Duty L: Demonstrate Knowledge of Heat Pump Systems
- Duty M: Demonstrate Knowledge of Heating Systems
- Duty N: Demonstrate Knowledge of Commercial Refrigeration
- Duty O: Demonstrate Knowledge of Air Handling
- Duty P: Demonstrate Knowledge of System Installation and Start-Up
- Duty Q: Demonstrate Knowledge of System Servicing and Troubleshooting
- Duty R: Demonstrate Knowledge of Indoor Air Quality
- Duty S: Demonstrate Knowledge of Preventative Maintenance
- Duty T: Demonstrate Knowledge of Refrigerant Recovery
- Duty U: Demonstrate Knowledge of Refrigerant Retrofits
- Duty V: Demonstrate Knowledge of Refrigerants and Lubricants
- Duty W: Demonstrate Knowledge of and Comply with Industry Regulations
- Duty X: Demonstrate Knowledge of Professional Service

The duties and tasks in this publication correspond with the *PAHRA Technical Requirements* for Residential Heating and Air Conditioning occupation only. These requirements are TPR1= Safety, TPR2=Basic Entry Level Skills, and TPR3=Residential Heating and Air Conditioning.

Frequency: represents how often the task is performed on the job. Frequency rating scales vary for different occupations. The rating scale used in this publication is presented below:

- 1 = less than once a week
- 2 = at least once a week
- 3 = once or more a day

Criticality: denotes the level of consequence associated with performing a task incorrectly. The rating scale used in this publication is presented below:

- 1 = slight
- 2 = moderate
- 3 = extreme

DUTY A: Demonstrate Knowledge of the HVAC/R Industry

CODE	TASK	F/C
A.01	Introduction to Refrigeration <ul style="list-style-type: none"> • Explain the history of air-conditioning and refrigeration • Define air-conditioning and refrigeration • Explain the differences between air-conditioning and refrigeration • Determine career opportunities in the HVACR industry • Describe the role of Trade Association 	1 / 1
A.02	Introduction to Air Conditioning <ul style="list-style-type: none"> • Understand the historical development of air-conditioning • Define "air-conditioning" and relate to human comfort conditions • Discuss the differences between air-conditioning and heating • Discuss the various systems of air-conditioning <ul style="list-style-type: none"> • mechanical compression cycle • evaporative cooling • desiccant dehumidification • absorption cycle • Explain why ventilation is often inadequate 	1 / 1
A.03	Introduction to Heating <ul style="list-style-type: none"> • Define heating • Discuss the differences between air-conditioning and heating • Explain the various heating systems <ul style="list-style-type: none"> • gas • oil • heat pump • electric resistance • hydronics • solar 	1 / 1

Duty B: Demonstrate Knowledge of Thermodynamics and Heat Transfer Principles

CODE	TASK	F/C
B.01	Matter and Heat Behavior <ul style="list-style-type: none"> • Define matter and heat • Explain the direction and rate of heat flow • Describe the three methods of heat transfer • Identify the reference points of temperature <ul style="list-style-type: none"> • boiling point • freezing point • critical temperature • absolute zero • Explain the difference between heat and temperature • Explain the difference between latent and sensible heat 	3 / 3

	<ul style="list-style-type: none"> • Explain the change of state of matter • Explain heat/cool storage • Define specific heat • Define sensible heat. • Define latent heat of fusion • Define latent heat of vaporization • Define enthalpy • Define saturation temperature (dew point temperature) • Define water vapor pressure. • Explain the direction and rate of moisture transfer • Calculate total heat (in BTU's) a pound of any substance contains 	
B.02	<p>Fluids and Pressures</p> <ul style="list-style-type: none"> • Explain the relationship of pressures and fluids at saturation temperatures • Identify the relationship between temperature and pressure using the P/T Chart • Define pressure • Explain atmospheric pressure • Explain compound gauges • Explain bourdon tubes • Explain barometric pressure • Explain absolute pressure • Explain gauge pressure • Explain inches of mercury absolute • Explain micron 	3 / 3
B.03	<p>Refrigeration Cycle/Diagrams</p> <ul style="list-style-type: none"> • Identify the four major components of the vapor compression refrigeration system • Describe the state and conditions of the refrigerant during a cycle • Explain the effects of: <ul style="list-style-type: none"> • superheating the suction gases • increasing the condensing pressure • subcooling the liquid • Explain the importance of superheat and subcooling • Define refrigeration • Explain the functions of the four major components of a refrigeration system <ul style="list-style-type: none"> • compressor • condenser • metering device • evaporator • List the components which separate the high side from the low side of the system • Describe the Temperature/Enthalpy (T-H) Diagram • Calculate problems using Pressure/Enthalpy (P-H) Diagram • Label the line which represents each of the four basic components on a Pressure/Enthalpy (P-H) Diagram 	3 / 3
B.04	<p>Measurement Systems</p> <ul style="list-style-type: none"> • Explain units of heat, power, velocity, mass and length • Identify U.S. and S.I. units • Convert from U.S. to metric units <ul style="list-style-type: none"> • Length • Area • Volume • Mass • Force • Velocity • Density 	2 / 2

	<ul style="list-style-type: none"> • Pressure • Temperature • Energy • Power • Specific Heat • Volume Flow Rate • Capacity • Convert pounds to ounces • Convert cooling capacity from tons of refrigeration to kW and Btu/h to kW 	
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DUTY C: Demonstrate Safety Skills

CODE	TASK	F/C
C.01	Personal Safety and Work Practices <ul style="list-style-type: none"> • Explain clothing and safety equipment • Review OSHA standards • Explain the effects of substance abuse on safety • Review safe driving practices • Identify, handle, use, and dispose of hardware material • Wear appropriate clothing • Use safety equipment (e.g., footwear, hearing protection, hardhat, goggles, gloves) • Demonstrate good housekeeping practices in the lab • Demonstrate proper ladder safety <ul style="list-style-type: none"> • wooden • aluminum • fiberglass • scaffolding • Demonstrate proper lifting procedures • Pass safe driving course • Use appropriate fire extinguishers • Conduct routine safety inspections 	1 / 3
C.02	Handling of Pressurized Fluids <ul style="list-style-type: none"> • List safety requirements • Explain application of pressure relief devices • Explain proper storage and handling of refrigerants • 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 • Properly fill and label a refrigerant cylinder • Determine if a refrigerant cylinder needs retesting 	2 / 3
C.03	Handling Hazardous Substances <ul style="list-style-type: none"> • Explain use of Material Safety Data Sheets (MSDS) • Define difference between hazardous materials, substances and wastes • Explain use of hazardous material manifest • Locate MSDS and identify particular effect • Demonstrate use of proper clothing and equipment • Demonstrate basic first aid procedure 	2 / 3
C.04	Electrical Safety <ul style="list-style-type: none"> • Explain importance of ground fault circuit interrupters • Explain the use of power tools and accessories 	2 / 3

