Competency and Task List
Supplement for program alignment to nationally established standards

Revised January 2017
The HVAC Excellence competency and task list assist instructors in providing their students with the knowledge and skills necessary for employment in the HVACR industry. The competency and task list covers the basics that should be incorporated in most HVACR educational programs. The specific school curriculum will dictate the competencies required, and may require additional competencies be added.

While no specific text books are required to integrate the competency and task list, a number of publishers have cross walked their publications to this list. Your specific publisher can provide you with valuable assistance when selecting materials for your program.

There is continual pressure for increased accountability in career and technical education programs. As a result, increasing numbers of HVACR programs are using some form of discipline - specific course assessments or end of program employment ready certification. In most cases this involves objective or standardized testing. This competency and task list is an excellence resource to ensure a program is aligned with nationally established certifications, including the stackable credentials offered by HVAC Excellence.

The following are the minimum competencies 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. Air Conditioning
4. Heat Pumps
5. Electric Heat
6. Light Commercial Air Conditioning
7. Light Commercial Refrigeration
8. Gas Heat
9. Oil Heat

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.
## Competency and Task List

### Core Competencies

**Mathematics for HVAC**

- Adding, subtracting, multiplying, and dividing decimal numbers including negative numbers
- Adding, subtracting, multiplying, and dividing fractions
- Adding, subtracting, multiplying, and dividing whole numbers including negative numbers
- Calculating $\Delta T$
- Calculating squares, cubes, and roots for area and volume
- Converting English measurements to Metric measurements and Metric to English
- Converting fractions to decimals, and decimals to fractions
- Measure length, area, and volume using both inch pound (English) and SI (metric) measurements
- Solving basic equations
- Manipulate ratios and proportions as they relate to various equipment and components such as:

  - **Compressors**
  - **Pumps**
  - **Drive systems**
  - **Fans**

### HVACR General Studies

- HVACR industry organizations
- Energy resources
- Energy efficiency ratings
- Defining and differentiating between Renewable and Sustainable energy
- Life Cycle cost Analysis
- The meaning of the follow acronyms BIM, CBECS, ECM, EIA, EER, SEER, AFUE, HSPF, COP, ECM
- Energy auditing
- The thermodynamics of air and water vapor
- The water vapor cycle in the Earth’s atmosphere
- Standard air volume and density
- Psychrometrics
- The properties of each line on a psychrometric chart
- Plotting any two basic points on the psychrometric chart and evaluating the data
- Describing the eight processes of air conditioning and how to plot each on a psychrometric chart
- Defining and use the Process Triangle on the psychrometric chart to calculate, sensible heat, latent heat and total heat
- Explaining the comfort zone and the different temperatures and relative humidity's effect on human comfort
- Explaining sensible heat ratio
- Calculating mixed air problems for infiltration and ventilation
- Calculating residential structure heat loss and gain
- Calculating duct sizing, using duct sizing formulas
- Developing critical thinking skills including analysis, evaluation, calculations, and the use of computer technology
Competency and Task List

Electrical Safety
The structure of an Atom
Direct current
Alternating current
Positive and negative charged atoms
Potential difference
Current flow
Ohm’s Law and solving problems applying to Ohm’s Law
Watts Law
Series and Parallel circuit rules
The effects of voltage drop, amps, and resistance in a series circuit
The effects of voltage, amps, and resistance in a parallel circuit
The effects of voltage, amps, and resistance in a combination series-parallel circuit
Impedance and how it effects a circuits
Interpreting Electrical Diagrams
Calculating and measuring the voltage output of a transformer using the number of turns on the primary vs. the secondary sides
Defining and identifying conductors
Describing and identifying insulators
Describing and identifying semi-conductors
Identifying the types and describing the proper application and use of “Circuit Protectors”
Overload protectors construction and function
Evaluating, replacing, and describing the function, application and wiring of a start capacitor
Evaluating, replacing and describing the function, application and wiring of a run capacitor
The fundamentals of single phase and three phase motors
Defining and measuring Locked Rotor Amps, and Full Load Amps
Demonstrating and explaining the purpose of checking the resistance of motor windings
Describing a dual voltage three phase motor
Describing a dual voltage three phase motor and demonstrating the wiring configurations
Describing a permanent split capacitor motor, capacitor start induction run motor, and a multi speed motor
Describing the operation and characteristics of motor speed drives
Describing and demonstrating setup and adjustment of a Variable Frequency Drive (VFD)
Describing and demonstrating setup and adjustment of a Variable Speed Drive (VSD)
Describing and demonstrating the method used to change rotation direction in a three phase motor
Describing and explaining motor construction, speed, rotation for single phase motors
Describing the operation and characteristics of an Electronically Commutated Motor (ECM)
Disassembling, assembling, and describing the function of the parts of an induction motor
Explaining the difference between a Wye and Delta three phase motor
Describing the differences between a “Pictorial”, a “Ladder Diagram”, and a “Schematic”
Cleaning evaluating and installing different types of motors (Shaded pole, split phase, PSC, CSR, and ECM)
Evaluating and installing a run and start capacitor
Determining the sequence of operation using schematic wiring diagrams
Drawing and interpreting electrical diagrams for the purpose of troubleshooting
Installing and evaluating a transformer.
Installing and evaluating a contactor
### Competency and Task List

