



The Benchmark  
of  
Academic Excellence

Minimum  
Tasks and Competencies  
for  
HVAC Excellence  
Accredited Programs

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## **About Curriculum Requirements:**

The following competencies are required for any coursework listed or published in the program brochure, school catalog, or website corresponding to the following titles;

1. Core Competencies
2. Electrical
3. Electric Heat
4. Air Conditioning
5. Gas Heat
6. Oil Heat
7. Heat Pumps
8. Light Commercial Air Conditioning
9. Light Commercial Refrigeration

### **It is recommended that:**

1. Electrical and Electric Heat competencies be completed prior to the Gas Heat or Oil Heat competencies.
2. Electrical, Electric Heat and Air Conditioning competencies be completed prior to the Heat Pump competencies.
3. Electrical and Air Conditioning competencies be completed prior to the Commercial Air Conditioning and / or Commercial Refrigeration competencies.

# Core Competencies

## Mathematics for HVACR

Demonstrate proficiency in converting fractions to decimals, and decimals to fractions.

Demonstrate proficiency in calculating squares, cubes, and roots.

Demonstrate proficiency in solving equations.

Calculate  $\Delta T$ .

Understand ratios and proportions as they relate to various equipment and components such as;

Compressors / Pumps

Pulleys

Drive systems

Fans

Calculate areas and volumes of various shapes.

Demonstrate the ability to convert English measurements to metric measurements.

Understand and demonstrate knowledge of proper duct sizing.

Explain the process and demonstrate the ability to calculate heat loss and gain for single family dwelling and residential duplex / two flat.

# Electrical

## Electrical Theory

Describe the structure of an atom.

Describe the difference between positive and negative charged atoms.

Describe potential difference.

Describe current flow.

Define impedance.

Describe and identify conductors.

Describe and identify insulators.

Describe and identify semi-conductors

Describe Ohm's Law and solve problems applying Ohm's Law.

Demonstrate proficiency in calculating the total resistance of multiple resistors in a series circuit.

Demonstrate proficiency in calculating the total resistance of multiple resistors in a parallel circuit.

Describe and demonstrate the effects of voltage drop in a series circuit.

Calculate and measure the voltage output of a transformer using the number of turns on the primary vs. the secondary sides.

## Electrical Safety

Describe and perform "Lock out and Tag" procedures.

Identify the safety ground.

Identify the "Hot" conductor.

Identify "Neutral" conductor.

Describe and demonstrate emergency first aid procedures.

## Interpreting Electrical Diagrams

Describe the difference between a "Pictorial", a "Ladder Diagram", and a "Schematic".

Identify standard electrical symbols used in schematics.

Identify inoperative/defective component using schematic wiring diagrams.

Identify voltage between two points using schematic wiring diagrams.

Determine sequence of operation using schematic wiring diagrams.

### **Knowledge of Electrical Components**

Identify the types and describe the proper application and use of "Circuit Protectors".

Identify, describe, and explain the function and application of; contactors, line starters, defrost timers, thermostats, heat anticipators, transformers, relays, loads, switches, solenoid valves, positive and negative temperature coefficient thermistors.

Evaluate and replace; contactors, line starters, defrost timers, thermostats, heat anticipators, transformers, relays, loads, switches, solenoid valves, positive and negative temperature coefficient thermistors.

### **Fundamentals of Motors / Capacitors**

Describe how capacitors are rated and tested.

Disassemble and assemble, and describe the function of the parts of an induction motor.

Define and measure Locked Rotor Amps, and Full Load Amps.

Describe how overload protectors function.

Evaluate, replace and describe the function, application and wiring of a start capacitor.

Evaluate, replace and describe the function, application and wiring of a run capacitor.

Describe and explain motor speed.

Explain and change the direction of rotation in a single phase motor.

Describe and demonstrate the method used to change rotation direction in a three phase motor.

Describe a three phase motor.

Explain the difference between a Wye and Delta three phase motor.

Demonstrate and explain the purpose of checking the resistance of motor windings.

Describe a dual voltage three phase motor and demonstrate the wiring configurations.