	<ul style="list-style-type: none"> • Discuss work habits • Explain environmental safety practices • Explain proper procedures when working with hands on live equipment • Fault a ground fault interrupter • Demonstrate the use of lockout/tagout equipment 	
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DUTY D: Demonstrate Knowledge of Tools and Equipment

CODE	TASK	F/C
D.01	<p>Hand Tools and Accessories</p> <ul style="list-style-type: none"> • Identify basic tools <ul style="list-style-type: none"> • adjustable wrenches • Allen (hex) wrenches • crimpers • diagonal cutting pliers (dikes) • flare nut wrenches • general-use pliers • hack saw • hand saw • lineman pliers (sidecutters) • nutdrivers • open & box end wrenches • pipe wrenches • pulley & gear pullers • punches • scratch awl • sheet metal snips • socket wrenches • torque wrenches • various hammers • various screwdrivers • wire strippers • tape measure • solder gun • Schrader valve • Identify power tools <ul style="list-style-type: none"> • general-purpose drills • hammer drill • power screwdriver • reciprocating saws • screwgun • Identify fasteners <ul style="list-style-type: none"> • bolts • conduit, pipe & cable clamps • masonry anchors • nails • screws • various electrical connectors • pop rivets • Identify pipe and tubing tools <ul style="list-style-type: none"> • benders • flaring tools • pipe cutters, reamers and threaders • pipe vises • swaging tools 	3 / 3

	<ul style="list-style-type: none"> • tubing cutters and reamers • Describe lubrication methods using different types of circuits <ul style="list-style-type: none"> • grease guns • oilers • spra • Show the proper use of a pipe cutter • Show the proper use of a threader • Demonstrate how to make a flared tubing joint 	
D.02	<p>Electrical Testing Devices/Meters</p> <ul style="list-style-type: none"> • Define amps, volts, ohms and watts • Demonstrate understanding of the basic types of electrical measurement • Measure voltage with digital and analog voltmeters • Measure AC current with a clamp-on ammeter • Measure resistance with an ohmmeter • Check winding insulation with megohmmeter • Check voltage with a voltage tester • Use a continuity tester to determine whether an open circuit or dead short exists • Use a capacitance meter to measure capacitance of run and start capacitors • Calculate capacitance • Wire and measure resistance of different types of circuits <ul style="list-style-type: none"> • series • parallel • unequal • series - parallel 	3 / 3
D.03	<p>Refrigeration: Servicing and Testing Equipment</p> <ul style="list-style-type: none"> • Measure pressures with the refrigeration gauge manifold • Evacuate systems with a two-stage vacuum pump • Measure vacuums with a thermistor vacuum gauge • Measure temperatures with electronic thermometers • Measure temperatures with bimetal, thermocouple or glass stem thermometer • Charge a system with a charging cylinder • Charge a system with an electronic charging scale • Check for leaks with electronic leak detector and halide torch • Use nitrogen with trace of R-22 for leak detection • Compare readings to manufacturers' specifications • Determine refrigerant amount and type • Charge a system to manufacturers' specification 	3 / 3
D.04	<p>Heating: Servicing and Testing Equipment</p> <ul style="list-style-type: none"> • Measure chimney draft with a gauge <ul style="list-style-type: none"> • Measure draft over fire • Measure draft at the chimney breaching • Perform an efficiency test on an oil-gas burner <ul style="list-style-type: none"> • smoke test • CO₂ test • O₂ test • check draft • check stack temperature • Determine effectiveness of an oil pump using <ul style="list-style-type: none"> • vacuum gauge • pressure gauge • Determine relative humidity using a sling psychrometer <ul style="list-style-type: none"> • Find the relative humidity and dew point using psychrometric chart • Measure gas pressure with the following equipment: 	2 / 3

	<ul style="list-style-type: none"> • U-tube manometer • pressure gauge • Calculate proper size of chimney for both 80 and 90+ furnaces • Determine what to do with an "orphaned" water heater • Check wall thermostat and anticipator <ul style="list-style-type: none"> • cooling system (fan on-automatic) • Check electronic pilot system • Check and adjust blower system • Check and adjust fan control • Check limit and safety controls 	
D.05	<p>Air Flow: Measuring and Testing Equipment</p> <ul style="list-style-type: none"> • Determine air velocity within a duct via <ul style="list-style-type: none"> • pitot tube • inclined manometer • electronic velometer • U-tube manometer • Determine air velocity at grilles and diffusers via: <ul style="list-style-type: none"> • deflecting vane anemometer • velometer • hot wire anemometer • pitot tube • rotating vane anemometer • Measure pressure drop with a magnahelic gauge • Determine Cubic Feet Per Minute (CFM) • Use manufacturers' airflow data sheet <p>Solve problems using friction loss chart</p>	2 / 2

DUTY E: Demonstrate Knowledge of Piping and Piping Practices

CODE	TASK	F/C
E.01	<p>Piping Material and Fabrication</p> <ul style="list-style-type: none"> • Identify types of pipe and tubing used in refrigeration work • Identify various types of fittings • Describe methods of insulating pipe and tubing • Identify soldering and brazing alloys used in HVACR • Explain applications of soldering and brazing alloys • Describe heat sink methods • Describe heat exchange techniques • Describe the applications and installation of vibration eliminators • Identify types of torches • Flare copper tubing • Swage copper tubing • Bend copper tubing • Solder and braze copper tubing • Cut and thread steel/iron pipe • Braze aluminum tubing 	2 / 3
E.02	<p>Pipe Sizing and Troubleshooting</p> <ul style="list-style-type: none"> • Explain capacities of refrigerant lines • Explain effects of refrigerant velocity in lines • Explain equivalent lengths of piping for fittings 	2 / 2

	<ul style="list-style-type: none"> • Explain use of traps in vapor risers • Explain the effects of pressure drop in the refrigeration system • Explain gas piping • Calculate total effective length of pipe runs • Calculate amount of refrigerant in lines • Size piping using manufacturers' installation instructions • Calculate pressure drop in liquid line risers • Size liquid and vapor lines • Calculate gas piping sizes to multiple units, fed from a single meter 	
E.03	Sheetmetal <ul style="list-style-type: none"> • Explain use of bending tools • Explain use of cutting tools • Explain the types of ductwork and fittings • Demonstrate use of tin snips left, right and straight • Identify the different pressures of ductwork • Identify the different types of connections 	2 / 2

