



**The Benchmark
of
Academic and Technical Excellence**

**Minimum Tasks and Competencies
for
HVAC Excellence
Accredited Programs**

HVAC Excellence
P.O. Box 491
Mount Prospect, IL 60056

Tele: 1-800-394-5268
Fax: 1-800-546-3726
www.hvacexcellence.org

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 are prerequisites to Gas Heat or Oil Heat competencies.
2. Electrical, Electric Heat and Air Conditioning competencies are prerequisites to Heat Pump competencies.
3. Electrical and Air Conditioning competencies are prerequisites to Commercial Air Conditioning and / or Commercial Refrigeration competencies.

Core Competencies

Mathematics for HVACR

Students should have knowledge of:

- Converting fractions to decimals, and decimals to fractions
- Calculating squares, cubes, and roots for area and volume
- Solving basic equations
- Calculating ΔT
- Converting English measurements to metric measurements
- Ratios and proportions as they relate to various equipment and components such as;
 - Compressors / Pumps
 - Pulleys
 - Drive systems
 - Fans

Students should be able to:

- Demonstrate proficiency in converting fractions to decimals, and decimals to fractions
- Demonstrate proficiency in calculating squares, cubes, and roots
- Demonstrate proficiency in solving equations
- Demonstrate the ability to calculate ΔT
- Demonstrate the ability to calculate areas and volumes of various shapes
- Demonstrate the ability to convert English measurements to metric measurements
- Calculate ratios and proportions for various equipment and components such as;
 - Compressors / Pumps
 - Pulleys
 - Drive systems
 - Fans

HVACR General Studies

Students should have knowledge of:

- HVACR industry organizations
- Energy resources
- Air and water vapor thermodynamics
- Energy auditing
- Energy efficiency ratings
- Psychrometrics
- Duct sizing formulas
- Heat loss and gain

Students should be able to:

Calculate duct sizing, using duct sizing formulas

Describe the process and demonstrate the ability to calculate a residential structure heat loss and gain

Define and differentiate between Renewable and Sustainable energy

State the meaning of the follow acronyms BIM, CBECS, ECM, EIA

Describe an energy audit

Describe a Life Cycle cost Analysis

Define: EER, SEER, AFUE, HSPF, COP, ECM

Define psychrometrics fundamentals.

Explain the thermodynamics of air and water vapor

Explain the water vapor cycle in the Earth's atmosphere

Define standard air volume and density

Identify each line on a psychrometric chart

Explain the properties of each line on a psychrometric chart

Plot any two basic points on the psychrometric chart and evaluate the data

Explain the comfort zone and the different temperatures and relative humidity's effect on human comfort

Describe the eight processes of air conditioning and how to plot each on a psychrometric chart

Define and use the Process Triangle on the psychrometric chart to calculate, sensible heat, latent heat and total heat

Explain sensible heat ratio

Calculate mixed air problems for infiltration and ventilation

Develop critical thinking skills including analysis, evaluation, calculations, and the use of computer technology

Electrical

Students should have knowledge of:

- The structure of an Atom
- Electrical Theory and Ohms Law
- Electrical Safety
- Direct current
- Alternating current
- Electrical Components
- The fundamentals of motors
- Interpreting Electrical Diagrams
- Electrical Troubleshooting and Problem Solving

Students should be able to:

- Define the structure of an atom
- Describe the difference between positive and negative charged atoms
- Describe potential difference
- Describe current flow
- Describe Ohm's Law and solve problems applying Ohm's Law
- 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
- Define impedance
- Define and identify conductors
- Describe and identify insulators
- Define and identify semi-conductors
- 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
 - Relays
 - Loads, switches
 - Solenoid valves
 - Transformers
 - Positive temperature coefficient thermistors
 - Negative temperature coefficient thermistor
- Describe how capacitors are rated and tested
- 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 a three phase motor
- Explain the difference between a Wye and Delta three phase motor
- Describe a dual voltage three phase motor
- 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 the difference between a "Pictorial", a "Ladder Diagram", and a "Schematic"
- Identify electrical symbols used in HVACR 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

Students should have knowledge of and be able to describe and demonstrate the following safety requirements

Ladder safety procedures
Describe and perform "Lock out and Tag" procedures.
Identify the safety ground.
Identify the "Hot" conductor.
Identify "Neutral" conductor.
Electrical Shock, prevention and first aid
Electrical Burns, prevention and first aid
Describe and demonstrate emergency first aid procedures.