Describe a permanent split capacitor motor, capacitor start induction run motor, and a multi speed motor.

Describe the operation and characteristics of an Electronically Commutated Motor (ECM).

Describe and demonstrate setup and adjustment of a Variable Frequency Drive (VFD).

Describe and demonstrate setup and adjustment of a Variable Speed Drive (VSD).

### **Electrical Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involve diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the HVACR electrical system components, circuits, and/or power supply should be included in Troubleshooting and Problem Solving.*

### **Knowledge of the following test instruments and or tools is required.**

Ohmmeter

Megger

Ammeter

Capacitor analyzer

Voltmeter

Multimeter

# Electric Heat

## Theory and Application

- Differentiate between a resistive and inductive load.
- Define Coefficient of performance.
- Define Watts Law.
- Identify the formula for sensible heat.
- Describe maximum allowable voltage imbalance in a three phase circuit.
- Measure voltage imbalance in a three phase circuit.
- Identify the heating value of one Watt in BTU's.
- Describe and demonstrate the method of measuring static pressure.
- Describe the effects of relative humidity on comfort and health.
- Describe voltage tolerances.
- Describe sensible and latent heat.
- Define BTU.
- Describe the principles of dehumidification and humidification.

## Safety

- Describe and demonstrate "Lock out and Tag" procedures.
- Identify the safety ground.
- Identify the "Hot" conductor.
- Identify "Neutral" conductor.
- Describe and perform emergency first aid procedures.
- Describe and install a GFCI circuit breaker.
- Describe and demonstrate safety grounding procedures for electric motors.
- Describe the application of and test a fusible link.
- Describe and demonstrate the safe usage of extension ladders.

## Knowledge of System Components

- Describe and properly wire a dual transformer system.
- Identify the material used to construct electric heater elements.

Describe the insulating properties of mica and ceramics and their application.

Describe the operation of, and evaluate/replace a limit switch.

Describe the operation of, and evaluate/replace a heat sequencer.

Describe snap discs and their operation.

Describe the operation and purpose of, and evaluate/replace a fan interlock switch.

Describe how electric heating elements are rated.

Describe how a sequencer controls blower operation.

Evaluate and replace a heating element and a sequencer.

Describe the types and proper sizing of drive belts.

Demonstrate the proper sizing and installation of drive belts.

State the typical operating characteristics of a residential direct driven blower

Identify the various types of motor mounts used on residential furnace blower assemblies.

Evaluate, replace, and set a pressure differential switch, and describe its operation.

Evaluate and replace, a duct heater, and describe its operation

### **Installation and Service**

Describe and demonstrate the procedure to adjust air flow on a belt driven blower assembly.

Choose and install the proper bearings for a residential blower motor.

Choose and use the proper lubricant for residential blower motor maintenance.

Describe and demonstrate the method of wiring heating elements in a single phase system.

Describe procedures for retrofit of a combustion system to electric heat.

State the minimum required clearances for service and safety of an electric furnace.

Determine appropriate wire size for electric furnace installation.

Describe and demonstrate the proper soldering procedures for electrical wiring.

Describe and calculate wire sizing as it applies to voltage drop and length of wiring run.

### **Thermostat**

Identify the proper location for and install a conventional thermostat.

Explain the detailed wiring and operation of a set back programmable thermostat.

Explain the procedure for and demonstrate setting a heat anticipator on an electric furnace.

Identify the NEC code requirements for residential thermostat wiring.

### **Air Flow**

Describe and measure temperature rise.

Explain the procedure for determining CFM and demonstrate.

Describe the effects of static pressure on air flow and demonstrate.

Describe the application of and install turning vanes.

State the recommended air velocities throughout the supply and return duct system.

Measure air velocities throughout the supply and return duct system.

Describe the construction and efficiencies of varying filtering media and systems.

Describe, fabricate and install various types of duct connectors.

Describe "R" values and noise reduction elements of various duct materials.