#### Electrical

- Students should have knowledge of and be able to demonstrate proficiency in:
  - Installing and evaluating a control relay
  - Installing and evaluating a defrost timer
  - Installing and evaluating a digital thermostat
  - Installing and evaluating a line starter
  - Installing and evaluating a solenoid valve
  - Installing and evaluating start relays (current, potential, and solid state)
  - Installing and evaluating temperature coefficient thermistors
  - Identifying electrical symbols used in HVACR schematics
  - Identifying inoperative/defective components using schematic wiring diagrams
  - Identifying voltage between two points using schematic wiring diagrams
  - Installing and evaluating a communications thermostat
  - Installing, evaluating and servicing a dual stage thermostat
  - Servicing and installing equipment control circuits
  - Servicing and installing equipment power supply
  - Identifying the types and describing the proper application and use of common switches use in HVACR
  - Identifying the types and describing the proper application and use of a Positive temperature coefficient thermistors (PTC)
  - Describing and demonstrating the proper solder, flux, and procedures for soldering electrical wiring

- Knowledge of the following test instruments and or tools is required:
  - Ladder safety procedures
  - Describe and perform “Lock out and Tag” procedures
  - Identifying the safety ground
  - Identifying the “Hot” conductor
  - Identifying “Neutral” conductor
  - Electrical Shock, prevention and first aid
  - Electrical Burns, prevention and first aid
  - Describe and demonstrate emergency first aid procedures
  - Ohmmeter
  - Multimeter
  - Ammeter
  - Voltmeter
  - Wattmeter
  - Hermetic compressor analyzer
  - Relay tester
  - Megger meter
  - Capacitor analyzer
Competency and Task List

Students should have knowledge of Air Conditioning components and be able to demonstrate proficiency in:

- The three states of matter
- The laws of Thermodynamics
- Heat transfer Convection, Conduction, and Radiation
- Atmospheric pressure and the effect of altitude
- Absolute and gauge pressures
- Psychrometrics
- Refrigerant charging methods
- Refrigerant piping
- Soldering and brazing
- Refrigerant leak detection and types of leak detectors
- Recovery and recycling processes
- Defining enthalpy and entropy
- Change of state between liquids, vapor, and solids
- Describing and defining the following; conduction, convection and radiant heat transfer
- Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin
- Condensation of a vapor, and its effect on heat
- Vaporization of a liquid, and its effect on heat
- Describing the thermodynamics of refrigerants
- Describing and defining the following; BTU, latent heat, sensible heat
- Describing and defining the following; subcooled liquid, superheated vapor
- Describing the state of refrigerant, and explain what occurs in each major component during normal operation
- Using saturation tables
- Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic
- Identifying and defining; CFC’s, HCFC’s, HFC’s, HFO’s & HC’s
- Describing temperature glide
- Describing fractionation and its causes
- Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point
- Measuring wet and dry-bulb temperatures
- Defining wet bulb depression
- Describing the principles of dehumidification and humidification
Competency and Task List

Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:

Compressors (reciprocating, scroll, rotary, and screw)
Compressor capacity control methods and operation
Condensers air cooled
Condensers water cooled
Metering devices (capillary tube, thermostatic expansion valve, automatic expansion valve, electronic expansion valve)
Evaporators
Receivers
Discharge line
Liquid line
Suction line
Liquid line filter/driver
Sight glass
Suction line filter
Accumulator
Head pressure controls
Low pressure controls
Pump down solenoid