DUTY F: Demonstrate Knowledge of Electricity

CODE	TASK	F/C
F.01	Basic Electricity <ul style="list-style-type: none"> • Define watts, ohms, volts, and amps • Define and compare single- and three-phase voltage and current • Identify types of electrical loads (i.e., capacitive, inductive and resistive) • Analyze applications of magnetism in electricity • Apply magnetic principles to electrical theory • Compare conducting and insulating materials • Identify principles of solid-state switching devices • Demonstrate proper use of ammeter, ohmmeter, voltmeter and wattmeter • Use Ohms Law to solve circuit problems and calculate circuit loads • Use appropriate meters to check basic electrical components • Determine the electrical characteristics of both series and parallel circuits • Demonstrate algebra/math skills • Determine the equivalent resistance in a parallel and series circuit • Determine the equivalent capacitance in a parallel and series circuit • Construct and analyze: <ul style="list-style-type: none"> • series circuit • parallel circuit • series-parallel circuit 	3 / 3
F.02	Electrical Generation and Distribution <ul style="list-style-type: none"> • Explain basic generator principle • Explain how electricity is produced and distributed • Define Wye (Y) and Delta (Δ) distribution systems • Draw and identify power transformer types • Use electrical meters appropriately to test and identify voltages in both 	2 / 2

	<p>single- and three-phase systems</p> <ul style="list-style-type: none"> • Size/test fuses/breakers and safely replace them • Use National Electrical Code (NEC) tables (i.e., NEC 310-16) to check wire size and conduit size for connected equipment • Determine correct wire size and voltage drops for electrical circuits • Determine whether existing load centers are adequate to supply desired load addition 	
F.03	<p>Electrical Components</p> <ul style="list-style-type: none"> • Define magnetic theory • Define and explain the use or function of: <ul style="list-style-type: none"> • Aquastats • Capacitors • Contactor/Starters • Crankcase Heaters • Current relays • Damper Actuators • Defrost Timers • Fan/Limit Controls • Oil pressure safety • Overloads • Positive Temperature Co-efficient (PTC) • Potentiometers • Pressure Controls • Relays • Rheostats • Sail Switches • Sequencers • Solenoids • Solid state time delays • Thermostats • Water Valves • Zone Valves • Demonstrate proper use of test equipment for testing the above items 	3 / 3
F.04	<p>Electric Motors</p> <ul style="list-style-type: none"> • Explain electric motor theory (i.e., magnetism, electromotive force, etc.) • Explain the operation and application of: <ul style="list-style-type: none"> • Capacitor start induction run motor (CSIR) • Capacitor start capacitor run motor (CSCR) • Electronically controlled motor (ECM) • Modulating motor (economizers) • Multi-speed motor • Permanent split capacitor (PSC) • Shaded pole • Split-phase motor (RSIR) • Three-phase motor • Variable-speed motor • Describe starting components associated with single-phase and three-phase motors • Explain the significance of power factor • Demonstrate proper use of testing equipment for motors 	3 / 3

	<ul style="list-style-type: none"> • Determine physical conditions of motor bearings and rotors • Build a basic motor-using a piece of wood, copper wire, and a coat hanger • Draw and explain the starting and run circuit for a single-phase CSIR compressor using a current type starting relay • Draw and explain the starting and run circuit for a single-phase CSCR compressor using a potential type starting relay • Draw and explain the circuit for a PSC compressor 	
F.05	<p>Electrical Circuits and Controls</p> <ul style="list-style-type: none"> • Interpret detailed instructions for wiring circuits • Draw electrical circuits that conform to standard industry logic and symbols using appropriate loads and controls • Wire actual electrical circuits from wiring diagrams • Demonstrate use and understanding of basic electrical meters in actual wiring and testing of circuits • Identify and draw all electrical symbols used by the HVACR industry in diagrams • Size an electric motor circuit, single and multiple, including overcurrent protection in accordance with National Electrical Code (NEC) 	3 / 3

DUTY G: Demonstrate Knowledge of Controls

CODE	TASK	F/C
G.01	<p>Gas Valves</p> <ul style="list-style-type: none"> • Identify types of gas valves <ul style="list-style-type: none"> • low voltage • line voltage • redundant • two-stage • modulating • Explain the operation of solenoid valves used to control gas flow • Describe function and application of regulators • Describe the methods of pilot/burner ignition: <ul style="list-style-type: none"> • Standing pilot thermocouple • Glow coil pilot ignition • Intermittent spark pilot ignition • Direct spark burner ignition • Hot surface burner ignition • Describe methods of fan control for the three categories of gas furnaces: <ul style="list-style-type: none"> • Low-efficiency - 60-70% efficient • Mid-efficiency - 78-80% efficient • High-efficiency - 90%+ efficient • Describe the sequence of operation for 78-80% efficient gas furnaces • Identify the components used in all types of gas furnaces: <ul style="list-style-type: none"> • Low-efficiency - 60-70% efficient • Mid-efficiency - 78-80% efficient • High-efficiency - 90%+ efficient • Explain the operation of a redundant gas valve • Check gas valve operation 	3 / 3

	<ul style="list-style-type: none"> • Check flame sensing current of flame sensing device • Check and adjust inlet and outlet pressure of a gas valve • Perform conversion on gas valve from natural gas to liquified petroleum (LP) or reverse • Check the operation of an induced draft blower by blocking flue outlet 	
G.02	Fuel Control <ul style="list-style-type: none"> • Explain the operation of ignition and pilot proving devices • Explain operation of an oil delay valve • Test and change a thermocouple flame sensor • Test spark ignition modules • Perform safety lockout procedures for burners • Measure resistance of cad cell 	3 / 3
G.03	Residential Control Systems—Heating/Cooling <ul style="list-style-type: none"> • Identify residential heating and cooling thermostats • Identify controls for heating and cooling • Explain heat and cooling anticipators • Install and test a fan/limit control to identify set point of control • Wire a complete heating system - line and low voltage • Wire a humidistat into electrical circuit • Wire an electronic air cleaner into an electrical circuit • Program a programmable thermostat for heating, cooling and heat pump operation including set-up and set back • Set heat anticipator on system thermostat • Install residential heating and cooling thermostats 	3 / 3
G.04	Heat Pump Controls <ul style="list-style-type: none"> • Explain the operation and function of a reversing valve • Identify the main types of defrost controls • Identify and explain the operation of each type of defrost control • Identify and explain the operation of flow and safety control for geothermal system • Describe the purpose and function of outdoor thermostats • Describe the sequence and purpose of emergency heat controls • Identify and explain the operation of check valves in heat pumps • Describe the sequence between first stage and second stage heating thermostat • Describe the auxiliary heat controls • Select and install appropriate system thermostat • Wire the control circuit of a heat pump system • Install or replace a heat-sequencing relay • Perform tests on reversing valve to determine if mechanical or electrical failure 	3 / 3