### **Electric Heat Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the HVACR electric furnace*

*system components, circuits, air distribution system, and/or power supply may be part of the Troubleshooting and Problem Solving question area.*

**Knowledge of the following test instruments and or tools is required.**

Voltmeter	Ammeter
Ohmmeter	Megger
Thermometer (wet / dry)	Anemometer
Static pressure gauge	Velometer

## **Air Conditioning**

### **Fundamentals and Theory**

Describe the laws of Thermodynamics.

Describe and demonstrate Convection.

Describe and demonstrate Conduction.

Describe and demonstrate Radiation.

Define enthalpy and entropy.

Explain condensation of a vapor, and its effect on heat.

Explain and demonstrate vaporization of a liquid, and its effect on heat.

Describe the three states of matter.

Describe change of state.

Differentiate between absolute and gauge pressure.

Describe atmospheric pressure and the effect of altitude.

Define vacuum as it is used in the HVACR industry and demonstrate how it is measured.

Use saturation tables.

Describe the principles of dehumidification and humidification.

Describe and define the following; BTU, latent heat, sensible heat, subcooled liquid, superheated vapor, dry bulb temperature, wet bulb, temperature, and dew point.

### **Refrigerants and Refrigerant Oils**

Describe the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters.

Describe the thermodynamics of refrigerants

Identify and define; CFC's, HCFC's, and HFC's.

Identify and define the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic.

Describe fractionation and its causes.

Describe temperature glide.

### **System Components**

Describe and explain the function of, and evaluate and replace (when feasible) the following components;

evaporator

accumulator

suction line  
suction line filter  
compressor (reciprocating, scroll, rotary, screw, centrifugal)  
discharge line  
condenser  
liquid line  
receiver  
liquid line filter/drier  
pump down solenoid  
sight glass  
head pressure controls  
low pressure controls  
oil safety switch  
heat exchangers  
metering device (capillary tube, thermostatic expansion valve, automatic expansion valve).

Describe the state of refrigerant, in each major component during normal operation.

Describe and perform a compressor efficiency test.

### **Recovery / Recycling / Reclamation**

Define and demonstrate refrigerant recovery

Define and demonstrate refrigerant recycling

Define reclaim

### **Leak Detection / Testing**

Describe the six types of leak detectors.

Explain and demonstrate the method for pinpointing a leak.

Explain and demonstrate the proper use of each type of leak detector and their applicability.

Explain and demonstrate the proper use and handling of nitrogen in the leak detection process

Describe and demonstrate proper soldering and brazing techniques.

### **Evacuation and Charging**

Describe and demonstrate the operation and use of a gauge manifold assembly.

Identify and demonstrate proper charging of a blended refrigerant into an operating system.

Identify and demonstrate proper charging of a blended refrigerant into an empty system.

Identify and demonstrate proper charging of a compound refrigerant into an empty system.

Identify and demonstrate proper charging of a compound refrigerant into an operating system.

Select the proper refrigerant oil and add it to an operating system.

Describe and demonstrate charging using the superheat method.

Describe and demonstrate charging using the subcooling method.

Explain vacuum pump selection.

Describe and demonstrate the triple evacuation method.

Identify the types of micron gauges.

Explain and demonstrate the proper method of connecting and a micron gauge to the system.

### **Air Conditioning Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involve diagnostic procedures requiring the use of test equipment, manufacturers installation and start up procedures, and data plate information.*

**Knowledge of the following test instruments and or tools is required.**

Thermometers (wet and dry)  
Gauge manifold assembly  
Recovery equipment  
Vacuum pump  
Micron gauge

Refrigerant throttling valve  
Charging scale and Charging cylinder  
Soldering and brazing equipment  
Nitrogen Cylinder  
Leak detector

## **Gas Heat**

### **Combustion Theory and Heating Fuels**

State the BTU content of various fuels.

State the specific gravity of various fuels.

Describe the various categories of furnaces as classified by the National Fuel Gas Code.

State the typical flue gas temperatures of the varying categories of furnaces.

State the proper chemical names of various fuels.

Define BTU

Determine the quantity of combustion air required to burn one cubic foot of various fuels.

State the ignition temperature of various fuels.

Define and differentiate between primary air and excess air.

State the cubic feet of flue gas required for every one cu ft. of various fuels burned.