Students must have Knowledge of Electrical Systems and Components and be able to:

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

Evaluate and replace:

Contactors	Loads, switches
Line starters	Solenoid valves
Defrost timers	Transformers
Thermostats	Positive temperature coefficient thermistors
Heat anticipators	Negative temperature coefficient thermistor
Relays	

Define and measure Locked Rotor Amps, and Full Load Amps.
Disassemble and assemble, and describe the function of the parts of an induction motor.
Describe and demonstrate the method used to change rotation direction in a three phase motor.
Describe a dual voltage three phase motor and demonstrate the wiring configurations.
Demonstrate and explain the purpose of checking the resistance of motor windings.
Describe and demonstrate setup and adjustment of a Variable Frequency Drive (VFD).
Describe and demonstrate setup and adjustment of a Variable Speed Drive (VSD).
Determine sequence of operation using schematic wiring diagrams.

Students must have the knowledge skills and ability to:

Service, install equipment power supply.
Service, install equipment control circuit.
Clean evaluate and install a contactor.
Clean evaluate and install a control relay.
Evaluate and install start relays (current, potential, and solid state).
Evaluate and install a defrost timer.
Evaluate and install a line starter.
Evaluate and install a digital thermostat.
Clean, service and evaluate and install a single stage thermostat.
Clean, service and evaluate and install a dual stage thermostat.
Evaluate and install a transformer.
Evaluate and install a solenoid valve.
Evaluate and install temperature coefficient thermistors.
Clean, evaluate and install a run and start capacitor.
Clean evaluate and install different types of motors (Shaded pole, split phase, PSC, CSR, and ECM).
Adjust blower fan speed.
Draw and interpret electrical diagrams for the purpose of troubleshooting

Electrical Troubleshooting and Problem Solving

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.

Contactors

Line starters

Defrost timers

Thermostats

Heat anticipators

Relays

Loads, switches

Solenoid valves

Transformers

Positive temperature coefficient thermistors

Negative temperature coefficient thermistor

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

Ohmmeter

Multimeter

Ammeter

Voltmeter

Wattmeter

Megger meter

Capacitor analyzer

Electric Heat

Students should have knowledge of:

Electric Heat Theory	Safety
System Components	Thermostats
Installation and Service Procedures	Air Flow
Electric Heat Troubleshooting and Problem Solving	

Students should be able to:

- Define BTU
- 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 the 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
- Describe the principles of dehumidification and humidification
- Describe and 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 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
- Describe the types and proper sizing of drive belts
- State the typical operating characteristics of a direct drive blower
- Identify the various types of motor mounts used on residential furnace blower assemblies
- Describe procedures for retrofit of a 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
- Identify the proper location for and install a conventional thermostat
- Explain the detailed wiring and operation of a setback programmable thermostat
- Explain the procedure for setting a heat anticipator on an electric furnace
- Identify the NEC code requirements for residential thermostat wiring
- Explain the procedure for determining CFM
- State the recommended air velocities throughout the supply and return duct system
- Describe the construction and efficiencies of varying filtering media and systems
- Describe "R" values and application of various duct insulation materials
- Describe the effects of static pressure on air flow

Students should have knowledge of and be able to demonstrate the following safety requirements

- Ladder safety procedures
- Describe and perform "Lock out and Tag" procedures
- Identify the safety ground
- Identify the "Hot" conductor
- Identify "Neutral" conductor
- 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. Electrical Shock, prevention and first aid
- Electrical Burns, prevention and first aid
- Describe and demonstrate emergency first aid procedures

Students must have Knowledge of Electric Heat and Components and be able to:

- Evaluate and install a limit switch
- Evaluate and replace a heating element and a sequencer
- Demonstrate the proper sizing and installation of drive belts
- Evaluate, describe its operation, install, and set a pressure differential switch
- Evaluate, describe its operation, and install a duct heater
- Explain and measure temperature rise
- Demonstrate the procedure for finding CFM
- Demonstrate and determine the amp draw of electric heating element
- Set a heat anticipator on an electric furnace
- Measure the effects of static pressure on air flow
- Measure air velocities throughout the supply and return duct system
- Describe the application of and install turning vanes
- Describe and demonstrate the procedure to adjust air flow on a belt driven blower assembly
- Choose and install the proper bearings for a residential belt driven blower assembly
- 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 and demonstrate the method of wiring heating elements in a three-phase system (wye or delta)
- Describe, fabricate and install various types of duct connectors
- Install a setback programmable thermostat