DUTY H: Demonstrate Knowledge of Solid State Electronics

CODE	TASK	F/C
H.01	Solid State Components <ul style="list-style-type: none"> • Explain the function and/or application in HVACR circuits and controls of: <ul style="list-style-type: none"> • Amplifiers • Bilateral switches • Capacitors • Diodes • Direct Digital Control/System (DDC/DDS) • Effects of heat and moisture • Photoelectric Cell 	1 / 1

	<ul style="list-style-type: none"> • Rectifiers • Resistors • Semiconductors • Shielded wiring • Sensors • Silicon Controlled Rectifiers (SCR) • Thermistors • Transducers • Transistors • Triacs • Explain the role computers are now playing in the HVACR industry • Measure resistive value of various sensors • Measure operability of various boards • Test electronic air cleaners 	
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DUTY I: Demonstrate Knowledge of Load Calculations

CODE	TASK	F/C
I.01	Refrigeration Loads <ul style="list-style-type: none"> • Define "U" value: (Btu/hr • ft² • °F) • Define "K" value: (Btu/hr • ft² • °F) • Define "C" value: (Btu/hr • ft² • °F) • Define "R" value: (hr • ft² • °F/Btu) • Interpret heat transfer tables ("U," "K," "C," "R") • Explain the heat load sources: <ul style="list-style-type: none"> • conduction • infiltration (sensible and latent) • product • miscellaneous loads (people, motors, equipment, sensible and latent) • radiation • Explain the purpose of vapor barriers • Interpret tables of specific heat values, latent heat, and heat of respiration • Calculate total heating transfer value of any surface (R) - (U) 	1 / 1
I.02	Psychrometrics <ul style="list-style-type: none"> • Identify the following on a psychrometric chart: <ul style="list-style-type: none"> • dry bulb line (DB) • wet bulb line (WB) • relative humidity (RH) • dew point (DP) • enthalpy (h) • specific humidity (grains of moisture) or (lbw/lbda) • apparatus dew point • Explain: <ul style="list-style-type: none"> • specific humidity • apparatus dew point • contact factor • relative humidity • dry bulb • wet bulb • dew point • enthalpy • specific volume • Calculate: <ul style="list-style-type: none"> • refrigeration sensible heat ratio • latent heat ratio 	1 / 2

	<ul style="list-style-type: none"> • contact factor • latent heat • sensible heat • total heat • water removal • mixed air condition • On a psychrometric chart, plot the following: <ul style="list-style-type: none"> • sensible heating • sensible cooling • heating and humidifying • heating and dehumidifying • cooling and humidifying • cooling and dehumidifying • humidifying • dehumidifying • cooling cycle • mixed air process • cooling and reheat 	
1.03	<p>Heating Loads</p> <ul style="list-style-type: none"> • Interpret structure design data • Interpret building prints - size of rooms, etc • Determine total resistance to heat flow ("R"), ("U") • Calculate conduction loss: <ul style="list-style-type: none"> • Walls • Roofs • Floors • Windows • basement (walls, floor) • unconditioned space • Calculate infiltration: <ul style="list-style-type: none"> • doors • windows • Calculate ventilation load • Calculate duct loss • Calculate effects of bath and kitchen exhaust • Calculate effects of power roof ventilators • Calculate total heating load 	1 / 2
1.04	<p>Cooling Loads</p> <ul style="list-style-type: none"> • Interpret structure design data • Calculate "U" values for building material • Calculate Cooling Load Temperature Difference (CLTD) • Make corrections for CLTD • Calculate conduction loads: <ul style="list-style-type: none"> • walls • roofs • windows • doors • unconditioned space • floors • Calculate lighting load • Calculate equipment load • Calculate infiltration and ventilation load: <ul style="list-style-type: none"> • heat load • moisture loads • Calculate duct gain • Calculate refrigeration sensible heat ratio 	1 / 2

	<ul style="list-style-type: none"> • Calculate storage factor • Calculate effects of bath and kitchen exhaust • Calculate effects of power roof ventilators • Calculate total cooling load: <ul style="list-style-type: none"> • sensible loads • latent loads 	
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DUTY J: Demonstrate Knowledge of Refrigerant System Components

CODE	TASK	F/C
J.01	<p>Metering Devices</p> <ul style="list-style-type: none"> • Define types of metering devices: <ul style="list-style-type: none"> • capillary tubes • thermal expansion valve • automatic expansion valve • low side float • high side float • hand expansion valve • restrictor orifices • electronic expansion valve • solid state expansion valve • Evaluate system performance when using different types of flow control devices • Explain how to size expansion valves • Explain how to size a thermal expansion valve • Explain how to size an automatic expansion valve • Adjust and size metering devices when and where appropriate • Check and adjust superheat and/or subcooling to manufacturers' specifications • Install capillary tube 	2 / 3
J.02	<p>Evaporators</p> <ul style="list-style-type: none"> • Identify types of evaporators: <ul style="list-style-type: none"> • bare-tube • finned <ul style="list-style-type: none"> ○ internal ○ external • plate • unit coolers • chillers • Determine the Mean Effective Temperature Difference (METD) • Adjust for proper coil air flow • Check coil performance • Select and size evaporator based on compressor capacities 	1 / 1
J.03	<p>Compressors</p> <ul style="list-style-type: none"> • Identify types of compressors: <ul style="list-style-type: none"> • Hermetic • semi-hermetic • open type • Identify methods of compression: <ul style="list-style-type: none"> • Centrifugal • Rotary • Screw • scroll • reciprocating • Explain the methods of compression 	2 / 2