Describe and state the causes of burner "Flashback".

Describe and state the causes of a lifting flame.

Describe and state the causes of yellow flame.

Describe and state the causes of floating flame.

State the percentage of Carbon Dioxide present in the flue gases of a natural gas furnace, if perfect combustion occurred.

State the percentage of Carbon Dioxide present in the flue gases of a properly operating LP furnace.

### **Safety**

State the national standard for burners and ignition source height for a garage installation.

Describe and demonstrate ladder safety procedures.

Describe the safety procedure to be followed upon discovery of a defective heat exchanger.

State the distance that type B vent pipe must be kept from combustible materials.

State the minimum number of inches required for service access.

Determine the acceptable ppm of Carbon Monoxide in a flue gas sample.

State the proper safety procedures to follow upon discovering a gas leak.

### **Knowledge of Heating Systems and Components**

Describe the operation of and test a thermocouple.

Describe the operation of and test a millivolt generator.

Describe the operation of and test a door safety switch.

Describe the operation of and test a spark igniter.

Describe the operation of and test a hot surface igniter.

Describe the operation of and test a flame sensor.

Describe the operation of and test an ignition module.  
Describe and test the operation of gas valve used with residential furnaces.  
Describe the operation of and test a vent pressure switch.  
Describe a pilot burner and orifice and explain its operation.  
Describe a main burner and orifice and explain its operation.  
Describe the operation of and test a combustion fan limit switch.  
Describe the various fan controls and test their operation.  
Describe the operation of and test a limit switch.  
Describe the operation of and test a blower motor relay.  
Describe the operation of and test a vent motor relay.  
Describe the operation of and test a vent blower.  
Describe and inspect the condition of a heat exchanger.  
Describe, test, and install a run and start capacitor.  
Describe and set a heat anticipator on a thermostat.  
Describe and install a single stage thermostat.  
Describe and install a dual stage thermostat.  
Adjust primary air and describe the procedure.  
Describe and clean flue baffles.  
Describe and install a blower housing cut-off plate.  
State the materials used in the construction of Type B vent pipe.  
Measure static pressure and describe the appropriate range in residential furnaces.  
Describe the types of burners used on residential gas furnaces.  
Differentiate between the bonnet rating and input rating of a furnace.  
State the reason for appropriate polarity wiring on solid state circuits.  
Describe the principles of dehumidification and humidification.

## **Installation and Service**

State the generally accepted standard gas manifold pressure for a residential furnace.  
Measure manifold gas pressure.  
Describe the proper venting configurations of mid and high efficiency furnaces.  
State the National Fuel Gas Code maximum fuel line pressure drop allowance.  
State the proper procedures for installation of gas piping.  
Cut and thread gas pipe.  
State the standard acceptable supply pressures of various fuels.  
Describe the purpose of and install a fire stop support plate.  
Describe the types of and install duct connectors and hangers.  
Describe "R" values and noise reduction elements of various duct materials.  
Describe and size wire as it applies to voltage drop and length of wiring run.  
Describe and demonstrate proper soldering procedures for electrical wiring.  
Describe the procedure and adjust air flow on a belt driven blower assembly.  
State the formula for sensible heat.  
Describe the procedure to de-rate a gas furnace at altitudes of 2,000 feet and above.  
Identify the different types of conduit used for power wiring.  
Adjust blower fan speed.

## **Gas Heat Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the gas furnace system components, circuits, air distribution system, and/or power supply should be part of Troubleshooting and Problem Solving.*

**Knowledge of the following test instruments and or tools is required.**

Combustion analyzer	Tap and die set
Combustible gas detector	Pipe cutter
Carbon Monoxide detector	Pipe Reamers
Manometer	Velometer
Voltmeter	Ammeter
Soldering and brazing equipment	Ohmmeter

**Oil Heat**

**Combustion Theory and Heating Fuels**

State the BTU content of fuel oil #1 and #2.

Describe the various categories of furnaces as classified by the National Fuel Gas Code.

State typical flue gas temperatures of the varying categories of furnaces.

Define BTU

Define AFUE

State the quantity of combustion air required to burn one gallon of fuel oil.