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

Students should have knowledge of:

- Leak detectors
- The laws of Thermodynamics
- Psychrometrics
- Recovery and recycling processes
- Refrigerant leak detection and types of leak detectors
- Heat transfer Convection, Conduction, and Radiation
- The three states of matter
- Atmospheric pressure and the effect of altitude
- Absolute and gauge pressure
- Refrigerant piping
- Soldering and brazing
- Refrigerant charging methods

Students should be able to:

- Define enthalpy and entropy
- Explain condensation of a vapor, and its effect on heat
- Explain vaporization of a liquid, and its effect on heat
- Describe change of state
- Define vacuum as it is used in the HVACR industry
- Describe the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters
- Describe the thermodynamics of refrigerants
- Identify and define the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic
- Identify and define; CFC's, HCFC's, and HFC's
- Describe fractionation and its causes
- Describe temperature glide
- Define and demonstrate refrigerant recovery
- Define and demonstrate refrigerant recycling
- Define reclaim
- Describe the six types of leak detectors
- Explain the method for pinpointing a leak.
- Explain the proper use of each type of leak detector and their applicability.
- Explain the proper use and handling of nitrogen in the leak detection process
- Describe the principles of dehumidification and humidification.
- Describe and define the following; BTU, latent heat, sensible heat,
- Describe and define the following; subcooled liquid, superheated vapor.
- Describe and define the following; wet bulb temperature, dry bulb temperature, and dew point.

Students should have knowledge of and be able to describe and demonstrate the following safety requirements

- Ladder and fall protection safety procedures
- Lock Out and Tag Out procedures
- Proper and safe handling of refrigerants
- Proper PPE requirements
- Emergency First Aid procedures
- Proper use of hand tools

Students must have Knowledge of Air Conditioning Systems and Components and be able to:

- Describe and explain the function of the following components;
 - Evaporator
 - Accumulator
 - Condenser
 - Receiver
 - Sight glass
 - Pump-down solenoid
 - Head pressure controls
 - Heat exchangers
 - Metering device (capillary tube, thermostatic expansion valve, automatic expansion valve)
 - Discharge line
 - Liquid line
 - Suction line
 - Suction line filter
 - Liquid line filter/drier
 - Oil safety switch
 - Low pressure controls

Compressor (reciprocating, scroll, rotary, screw, centrifugal)
 Describe the state of refrigerant, and explain what occurs in each major component during normal operation
 Describe a compressor efficiency test.
 Describe proper soldering and brazing techniques.
 Describe the operation and use of a gauge manifold assembly.
 Identify proper charging of a blended refrigerant into an operating system.
 Identify proper charging of a blended refrigerant into an empty system.
 Identify proper charging of a compound refrigerant into an empty system.
 Identify proper charging of a compound refrigerant into an operating system.
 Describe charging using the superheat method.
 Describe charging using the subcooling method.
 Explain vacuum pump selection
 Describe the triple evacuation method.
 Identify the types of micron gauges.

Students must have the knowledge skills and ability to:

To measure wet and dry-bulb temperatures
 To measure vacuum
 Use saturation tables.
 Properly use a gauge manifold assembly.
 To obtain gauge pressure using compound gauges and convert to absolute
 To pinpoint a refrigerant leak in a system
 The proper use and handling of nitrogen in the leak detection process
 Demonstrate proper use of leak detectors.
 Demonstrate use of a vacuum pump
 Demonstrate the proper method of connecting a micron gauge
 Demonstrate the triple evacuation method.
 Demonstrate proper charging of HCFC and HFC refrigerants into an operating system
 Demonstrate proper charging of HCFC and HFC refrigerants into an empty system
 Select the proper and add refrigerant oil it to an operating system.
 Demonstrate charging using the manufacturers literature
 Determine superheat and subcooling on an operating system
 Calculate and demonstrate the weigh-in charging method
 Demonstrate charging using the superheat method.
 Demonstrate charging using the subcooling method
 Select the proper refrigerant oil and add it to an operating system.
 Solder and braze using correct techniques
 Perform a compressor efficiency test.
 To evaluate, clean, and replace (when feasible) the following components;
 Evaporator
 Accumulator
 Condenser
 Receiver
 Sight glass
 Pump-down solenoid
 Head pressure controls
 Heat exchangers
 Metering device (capillary tube, thermostatic expansion valve, automatic expansion valve)
 Compressor (reciprocating, scroll, rotary, screw, centrifugal)
 Discharge line
 Liquid line
 Suction line
 Suction line filter
 Liquid line filter/drier
 Oil safety switch
 Low pressure controls