	<ul style="list-style-type: none"> • Explain methods of capacity control: <ul style="list-style-type: none"> • cylinder unloading • multiple compressors • hot gas bypass • variable speed compressors • Select the compressor based on cooling load • Determine the system balance based on the selected components 	
J.04	<p>Condensers:</p> <ul style="list-style-type: none"> • Define the types of condensers: <ul style="list-style-type: none"> • air-cooled • water-cooled • evaporative-cooled • Determine proper air and water flow • Describe maintenance of a condenser • Describe maintenance of a cooling tower • Explain the operation and performance of a condenser • Explain the terms "range" and "approach" related to cooling towers • Explain purpose of heat reclaim • Adjust the air flow for proper temperature difference • Adjust water flow for proper gallons per minute (GPM) and temperature difference • Size a cooling tower • Select and size an air-cooled condenser 	3 / 3
J.05	<p>Accessories</p> <ul style="list-style-type: none"> • Identify the proper location of all accessories: <ul style="list-style-type: none"> • Accumulators • crankcase heaters • crankcase pressure regulating valves • defrost timers • driers/filters • evaporator pressure regulating valves • head pressure controls • heat exchangers • hot gas bypass • low pressure controls • low ambient controls • mufflers • oil separators • receivers • solenoid valves • suction filters • unloaders • vibration eliminators • check valves • water regulating valve • liquid sight valve-refrigerant and oil • relief valve • Determine appropriate accessories for systems application • Explain the operation of the above listed accessories (Item #1) • Replace a drier/filter • Adjust a crankcase pressure regulating valve 	3 / 3
J.06	<p>Access Valves</p> <ul style="list-style-type: none"> • Identify front and back seat valves in the: <ul style="list-style-type: none"> • Operation and use of the suction and discharge service valves that service the compressor • Application and operation of the king valve at the outlet of the receiver 	3 / 3

	<ul style="list-style-type: none"> • Application and operation of the queen valve where present, near the receiver • Small system high side and low side service ports • Front seating and Schrader valves, OEM and field installed • Identify Schrader Type OEM and field installed in the: <ul style="list-style-type: none"> • Installation and use of clamp on valves • Installation and use of solder (in) or (on) stem valves • Use of A/C front seating/Schrader OEM service valves • Use of quick disconnects with Schrader-Based Valves 	
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DUTY K: Demonstrate Knowledge of Air-Conditioning Systems

CODE	TASK	F/C
K.01	Unitary Cooling <ul style="list-style-type: none"> • Describe the sequence of the basic refrigeration cycle and operation of the various types of air-conditioning systems • Use and read various tools and instrumentation needed for checking, testing, and operating air-conditioning systems 	3 / 3
K.02	Service and Problem Analysis <ul style="list-style-type: none"> • Explain the causes of electrical problems • Explain the causes of mechanical problems • Explain the causes of hydronic problems • Analyze air-conditioning systems and appropriately diagnose: <ul style="list-style-type: none"> • Electrical problems • Mechanical problems • Hydronic problems 	3 / 3

DUTY L: Demonstrate Knowledge of Heat Pump Systems

CODE	TASK	F/C
L.01	Basic Principles and Components <ul style="list-style-type: none"> • Review the history of heat pumps • Explain the basic theory of the air source heat pump system • Explain the basic theory of the water source heat pump system • Explain the basic theory of geothermal source heat pump system • Identify and explain the function of the electrical and mechanical components of the heat pump systems • Explain terms typically used for heat pumps: <ul style="list-style-type: none"> • Seasonal Energy Efficiency Ratio (SEER) • Coefficient of Performance (COP) • Heating Seasonal Performance Factor (HSPF) • Balance Points • Outdoor Design Temperature (ODT) • Optimizer • Analyze and explain the refrigerant cycle in both cooling and heating -- identifying the pressure and state of the refrigerant at any point in the refrigerant circuit • Explain the different types of defrost methods • Describe the operation of the time clock in a defrost control • Identify which three components of a heat pump system are controlled directly during a defrost cycle • Describe a heat pump thermostat function • Check reversing valve for proper temperatures • Calculate both economic and thermal balance points 	3 / 3

	<ul style="list-style-type: none"> • Calculate temperature settings for multiple outdoor thermostats • Check refrigerant charge using charging chart • Check sequence of operation of an air-to-air split system heat pump for cooling, heating, and defrost modes 	
L.02	<p>Applications</p> <ul style="list-style-type: none"> • Identify and describe different types of heat pump systems: <ul style="list-style-type: none"> • Air-cooled • Water-source <ul style="list-style-type: none"> ○ open loop ○ closed loop ○ air-to-water ○ water-to-water ○ geothermal • Analyze and compare the operation and performance of the different types of Heat Pump Systems: <ul style="list-style-type: none"> • Explain the integration and operation of the air-to-air heat pump with electric resistance heat • Explain the integration and operation of the water-to-air heat pump with electric resistance heat • Explain the integration and operation of the air-to-air heat pump with a fossil fuel unit • Explain applications for open vs. closed loop geothermal heat pump systems • Mechanically and electrically connect and check out: <ul style="list-style-type: none"> • Air-to-air heat pump • Water-to-water heat pump 	3 / 3

DUTY M: Demonstrate Knowledge of Heating Systems

CODE	TASK	F/C
M.01	<p>Forced Warm Air Systems</p> <ul style="list-style-type: none"> • Check the operation of the ignition system • Derate or change over a gas burner • Adjust burner flame for proper fuel/air ratio • Check for proper temperature rise through the furnace • Test all safety controls • Remove, install and adjust blower motor and/or belt • Clean pilot assembly • Oil motor(s) and bearings • Check and adjust heat anticipator of thermostat • Use orifice sizing charts • Test induced draft pressure switches • Check all safety controls • Check operation of sequence 	3 / 3
M.02	<p>Hydronic Systems</p> <ul style="list-style-type: none"> • Identify types of hydronic piping systems • Identify types of boilers • Check circulator for alignment and lubrication • Set aquastat • Check water pressure regulating valve (PRV) • Check the zone valve operation • Remove air from system • Check backflow preventer • Check compression/expansion tank • Check water temperature rise across the boiler • Check and adjust water level in pressure tanks 	1 / 1