State the ignition temperature of fuel oil.

Define and differentiate between primary air and secondary air.

State the cubic feet of flue gas produced for every one cu ft. of fuels burned.

Describe the characteristics of good burner flames.

Describe and state the causes of "Flashback".

Describe and state the causes of flame problems.

State the percentage of Carbon Dioxide present in the flue gas if perfect combustion occurred.

**Safety**

State the national standard for burners and ignition source height for a garage installation.

Describe and demonstrate ladder safety procedures.

Describe the safety procedure to be followed upon discovery of a defective heat exchanger.

State the distance that type vent pipe must be kept from combustible materials.

State the minimum number of inches required for service access.

**Knowledge of Heating Systems and Components**

Describe the operation of and test a high voltage ignition system.

Describe the operation of and test a door safety switch.

Describe the operation of and test a flame sensor.

Describe the operation of and test a primary control.

Describe and test the various types of residential furnace fuel oil units (pumps).

Describe and install fuel oil supply and return piping.

Describe the operation of and test a combustion fan limit switch.

Describe the operation of and test the various fan controls.

Describe the operation of and test a blower motor relay.

Describe a heat exchanger.

Describe the operation of, and test and install a run and start capacitor.  
Describe and set a heat anticipator on a thermostat.  
Describe and install set back programmable thermostat.  
Describe the operation of and install a single stage thermostat.  
Describe the operation of and install a dual stage thermostat.  
Adjust primary air.  
Describe and install a blower housing cut-off plate.  
State the materials used in the construction of a vent pipe.  
Describe and measure static pressure and state the appropriate range in residential furnaces.  
Describe the types of burners used on residential furnaces.  
Differentiate between the bonnet rating and input rating of a furnace.  
State the reason for appropriate polarity wiring on solid state circuits.  
Describe the construction and application of oil guns.  
Check the operation of an oil gun.  
Set "spark gap".  
Describe the purpose of and install flame detention rings  
Describe the purpose of and check the operation of delayed oil valve.  
Describe the operation of and adjust a barometric draft control.  
Describe the operation of and test a fuel unit cut-off device.  
Explain the procedure to determine combustion air requirements.  
Describe the principles of dehumidification and humidification.

### **Installation and Service**

Describe the relationship of nozzles to their application.  
Describe the proper venting configurations of standard and high efficiency furnaces.  
State the proper procedures for installation of oil piping.  
Cut and thread pipe.  
Describe and install a fire stop support plate.  
Describe and install various types of duct connectors and hangers.  
Describe "R" values and noise reduction elements of various duct materials.  
Describe wire sizing as it applies to voltage drop and length of wiring run.  
Describe and demonstrate proper soldering procedures for electrical wiring.  
Adjust air flow on a belt driven blower assembly.  
State the formula for sensible heat.  
Describe the procedure to de-rate a oil furnace at altitudes of 2,000 feet and above.  
Identify the different types of conduit used for power wiring.  
Adjust blower fan speed.  
Describe the proper location of oil storage tanks.  
Describe the equipment used and the procedure to smoke test a furnace.  
Smoke test a furnace.

### **Oil Heat Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test instruments, data plate information, and wiring diagrams. All of the oil furnace system components, circuits, air distribution system, and/or power supply should be part of Troubleshooting and Problem Solving.*

### **Knowledge of the following test instruments and or tools is required.**

Combustion analyzer	Tap and die set
Pipe cutter	Ohmmeter
Carbon Monoxide detector	Pipe Reamers

Manometer/ Magnehelic gauge  
Voltmeter  
Soldering and brazing equipment  
Stack Thermometers