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)	Refrigerant throttling valve
Gauge manifold assembly	Charging scale and charging cylinder
Recovery equipment	Soldering and brazing equipment
Vacuum pump	Nitrogen Cylinder
Micron gauge	Leak detector

Gas Heat

Students should have knowledge of:

- Combustion Theory and Heating Fuels
- BTU content of natural gas and propane gas
- Specific gravity of natural gas and propane gas
- Venting categories (i.e. category I II III IV)
- Typical flue gas temperatures of furnaces
- Chemical names of natural gas and propane gas
- The quantity of combustion air required to burn 1 cubic foot of natural gas and propane gas
- The ignition temperature of natural gas and propane gas

Students should be able to:

- Define BTU
- Define AFUE
- Define and differentiate between primary air and excess air.
- Describe and state the causes of burner "Flashback"
- Describe and state the causes of a lifting flame.
- State the maximum percentage of Carbon Dioxide produced by the perfect combustion of natural gas
- State the maximum percentage of Carbon Dioxide produced by the perfect combustion of propane gas
- State the reason for appropriate polarity wiring on solid state circuits
- State the generally accepted standard gas manifold pressure for a residential furnace
- State the formula for sensible heat.

Students should have knowledge of and be able to describe and demonstrate the following safety requirements

- Ladder safety procedures
- Clearances to combustibles for venting materials
- Maximum level of Carbon monoxide in ppm in a flue gas sample
- Proper safety procedures to follow on discovery of a gas leak.

Students must have Knowledge of Heating Systems and Components and be able to:

- Describe an orifice and its function
- Describe a pilot burner and its function
- Describe an in-shot burner and its operation
- Describe the function of a heat anticipator
- Describe the function of a dual stage thermostat
- Describe the function flue baffles
- Describe a blower housing cut-off plate
- Describe the principles of humidification
- Describe the principles of dehumidification
- Describe the operation of and the testing method for:
 - Thermocouple
 - Thermopile
 - Door safety switch
 - Spark igniter
 - Hot surface igniter
 - Flame sensor
 - Ignition module
 - Run and start capacitor
 - Vent blower
 - Vent motor relay
 - Vent pressure switch
 - Blower motor relay
 - Combination fan and limit switch
 - Gas valve used with residential furnaces
- 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.
- 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.

Students must have the knowledge skills and ability to:

Cut and thread gas pipe

Install a fire stops support plate

Install duct connectors and hangers

Adjust blower fan speed

Clean, service, install and evaluate:

Heat exchanger

Thermopile

Door safety switch

Spark igniter

Hot surface igniter

Flame sensor

Ignition module

Residential gas valve

Vent pressure switch

Orifice

Pilot burner

Thermocouple

Combination fan and limit switch

Blower motor relay

In-shot burner

Vent motor relay

Vent blower motor

Run and start capacitor

Single stage thermostat

Dual stage thermostat

Flue baffles

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

Combustible gas detector

Carbon Monoxide detector

Soldering and brazing equipment

Velometer

Ammeter

Ohmmeter

Voltmeter

Manometer

Pipe Reamers

Pipe cutter

Tap and die set

Oil Heat

Students should have knowledge of:

Combustion Theory

- BTU content of fuel oil #1 and #2.
- Venting categories (i.e. category I II III IV)
- Specific gravity of #2 fuel oil
- Typical flue gas temperatures of oil furnaces
- The quantity of combustion air required to burn gallon of #2 fuel oil
- Pour point
- Viscosity
- Minimum flash point

Students should be able to:

- Define BTU
- Define AFUE
- State the quantity of combustion air required to burn one gallon of fuel oil
- Define and differentiate between primary air and excess air
- State the cubic feet of flue gas produced for every gallon of fuel burned.
- State the maximum percentage of Carbon Dioxide produced by the perfect combustion #2 fuel oil
- State the reason for appropriate polarity wiring on solid state circuits
- State the formula for sensible heat.