	<ul style="list-style-type: none"> • Check automatic air vent operation • Wire multizone/multipump hydronic systems 	
M.03	<p>Testing and Balancing Equipment</p> <ul style="list-style-type: none"> • Perform pressure checks on air distribution system • Perform pressure checks on fuel system • Perform efficiency test and adjust to recommended rate: <ul style="list-style-type: none"> • check draft • check smoke (if applicable) • check stack temp • check CO₂ • check O₂ • check CO • Perform balance method for an air distribution system • Perform balance method for a hydronic system 	1 / 1
M.04	<p>Humidification</p> <ul style="list-style-type: none"> • Explain importance of humidification • Describe different types of humidifiers • Explain factors affecting humidity in business and residence • Select proper humidification equipment • Check operation of humidification equipment • Perform maintenance on humidification equipment • Determine relative humidity using a psychrometer • Determine dew point using a psychrometer 	2 / 2
M.05	<p>Unitary Combination Heating and Cooling Equipment</p> <ul style="list-style-type: none"> • Describe the sequence of operation of a heating system • Use and read various tools and instruments needed for checking and testing combination air-conditioning and heating systems 	3 / 3
M.06	<p>Oil Furnaces</p> <ul style="list-style-type: none"> • Explain and check the sequence of operation of oil stack switches • Explain and check the sequence of operation of Electronic Primary Controls • Understand how to replace oil filters • Understand how to purge water from oil storage tanks • Understand how to oil motors • Replace oil nozzle and adjust electrodes • Perform combustion test and adjust to optimum efficiency • Perform safety shutdown check • Replace oil nozzles with proper size replacements • Inspect and adjust electrodes replacing when necessary • Test and adjust oil pumps and couplers 	1 / 1
M.07	<p>Electric Furnaces</p> <ul style="list-style-type: none"> • Understand the use of sequencers in electric furnaces • Understand the effects of air flow on temperature rise • Inspect heating elements and insulators • Test thermal fuses • Inspect all electrical connections • Check for proper temperature • Oil motors • Test sequence of operation of electric furnaces 	3 / 3

DUTY N: Demonstrate Knowledge of Commercial Refrigeration

CODE	TASK	F/C
N.01	<p>Single Compressor</p> <ul style="list-style-type: none"> • Explain the importance of compressor/evaporator balance • Describe the differences in compressor displacement between the various 	1 / 1

	<p>temperature ranges</p> <ul style="list-style-type: none"> • Explain basic low and high pressure control theory and operation • Explain the operation of a vapor compression system and its effects on temperature and volume • Explain the operation and components used for the pump down cycle. • Explain the evaporator and the condenser side of a system • Explain application and operation of evaporator pressure regulating valves • Discuss the problems associated with compressors operating at lower evaporator temperatures: <ul style="list-style-type: none"> • decreased volumetric efficiency • higher discharge gas temperatures • potential overloading during initial temperature pull-down • Discuss the use of different compressor designs for increased efficiency and capacity • Describe the methods used for cycling the compressor on and off. • Explain methods of defrost • Explain methods of head pressure control system • Explain heat reclaim • Explain the lubrication methods for a compressor • Determine the terminal identification of a single-phase compressor • Explain how to measure the compressor lubrication oil pressure • Explain several manufacturers' model numbering system • Define compression ratio and the effect suction and discharge pressure have on compression ratio • Determine compressor capacity using the compressor's curve • Determine the correct operating amps using the compressor's curve • Describe the different types and designs of compressors: <ul style="list-style-type: none"> • Type: <ul style="list-style-type: none"> ○ hermetic ○ semi-hermetic ○ open drive • Design: <ul style="list-style-type: none"> ○ reciprocating ○ scroll ○ screw • Explain requirements of food preservation: <ul style="list-style-type: none"> • medium temperature • low temperature • Describe supermarket display cases • Explain the difference between an across-the-line start and a part-winding start • Identify the different types of compressors • Select a compressor for a particular capacity and temperature range • Check the operation of a compressor in a particular system • Compute the compression ratio for a particular system • Adjust Evaporator Pressure Regulating (EPR) valve • Check control circuits per manufacturers' specifications • Check system charge, superheat and subcooling • Check display case temperatures and determine if operating properly • Set cut-in and cut-out for a special product • Draw the wiring diagrams for an across-the-line start and a part-winding start • Draw a ladder diagram of a system equipped with a pump down cycle • Draw the schematic of a single-phase and a three-phase compressor motor • Draw a ladder diagram of a system using a defrost time clock and defrost termination fan delay switch 	
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	<ul style="list-style-type: none"> • Measure the compressor windings and determine if they are correct • Measure the operating amps and determine if it is correct • Check operation of defrost cycle and adjust time clock • Adjust head pressure controls for proper operation • Check operation of equipment equipped for automatic pump down 	
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DUTY O: Demonstrate Knowledge of Air Handling

CODE	TASK	F/C
O.01	Air Flow Principles/Duct Design <ul style="list-style-type: none"> • Draw layout of return and supply runs • Calculate equivalent length of trunk and branch ducts • Calculate total effective length of duct runs • Calculate total available static pressure • Size trunk and branch ducts by equal friction method • Use duct calculator to find duct size, velocity, cfm, and friction loss • Calculate air flow factors for heating and cooling • Size registers, grilles, and diffusers • Fabricate fittings • Fabricate a "HAND" pittsburg • Fabricate "HAND" slips and drives • Identify and use all basic hand-held sheet metal tools • Identify and use all basic hand-held tools for duct board 	3 / 3
O.02	Mechanical and Electronic Filtration <ul style="list-style-type: none"> • Identify types of mechanical filters: <ul style="list-style-type: none"> • disposable • permanent foam, mesh, and fiber • high efficiency • HEPA • electrostatic • Describe operation of electronic air cleaners • Install air cleaner system into existing ductwork • Remove and clear prefilter and cells: <ul style="list-style-type: none"> • check ionizer wires • test power pack 	3 / 3
O.03	Fans/Blowers <ul style="list-style-type: none"> • Identify different types of fans/blowers: <ul style="list-style-type: none"> • centrifugal • axial • Determine the proper direction of rotation • Explain the difference between tube axial and vane axial • Identify the types of centrifugal fans/blowers: <ul style="list-style-type: none"> • forward curved • backward curved • air foil • radial tip • Check for proper rotation • Interpret the fans/blowers curve • Select the fans/blowers via the curve • Check fans/blowers performance via curves • Check amp draws 	3 / 3