Velometer  
Ammeter  
Oil Pressure Gage  
Anemometer

## Heat Pumps

### Core Competencies

Define and demonstrate refrigerant recovery  
Define and demonstrate refrigerant recycling  
Define reclaim  
Describe the six types of leak detectors.  
Explain and demonstrate the method for pinpointing a leak.  
Explain and demonstrate the proper use of each type of leak detector and their applicability.  
Explain and demonstrate the proper use and handling of nitrogen in the leak detection process.  
Describe and demonstrate proper soldering and brazing techniques.  
Describe and demonstrate the operation and use of a gauge manifold assembly.  
Identify and demonstrate the proper method of charging a blended refrigerant into an operating system.  
Identify and demonstrate the proper method of charging a blended refrigerant into an empty system.  
Identify and demonstrate the proper method of charging a compound refrigerant into an empty system.  
Identify and demonstrate the proper method of charging a compound refrigerant into an operating system.  
Describe and demonstrate charging using the superheat method.  
Describe and demonstrate charging using the subcooling method.  
Explain vacuum pump selection.  
Describe and demonstrate the triple evacuation method.  
Identify the types of micron gauges.  
Explain and demonstrate the proper method of connecting a micron gauge to the system.  
Describe the thermodynamics of refrigerants  
Describe the principles of dehumidification and humidification.

### Competencies:

Describe the function of, and install a lockout relay in a circuit.  
Describe, test, and install a run and start capacitor.  
Describe and install a compressor potential start relay.  
Describe the operation of and test a high pressure switch.  
Describe the operation of and test a low pressure switch.  
Test a blower or fan motor and its circuit.

Identify and differentiate between the various types of service valves.  
Describe and wire the terminal connections of a thermostat temperature control.  
Describe and install a liquid line drier.  
Describe and install liquid line bi-flow drier.  
Describe and install suction line filter drier.  
Describe the procedure for and perform a compressor efficiency test.  
Describe the operation of and install heat/cool relay.  
Describe the operation of the following defrost controls, mechanical, time/temperature, and solid state.  
Install and test a defrost control.  
State the purpose of and test a bimetal outdoor coil temperature sensor.  
Describe and test thermistor type temperature sensors (PTC & NTC).  
Describe a heat pump's design, configuration, and demonstrate operation in both the heating and cooling cycle.  
Describe the sequence of the defrost cycle.  
Describe the operation of, and install/test a defrost relay.  
Describe, install, and set an outdoor thermostat.  
Describe how the set points for outdoor thermostats are established.  
Describe the operation of a reversing valve.  
Describe and demonstrate the procedures for testing the operation of a reversing valve.  
State the purpose of an accumulator.  
Describe the principle of operation of a capillary tube, fixed orifice, thermostatic expansion valve, and electronic expansion valve.  
Describe and check a Control Circuit Fuse.  
Describe and check a printed circuit board (PC).  
Describe and install a heat pump thermostat with emergency heat feature.  
Describe a defrost board and its operation.  
Define SEER, HSPF, and COP.  
Describe and demonstrate heat pump charging procedures.  
Replace a reversing valve, following proper procedures .  
Describe crankcase heating methods and how they operate.  
Describe the required CFM for system operation and demonstrate the methods for calculating air flow.  
Describe a check valve, its function and operation.  
Differentiate between a compressor designed for use in a heat pump and one that is designed for use in a cooling only air conditioner.

### **Heat Pump Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers installation and start up procedures, and data plate information.*

### **Knowledge of the following test instruments and or tools is required.**

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

Ohmmeter

Ammeter

Voltmeter

Sling Psychrometer

## **Light Commercial Air conditioning**

### **Core Competencies**

Define and demonstrate refrigerant recovery

Define and demonstrate refrigerant recycling

Define reclaim

Describe the six types of leak detectors.

Explain and demonstrate the method for pinpointing a leak.

Explain and demonstrate the proper use of each type of leak detector and their applicability.

Explain and demonstrate the proper use and handling of nitrogen in the leak detection process.

Describe and demonstrate proper soldering and brazing techniques.

Describe and demonstrate the operation and use of a gauge manifold assembly.

Identify and demonstrate the proper method of charging a blended refrigerant into an operating system.

Identify and demonstrate the proper method of charging a blended refrigerant into an empty system.

Identify and demonstrate the proper method of charging a compound refrigerant into an empty system.

Identify and demonstrate the proper method of charging a compound refrigerant into an operating system.

Describe and demonstrate charging using the superheat method.

Describe and demonstrate charging using the subcooling method.