Students should have knowledge of and be able to demonstrate the following safety requirements

- Ladder safety procedures
- Clearances to combustibles for venting materials
- Flue gas testing procedures for carbon monoxide
- Ambient air testing procedures for carbon monoxide
- Proper safety procedures to follow on discovery of an oil leak
- Describe the safety procedure to be followed upon discovery of a defective heat exchanger

Students must have Knowledge of Heating Systems and Components and be able to:

- Describe function of a thermostat heat anticipator
- Describe the function of a programmable thermostat
- Describe the procedure to measure static pressure
- Describe the function of flue baffles
- Describe a blower housing cut-off plate
- Describe the principles of humidification
- Describe the principles of dehumidification
- Describe the procedure to de-rate an oil furnace at altitudes of 2,000 feet and above
- Identify the different types of conduit used for power wiring
- Describe the purpose and operation of delayed action solenoid valve
- Describe the function of a barometric draft control
- Describe the testing and adjustment procedure of a barometric draft control
- Describe the function of and the testing method for a fuel unit cut-off
- Describe the function of a fire stop support plate
- Identify duct connectors and hangers
- Explain "R" value and noise reduction elements of various duct materials
- Describe wire sizing as it applies to voltage drop and length of wiring run
- Describe and proper soldering procedures for electrical wiring
- Describe the procedure to adjust air flow on a belt driven blower assembly
- Identify the different types of conduit used for power wiring
- Describe the procedure to perform a smoke density test on an oil furnace
- 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

Describe the operation of and the testing method for a:

high voltage ignition system	blower motor relay
door safety switch	heat exchanger
cadmium sulfide cell	run and start capacitor
burner primary safety control	single stage thermostat
fuel oil pump	dual stage thermostat
fan and limit switch	

Students must have the knowledge skills and ability to:

Measure static pressure

Install duct connectors and hangers

Adjust air flow on a belt driven blower assembly

Perform a smoke density test on an oil furnace

Clean, service, install and evaluate a:

High voltage ignition system	Combination fan and limit switch
Door safety switch	Evaluate a blower motor relay
Cadmium sulfide cell	Heat exchanger
Burner primary safety control	Run and start capacitor
Fuel oil pump	Blower assembly
Barometric draft control	

Service and install:

Programmable thermostat	Fire stop support plate
Single stage thermostat	Delayed action solenoid valve
Dual stage thermostat	Electrical wiring

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 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	Stack Thermometers
Carbon Monoxide detector	Ammeter
Manometers	Anemometer
Ohmmeter	Tap and die set
Velometer	Pipe cutter
Pressure Gages	Pipe Reamers
Voltmeter	Soldering and brazing equipment

Heat Pumps

Students should have knowledge of:

- Refrigerant recovery
- Refrigerant recycling
- Refrigerant reclamation
- Refrigerant charging
- Soldering and brazing techniques.
- Refrigerant thermodynamics
- Residential air conditioning and electric heating systems
- Psychrometrics

Students should have knowledge of and be able to demonstrate the following safety requirements

- Ladder safety procedures
- Fall prevention procedures
- Refrigerant handling
- Nitrogen handling procedures

Students must have Knowledge of Heat Pump Systems and Components and be able to:

- Describe the principles of dehumidification and humidification
- Describe the six types of leak detectors
- Describe the method of pinpointing a refrigerant leak
- Explain the use and handling of nitrogen in the leak detection process
- Explain the operation and use of a gauge manifold assembly
- Determine proper charging of HCFC and HFC refrigerants into an operating system
- Determine proper charging of HCFC and HFC refrigerants into an empty system
- Select the proper refrigerant oil for an operating system
- Explain charging using the manufacturers literature
- Determine required superheat and subcooling for an operating system
- Calculate the amount of refrigerant required for a system to weigh-in a charge
- Explain charging using the superheat method
- Explain charging using the subcooling method
- Describe the triple evacuation method
- Identify the types of micron gauges
- Explain the method for connecting a micron gauge to the system
- Describe the function of a lockout relay in a circuit
- Describe the function of and the testing method for a run and start capacitor
- Describe and install a compressor potential start relay
- Describe the operation of and the testing method for a high pressure switch
- Describe the operation of and the testing method for a low pressure switch
- Identify and differentiate between the various types of service valves
- Explain the function of a liquid line drier
- Explain the function of a liquid line bi-flow drier
- Explain the function of a suction line filter drier
- Describe the procedure to perform a compressor efficiency test
- Describe the operation of a heat/cool relay
- Describe the operation of the following defrost controls, mechanical, time/temperature, and solid state
- State the purpose of and testing method for a bimetal outdoor coil temperature sensor
- Describe a thermistor type temperature sensor (PTC & NTC).
- Describe a heat pump's design, configuration for both the heating and cooling cycle
- Describe the sequence of the defrost cycle
- Describe the operation of and the testing method for a defrost relay
- Describe the function of and testing method for an outdoor thermostat
- Describe the function and the control methods used by an indoor electronic thermostat
- Explain how the set points for outdoor thermostats are established
- Describe the operation of a reversing valve.
- Describe the procedures for testing the operation of a reversing valve
- State the purpose of an accumulator and how it is constructed
- Describe the principle of operation of a capillary tube