DUTY P: Demonstrate Knowledge of System Installation and Start-Up

CODE	TASK	F/C
P.01	Heating Start-up, Checkout, and Operation <ul style="list-style-type: none"> • Understand the importance of manufacturers' installation and operation requirements • Demonstrate use of tools and instruments • Determine equipment electrical, mechanical and code requirements • Verify equipment air flow and distribution requirements • Check operation of all electrical control components • Check operation of gas train components and measurements • Check oil burner components and measurements • Check ignition systems • Evaluate fuel supply systems • Test for proper combustion • Check electrical components for operation and wiring connections • Check for correct heating input and adjust to manufacturers' specifications 	3 / 3
P.02	Heat Pump Start-up, Checkout, and Operation <ul style="list-style-type: none"> • Understand the importance of manufacturers' installation and operation requirements • Understand alternative fuel methods • Demonstrate use of tools and test equipment • Determine equipment electrical requirements • Verify equipment air flow and distribution • Check operation of all electrical and mechanical components • Check system operation in the heating, cooling and defrost modes • Check supplementary and emergency heat • Instruct customer on operation and maintenance of system 	3 / 3
P.03	Air Conditioning Start-up, Checkout, and Operation <ul style="list-style-type: none"> • Understand the importance of manufacturers' installation and operation requirements • Demonstrate use of tools and test equipment • Determine equipment electrical requirements • Verify equipment air flow and distribution requirements • Check operation of all electrical and mechanical components • Check system operation while following all safety procedures • Pull and verify deep vacuum • Perform leak check and make repairs • Conform to all applicable governmental regulations 	3 / 3

DUTY Q: Demonstrate Knowledge of System Servicing and Troubleshooting

CODE	TASK	F/C
Q.01	Mechanical System Problems <ul style="list-style-type: none"> • Develop systematic way to diagnose system problems and demonstrate method • Identify and describe possible causes of failure and how to eliminate causes • Demonstrate use of tools and test equipment following safety practices • Record system data for the mechanical system operation • Verify mechanical system operation is acceptable • Determine cause of failure in system components • Determine actual system air flow using the appropriate test equipment • Determine system air flow requirements 	3 / 3
Q.02	Electrical Troubleshooting <ul style="list-style-type: none"> • Interpret electrical diagrams into sequence of operation 	3 / 3

	<ul style="list-style-type: none"> • Describe electrical mechanical sequence from electrical schematic • Develop a methodical routine for electrical troubleshooting • Analyze electrical performance of each component • Rewire an HVACR unit using an electrical diagram: <ul style="list-style-type: none"> • air conditioner • heat pump • furnace • Record electrical system data • Use electrical test instruments to diagnose electrical troubles and correct electrical system performance • Troubleshoot a faulty compressor overload protector • Change a schematic diagram to a "ladder" diagram in a drawing 	
Q.03	<p>Heating: Service and Problem Analysis</p> <ul style="list-style-type: none"> • Explain combustion theory for gas combustion and oil combustion • Identify and describe possible causes of failure and how to correct problems • Determine and measure combustion air, ventilation air and unit/system air requirements • Develop systematic method(s) to diagnose system problems and demonstrate method • Determine the cause of failure in a heating system • Record data and verify system operation 	3 / 3
Q.04	<p>Heat Pump: Service and Problem Analysis</p> <ul style="list-style-type: none"> • Test and evaluate the operation of the refrigeration cycle in cooling and heating modes • Test the operation of the supplementary heat component(s) • Test the operation of the emergency heat status for the heat pump system • Record appropriate data to evaluate complete system operation • Test proper operation of reversing valve • Check operation of defrost controls • Inspect wiring and tighten connections 	3 / 3
Q.05	<p>Air-Conditioning: Service and Problem Analysis</p> <ul style="list-style-type: none"> • Explain proper temperatures and pressures at various system locations • Explain proper fan/blower operation • Explain heat exchanger inspection • Explain thermostat setting and operation • Explain sounds that could indicate a problem • Explain how electrical measurements could indicate a problem • Explain value of nameplate data and service records • Discuss the required performance checks • Discuss the method of measuring superheat, subcooling, evaporator and condenser splits • Discuss the proper procedures for using a voltmeter and an ammeter • Explain normal operation of air-conditioning systems • Explain the effects of overcharge and undercharge of refrigerant • Explain the effects of improper airflow • Develop a systematic approach to diagnose mechanical or electrical problems. • Check system for system leaks • Check and clean heat exchangers • Check for proper refrigerant charge • Check for proper thermostat and electrical controls • Check oil sample for acidity • Check and replace filter/driers • Check available voltage and install high and low side manifold gauges • Compare static pressure on a P/T Chart to determine unit refrigerant • Start unit and allow to stabilize 	3 / 3

	<ul style="list-style-type: none"> • Measure superheat and subcooling • Check evaporator and condenser splits • Check amperage of each motor • Analyze performance using manufacturers' specifications • Check electrical component operation • Check air flow from furnace of air handler • Inspect electrical connections • Troubleshoot A/C systems from electrical schematics 	
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Duty R: Demonstrate Knowledge of Indoor Air Quality

CODE	TASK	F/C
R.01	Requirement and Maintenance of Air Quality <ul style="list-style-type: none"> • Define Indoor Air Quality (IAQ) as defined by ADHRAE Std. 62. • Explain Sick Building Syndrome (SBS) and Building Related Illness (BRI). • Explain the different factors that make up acceptable indoor air quality: <ul style="list-style-type: none"> • Pollutant levels • Ventilation air quantities • Air distribution effectiveness • Occupant comfort 	1 / 1

Duty S: Demonstrate Knowledge of Preventative Maintenance

CODE	TASK	F/C
S.01	Basic Maintenance <ul style="list-style-type: none"> • Explain the various types of maintenance programs • Explain broad tasks and frequencies for a quality maintenance program • Explain why each step of the Preventative Maintenance Program is necessary • Explain the benefits associated with proper equipment maintenance • Demonstrate various maintenance tasks • Develop a Preventative Maintenance Program for: <ul style="list-style-type: none"> • Absorption cooling unit • Electric heat system • Gas heat system • Heat pump system • Hydronic systems • Ice makers • Oil heat system • Package heat and cooling unit • Refrigeration systems • Split system condensing unit and evaporator • Walk-in boxes • Water-cooled centrifugal chiller • Water-cooled reciprocating chiller • Develop a list of tools needed to perform the Preventative Maintenance Program • Develop a Preventative Maintenance Check Sheet 	3 / 3