Explain vacuum pump selection.

Describe and demonstrate the triple evacuation method.

Identify the types of micron gauges.

Explain and demonstrate the proper method of connecting a micron gauge to the system.

Describe the thermodynamics of refrigerants

Describe the principles of dehumidification and humidification.

Define SEER and EER.

### **Competencies:**

Describe the function of, and install a lockout relay in a circuit.

Describe the operation of and install a contactor.

Describe, test, and install a run and start capacitor.

Describe and install a compressor potential start relay.

Describe the operation of and test a high pressure switch.

Describe the operation of and test a low pressure switch.

Test a blower or fan motor and its circuit.

Identify and differentiate between the various types of service valves.

Describe and wire the terminal connections of a thermostat temperature control.

Describe and install a liquid line drier.

Describe and install a suction line filter drier.

Describe the application and operation of the following types of compressors; (reciprocating, scroll, rotary, screw, centrifugal).

Describe and test thermistor type temperature sensors (PTC & NTC).

Describe the function and check the operation and of an oil pressure safety control.

Describe the operation of and test a solenoid valve.

Describe the operation of and test a hot gas bypass valve.

Describe the operation of and test a liquid line solenoid valve.

Describe an accumulator and its function.

Describe the operation of and adjust an inline, and pilot operated evaporator pressure regulator.

Describe a Head Master and its operation.

Describe a chilled water system and its operation.

Describe a capillary / distributor tube sizing and selection procedure.

Describe the operation of and install a fixed orifice metering device.

Describe the operation of and install a thermostatic expansion valve.

Describe the operation of and install a refrigerant receiver.

Describe an oil separator and its function.

Describe dry type evaporators and their operation.

Describe an air cooled condenser, its function, and operating parameters.

Describe and demonstrate the proper procedure for measuring and adjusting superheat.

Describe the operation and function of a flooded evaporator and its metering device.

Install and adjust a water regulating valve.

Install and adjust a low ambient temperature control.

Describe cooling towers and their operating limitations.

Describe the function and purpose of a multiple compressor system

Describe the automatic pumpdown system and its operation.

Describe the various fan controls, their application and operation.

Describe the purpose and check the operation of a crankcase heater.

Define fractionation and temperature glide.

State the reason why capillary tube systems require a critical charge.

Size, design, and install refrigerant lines.

Define compression ratio.

Describe the various methods of compressor capacity control.

State the selection process for refrigerant oils.

Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC.

Describe the required CFM for system operation and calculate air flow.

Define wet bulb depression.

Describe the design structure, function, operation, and selection of refrigerant distributors and feeder tubes.

Describe the function, selection and installation of a vibration eliminator.

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

Oil pressure gauge

Oil pump

Ohmmeter

Ammeter

Voltmeter

Sling Psychrometer

Describe the piping configuration for a multiple evaporator systems.

Install a condensate drain.

Describe and install an economizer.

Describe the principles of dehumidification and humidification.

### **Light Commercial Air Conditioning Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers installation and start up procedures, and data plate information.*

**Knowledge of the following test instruments and or tools is required.**

## **Light Commercial Refrigeration**

### **Core Competencies**

Describe the laws of Thermodynamics.

Define and demonstrate recovery

Define and demonstrate recycling

Define reclaim

Describe the six types of leak detectors.

Explain and demonstrate the method for pinpointing a leak.

Explain and demonstrate the proper use of each type of leak detector and their applicability.

Explain and demonstrate the proper use and handling of nitrogen in the leak detection process.

Describe and demonstrate proper soldering and brazing techniques.

Describe and demonstrate the operation and use of a gauge manifold assembly.

Demonstrate the proper method of charging a blended refrigerant into an operating system.

Demonstrate the proper method of charging a blended refrigerant into an empty system.

Demonstrate the proper method of charging a compound refrigerant into an empty system.

Demonstrate the proper method of charging a compound refrigerant into an operating system.

Describe and demonstrate charging using the superheat method.

Describe and demonstrate charging using the subcooling method.

Explain vacuum pump selection.

Describe and demonstrate the triple evacuation method.

Identify the types of micron gauges.