Describe the principle of operation of a fixed orifice
Describe the principle of operation of a thermostatic expansion valve
Describe the principle of operation of an electronic expansion valve.
Describe the function of and the testing method for a control circuit fuse
Describe a heat pump thermostat with emergency heat feature
Describe a defrost board and its operation
Define SEER, HSPF, and COP
Describe heat pump charging procedures
Describe crankcase heating methods and how they operate
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

Students must have the knowledge skills and ability to:

Find and repair a refrigerant leak
Handle and use nitrogen in the leak detection process
Demonstrate the operation and use of a gauge manifold assembly
Correctly use a micron gauge
Connect a micron gauge to the system
Perform the triple evacuation method
Demonstrate proper charging of HCFC and HFC refrigerants into an operating system
Demonstrate proper charging of HCFC and HFC refrigerants into an empty system
Select the proper and add refrigerant oil to an operating system
Demonstrate charging using the manufacturers literature
Calculate and demonstrate the weigh-in charging method
Accurately charge using the superheat method
Accurately charge using the subcooling method
Describe the function of a lockout relay in a circuit
Test and install a run and start capacitor
Evaluate and install a compressor potential start relay
Evaluate and install a high pressure switch
Evaluate and install a low pressure switch
Evaluate and install a service valve
Evaluate and install a liquid line drier
Evaluate and install a liquid line bi-flow drier
Evaluate and install a suction line filter drier
Perform a compressor efficiency test
Install a heat/cool relay
Install a mechanical defrost control
Install a time/temperature defrost control
Install a solid state defrost control
Service and install a bimetal outdoor coil temperature sensor.
Service and install a thermistor type temperature sensor (PTC & NTC)
Service and install a defrost relay
Service and install an outdoor thermostat.
Evaluate and replace a reversing valve
Evaluate and replace an accumulator
Evaluate and replace a capillary tube
Service and install a fixed orifice
Service and install a thermostatic expansion valve
Service and install an electronic expansion valve.
Service and install a Control Circuit Fuse.
Install a printed circuit board (PC).
Install a heat pump thermostat with emergency heat feature
Evaluate and replace a defrost board
Measure system air flow
Evaluate and replace a check valve

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

Students should have knowledge of:

- Leak detectors
- The laws of Thermodynamics
- Recovery and recycling processes
- Refrigerant leak detection and types of leak detectors
- Refrigerant piping
- Soldering and brazing
- Refrigerant types
- System components such as:
 - Metering devices
 - Receivers
 - Pressure controls
 - Suction accumulators
 - Refrigerant flow and control valves
- Evacuation methods and equipment
- Refrigerant charging methods

Students should be able to:

- Identify and differentiate between the various types of service valves
- Describe the application and operation of the following types of compressors; (reciprocating, scroll, rotary, screw, centrifugal)
- Identify the types of micron gauges
- Describe an accumulator and its function
- 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 an oil separator and its function
- Describe dry type evaporators and their operation
- Describe an air cooled condenser, its function, and operating parameters
- Describe cooling towers and their operating limitations
- Describe the function and purpose of a multiple compressor system
- Describe the automatic pump-down 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
- 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
- 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
- Describe the piping configuration for a multiple evaporator systems
- Describe the operation of an economizer
- Describe the principles of dehumidification and humidification
- Describe the thermodynamics of refrigerants
- Describe the principles of dehumidification and humidification
- Define SEER and EER
- Describe different types of leak detectors

Students should have knowledge of and be able to describe and demonstrate the following safety requirements

- Describe and perform "Lock out and Tag" procedures.
- System leak-test pressures and nitrogen regulator installation and adjustment
- Explain and demonstrate the proper method of connecting a micron gauge to the system.