Duty T: Demonstrate Knowledge of Refrigerant Recovery

CODE	TASK	F/C
T.01	<p>Introduction</p> <ul style="list-style-type: none"> Describe the environmental issues regarding refrigerant, including legislation, protocol, laws, and regulations Describe the basic refrigerant cycle Determine proper evacuation levels and leak rates Identify three different types of technician certification 	3 / 3
T.02	<p>Safety</p> <ul style="list-style-type: none"> Describe the problems associated with mixing of refrigerants Describe the methods of determining when a recovery cylinder is full Describe the problems associated with component isolation where unsafe hydrostatic pressures can occur Describe the problems associated with contaminants left in a refrigerant system after recovery 	3 / 3
T.03	<p>Refrigerant Recovery, Recycling, and Reclamation Methods</p> <ul style="list-style-type: none"> Describe how to manually pump down a system Describe how to isolate system components Describe system dependent and self-contained recovery equipment Describe the push-pull method Describe difference between recycled and reclaimed refrigerant Explain options in Industry Recycling Guideline (IRG-2) List the advantages/disadvantages, and application of liquid and vapor recovery List methods for decreasing recovery time 	3 / 3
T.04	<p>Refrigerant Recovery, Recycling and Reclamation Equipment</p> <ul style="list-style-type: none"> Identify proper equipment for a particular job Describe procedures for recovering multiple refrigerants with the same recovery unit Describe maintenance and efficiency testing procedures for recovery units Describe maintenance and testing for refrigerant recovery cylinders Identify recovery cylinders Explain when to change filter-driers in recycling equipment Explain methods of purging non-condensables when recycling Identify type of refrigerant in a given recovery cycle Perform procedures for recovery Perform procedures for recycling Perform maintenance on recovery machine Connect and operate recovery equipment 	3 / 3

Duty U: Demonstrate Knowledge of Refrigerant Retrofits

CODE	TASK	F/C
U.01	<p>Alternative Refrigerant Retrofits</p> <ul style="list-style-type: none"> Determine if the Alternative Refrigerant and/or Lubricant: <ul style="list-style-type: none"> is applicable for retrofitting specific system is on the EPA SNAP list is U.L. listed meets the equipment manufacturers' approval Determine the lubricant required for the alternate refrigerants Procure the Manufacturers' Changeover Guidelines and follow the retrofit procedures Measure the residual mineral oil in a system being changed from a CFC to an HFC refrigerant 	1 / 1

Duty V: Demonstrate Knowledge of Refrigerants and Lubricants

CODE	TASK	F/C
V.01	<p>Refrigerants</p> <ul style="list-style-type: none"> • Explain the different classes of refrigerants: <ul style="list-style-type: none"> • CFC Refrigerants • HCFC Refrigerants • HFC Refrigerants • HC Refrigerants • Other Refrigerants • Azeotropic mixtures (ASHRAE 500 series) • Zeotropic blends (ASHRAE 400 series) • Explain physical and chemical properties: <ul style="list-style-type: none"> • Flammability and toxicity • Materials compatibility • Miscibility and oil return • Pressure and temperature data • Refrigerant temperature glide • Environmental properties (ODP, GWP and TEWI) • Bubble point • Dew point • Define pure refrigerants and azeotropic mixtures • Define zeotropic mixtures • Define zeotropic blends • Identify the color and classification of refrigerants by Pantone Matching System (PMS) color number • Explain fractionization of blends • Look up saturation pressure and temperature: <ul style="list-style-type: none"> • single element refrigerant • azeotropic • zeotropic • blends • Identify when saturation pressure and temperature do not match the refrigerant • Calculate superheat and subcooling • Calculate superheat and subcooling glide 	3 / 3
V.02	<p>Lubricants</p> <ul style="list-style-type: none"> • Explain the function of lubricants in systems • Explain the different types and applications of lubricants: <ul style="list-style-type: none"> • Alkylbenzenes (AB) • Mineral oils • Polyolesters (POE) • Polyglycols (PAG) • Explain properties of lubricants: <ul style="list-style-type: none"> • Materials compatibility • Miscibility and oil return • Pour point and flash point • Viscosity • Water absorption • Rust and oxidation inhibitors • Describe proper oil disposal • Draw oil sample from system • Demonstrate proper handling of POE's • Use acid test kit for mineral oil and AB • Demonstrate proper use of a refractometer or oil sample test 	1 / 2

Duty W: Demonstrate Knowledge of and Comply with Industry Regulations

CODE	TASK	F/C
W.01	<p>Codes and Standards</p> <ul style="list-style-type: none"> • Describe the reasons for codes • Describe the three model codes: <ul style="list-style-type: none"> • Building Officials and Code Administrators (BOCA), National Mechanical Code • Southern Building Code Congress International (SBCCI), Standard Mechanical Code • International Conference of Building Officials (ICBO), Uniform Mechanical Code • Identify the codes and standards for the applicable area, locality and state • Discuss the relationship between codes and manufacturers' installation instructions • Identify pertinent standards published by the following organizations: <ul style="list-style-type: none"> • AGA • AMCA • ANSI • ARI • ASHRAE • IEC • ISO • SMACNA • UL 	3 / 3
W.02	<p>Regulations Affecting Ozone Depletion</p> <ul style="list-style-type: none"> • Explain ozone depletion • Explain significance of the Montreal Protocol • Explain significance of the Clean Air Act • Explain EPA requirements: <ul style="list-style-type: none"> • Technician certification • Refrigerant recover, recycle, and reclaim • Disposal of systems • Labeling • Shipping • Leak detection • Significant New Alternatives Policy Program (SNAP) • Recordkeeping • Know Department of Transportation (DOT) requirements concerning transportation of refrigerants • Determine if refrigerant container is DOT-approved and whether it needs to be retested • Determine if recovery/recycle equipment is certified and meets requirements. • Dispose of empty non-refillable cylinders • Use recovery equipment and prepare system for disposal • Obtain federal EPA technician certification 	3 / 3
W.03	<p>Other Regulations</p> <ul style="list-style-type: none"> • Explain global warming • Know OSHA Work Rules • Explain Indoor Air Quality (IAQ) standards (ASHRAE Std.62) • Explain impact of state and local codes on system application and retrofit • Explain proper disposal of oil, components, and other materials • Explain state and local licensing requirements • Explain DOT regulations 	3 / 3

Duty X: Demonstrate Knowledge of Professional Service

CODE	TASK	F/C
X.01	<p>Customer Relations/Communication</p> <ul style="list-style-type: none">• Describe methods of dealing with irate customers• Describe methods of dealing with technician delays and scheduling realities• Describe methods of selling service agreements and replacement equipment• Explain service(s) performed in layman's terms• Explain how to obtain customer satisfaction• Explain service contracts• Demonstrate professional/personal appearance and attitude• Discuss customer telephone etiquette• Describe, list, calculate and present a typical billing invoice• Demonstrate good customer relations	3 / 3
X.02	<p>Character Education</p> <ul style="list-style-type: none">• Discuss the following personal traits:<ul style="list-style-type: none">• Honesty• Integrity• Reliability• Responsibility• Accountability• Character• conflict resolution• teamwork• ethics• pride• initiative• time management	3 / 3