Explain and demonstrate the proper method of connecting a micron gauge to the system.

Describe the thermodynamics of refrigerants

Describe the principles of dehumidification and humidification.

### **Competencies:**

Describe the operation of and test a lockout relay.

Describe the operation of and test a contactor.

Describe, test, and install a run and start capacitor.

Describe the operation of and install compressor potential start relay.

Describe the operation of and install a compressor current start relay.

Describe a service valve and its operation.

Describe the operation of and test a high pressure switch.

Describe the operation of and test a low pressure safety switch.

Install and adjust a low pressure switch used for temperature control.

Describe the operation of and install a thermostat.

Describe the operation of and install a liquid line drier.

Describe the operation of and install a suction line filter drier.

Describe the application and operation of the following types of compressors; (reciprocating, scroll, rotary, screw, centrifugal).

Describe the operation of and adjust an oil pressure safety control.

Install and adjust a mechanical or electronic defrost timer.

Describe the operation of and test a defrost heater and a defrost terminator.

Describe defrost cycle initiation and termination.

Describe the purpose and applicability of a defrost cycle.

Describe a drain and drain pan heater and their operation.

Install a condensate drain.

Describe and test thermistor type temperature sensors (PTC & NTC).

Describe the operation of and test a solenoid valve.

Describe the operation of and test a hot gas bypass valve.

Describe the operation of and test a liquid line solenoid valve.

Describe an accumulator and its function.

Describe the operation of and install/adjust a crankcase pressure regulator (CPR).

Describe the operation of and install/adjust a evaporator pressure regulator (EPR).

Describe the operation of and install a operating pressure regulator (OPR).

Describe a Head Master and its operation.

Describe a capillary / distributor tube sizing and selection procedure.

Describe a fixed orifice metering device and its operation.

Describe the operation of and install/adjust an automatic expansion valve.

Describe the operation of and install/adjust a thermostatic expansion valve.

Describe a refrigerant receiver and its function.

Describe a oil separator and its function.

Describe dry type evaporators and their operation.

Describe an air cooled condenser, its function, and operating parameters.

Describe the proper procedure for measuring and adjusting superheat.

Describe the proper maintenance of a low temperature evaporator.

Describe the operation and function of a flooded evaporator and its metering device.

Describe types of water cooled condensers and their operation.

Install and adjust a water regulating valve.

Describe and test low ambient temperature controls.

Describe cooling towers and their operating limitations.

Describe the function and purpose of a multiple compressor system.

Describe the purpose and proper selection of, and install a suction line heat exchanger.

Describe a cascade system its application and operation.

Describe the automatic pumpdown system and its operation.

Describe the operation of and test various fan controls.

Describe the purpose of and check the operation of a crankcase heater.

Define and state the applications of High, Medium, and Low temperature refrigeration.

Define fractionation and temperature glide.

State the reason why capillary tube systems require a critical charge.

Define "Expendable Refrigerant".

Define and explain the use of high humidity evaporator coils.

Size, design and install refrigerant lines.

Determine refrigerant line pressure drop and explain the effects of pressure drop on a system.

Define compression ratio.

Describe the various methods of compressor capacity control.

Describe the function, selection and installation of a vibration eliminator.

Describe the basic operation of ice makers.

State the selection process for refrigerant oils.

Add refrigerant oil to an operating system.

Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC.

Define Cryogenics.

Describe the design structure ,function, operation, and selection of refrigerant distributors and feeder tubes.

### **Commercial Refrigeration Troubleshooting and Problem Solving**

*Troubleshooting and Problem Solving involves diagnostic procedures requiring the use of test equipment, manufacturers installation and start up procedures, and data plate information.*

### **Knowledge of the following test instruments and or tools is required.**

Thermometers (wet and dry)

Vacuum pump

Leak detector

Soldering and brazing equipment

Charging scale and Charging cylinder

Refrigerant throttling valve

Oil pressure gauge

Oil pump

Ohmmeter

Ammeter

Voltmeter

Sling Psychrometer

Gauge manifold assembly

Recovery equipment

Micron gauge

Nitrogen Cylinder