Students must have Knowledge of Light Commercial Air conditioning Systems and Components and be able to:

Define and demonstrate refrigerant recovery
Define and demonstrate refrigerant recycling
Explain and demonstrate the method for pinpointing a leak.
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.
Describe and demonstrate the triple evacuation method.
Explain and demonstrate the proper method of connecting a micron gauge to the system.
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.
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 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 the operation of and adjust an inline, and pilot operated evaporator pressure regulator.
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 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.
Size, design, and install refrigerant lines.
Describe the required CFM for system operation and calculate air flow.
Install and properly adjust an economizer
Install a condensate drain.

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.

Ammeter	Oil pressure gauge
Ohmmeter	Oil pump
Voltmeter	Nitrogen Cylinder
Micron gauge	Vacuum pump
Sling Psychrometer	Refrigerant throttling valve
Thermometers (wet and dry)	Recovery equipment
Leak detector	Charging scale and charging cylinder
Gauge manifold assembly	Soldering and brazing equipment

Light Commercial Refrigeration Core Competencies

Students should have knowledge of:

- The laws of Thermodynamics
- Recovery and recycling processes
- Refrigerant leak detection and types of leak detectors
- Refrigerant piping
- Soldering and brazing
- Refrigerant types
- System components such as:
 - Metering devices
 - Receivers
 - Pressure controls
 - Suction accumulators
 - Refrigerant flow and control valves
- Evacuation methods and equipment
- Refrigerant charging methods

Students should have knowledge of and be able to describe and demonstrate the following safety requirements

- Describe and perform “Lock out and Tag” procedures.
- System leak-test pressures and nitrogen regulator installation and adjustment
- Explain and demonstrate the proper method of connecting a micron gauge to the system.

Students must have Knowledge of Light Commercial Refrigeration Systems and Components and be able to:

- Define and demonstrate recovery
- Define and demonstrate recycling
- Define reclaim
- Explain the method for pinpointing a leak.
- Explain the proper use of leak detectors and their applicability.
- Explain the proper use and handling of nitrogen in the leak detection process.
- Describe proper soldering and brazing techniques.
- Describe the operation and use of a gauge manifold assembly.
- Describe proper charging of HCFC and HFC refrigerants into an operating system
- Describe proper charging of HCFC and HFC refrigerants into an empty system
- Select the proper refrigerant oil a system
- Describe charging using the manufacturers literature
- Calculate the required amount of refrigerant for the weigh-in charging method
- Accurately calculate charge for using the superheat method
- Accurately calculate charge for using the subcooling method
- Explain vacuum pump selection
- Describe the triple evacuation method
- Identify the types of micron gauges
- Describe the thermodynamics of refrigerants
- Describe the principles of dehumidification and humidification
- Determine refrigerant line pressure drop and explain the effects of pressure drop on a system
- Describe a cascade system its application and operation
- Describe the automatic pump-down system and its operation
- Describe a service valve and its operation
- Describe the application and operation of the following types of compressors; (reciprocating, scroll, rotary, screw, centrifugal)
- 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
- 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 a refrigerant receiver and its function
 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 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
 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 the operation of and test various fan controls
 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
 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
 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

Students must have the knowledge skills and ability to:

Install and adjust a low pressure switch used for temperature control
 Install a condensate drain
 Size, design and install refrigerant lines
 Add refrigerant oil to an operating system
 Install and evaluate the operation of:

Lockout relay	Thermostat
Contactors	Liquid line drier
Run and start capacitor	Suction line filter drier
Potential start relay	Oil pressure safety control
Current start relay	defrost heater
Compressor	defrost terminator
High pressure switch	mechanical or electronic defrost timer
Solenoid valve	temperature sensors (PTC & NTC)
Hot gas bypass valve	crankcase pressure regulator (CPR)
Liquid line solenoid valve	evaporator pressure regulator (EPR)
Pressure regulator (OPR)	automatic expansion valve
Thermostatic expansion valve	water regulating valve
Ambient temperature controls	accumulator
Crankcase heater	

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.

Ammeter	Oil pressure gauge
Ohmmeter	Oil pump
Voltmeter	Nitrogen Cylinder
Micron gauge	Vacuum pump
Sling Psychrometer	Refrigerant throttling valve
Thermometers (wet and dry)	Recovery equipment
Leak detector	Charging scale and charging cylinder
Gauge manifold assembly	Soldering and brazing equipment



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