Plotting the refrigeration cycle on a pressure enthalpy chart
Defining SEER and EER
Describing the operation and use of a gauge manifold assembly
Identifying and differentiate between the various types of service valves
Obtaining gauge pressure using compound gauges and convert to absolute
Defining vacuum and vacuum levels as required in the HVACR industry
Identifying the types of micron gauges and how they should be connected to measure evacuation levels
Explaining vacuum pump selection
Evacuating and measuring system evacuation level
Describing the triple evacuation method
Soldering and brazing using correct techniques
Demonstrating the triple evacuation method
Calculating and demonstrating the weigh-in charging method
Demonstrating charging using the superheat method
Demonstrating charging using the subcooling method
Identifying proper charging of a blended refrigerant into an operating system
Identifying proper charging a blended refrigerant by weight into an empty system
Demonstrating charging using the manufacturers literature
Demonstrating charging a mini-split system with two or more evaporators
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters
Select the proper refrigerant oil and add it to an operating system
Defining compression ratio
Describing and preforming a compressor efficiency test
Determine superheat and subcooling on an operating system
Identifying proper charging of a compound refrigerant into an empty system
Identifying proper charging of a compound refrigerant into an operating system
## Competency and Task List

| Students should have knowledge of Air Conditioning components and be able to demonstrate proficiency in: | Identifying proper charging a blended refrigerant by weight into an empty system  
Demonstrating charging using the manufacturers literature  
Demonstrating charging a mini-split system with two or more evaporators  
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters  
Select the proper refrigerant oil and add it to an operating system  
Defining compression ratio  
Describing and preforming a compressor efficiency test  
Determine superheat and subcooling on an operating system  
Identifying proper charging of a compound refrigerant into an empty system  
Identifying proper charging of a compound refrigerant into an operating system  
Describing the six types of leak detectors and demonstrating the proper use  
Explaining the proper use of each type of leak detector and their applicability  
Explaining the method for and pinpointing a leak  
Explaining the proper use and handling of nitrogen in the leak detection process  
Defining and demonstrating refrigerant recovery  
Defining and demonstrating refrigerant recycling  
Defining reclaim  
Installing an air handler  
Installing a condensing unit  
Adjusting blower fan speed  
Select the proper refrigerant oil it to an operating system  
Perform a compressor efficiency test |
|---|---|
| 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 |
| 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  
Refrigerant throttling valve  
Charging scale and charging cylinder  
Soldering and brazing equipment  
Flaring tool/ tubing cutters  
Tubing benders  
Nitrogen Cylinder  
Leak detector  
Valve Core removal tool  
Micron gauge  
Vacuum pump  
Recovery equipment |
<table>
<thead>
<tr>
<th>Competency and Task List</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students should have prior knowledge of:</strong></td>
</tr>
<tr>
<td>Refrigerant thermodynamics</td>
</tr>
<tr>
<td>Psychrometrics</td>
</tr>
<tr>
<td>Residential air conditioning and electric heating systems</td>
</tr>
<tr>
<td>Refrigerant charging</td>
</tr>
<tr>
<td>Refrigerant recovery</td>
</tr>
<tr>
<td>Soldering and brazing techniques.</td>
</tr>
<tr>
<td>Refrigerant recycling</td>
</tr>
<tr>
<td>Refrigerant reclamation</td>
</tr>
<tr>
<td><strong>Students must have knowledge of Heat Pump system components and be able to demonstrate proficiency in:</strong></td>
</tr>
<tr>
<td>Describing a heat pump’s design, configuration for both the heating and cooling cycle</td>
</tr>
<tr>
<td>Define SEER, HSPF, and COP</td>
</tr>
<tr>
<td>Identifying and differentiate between the various types of service valves</td>
</tr>
<tr>
<td>Differentiate between a compressor designed for use in a heat pump and one that is designed for use in a cooling only air conditioner</td>
</tr>
<tr>
<td>Demonstrating the proper connection and use of a gauge manifold assembly</td>
</tr>
<tr>
<td>Describing the operation of a reversing valve.</td>
</tr>
<tr>
<td>Describing the procedures for testing the operation of a reversing valve</td>
</tr>
<tr>
<td>Perform a reversing valve replacement</td>
</tr>
<tr>
<td>State the purpose of an accumulator and how it is constructed</td>
</tr>
<tr>
<td>Evaluate and replace a accumulator</td>
</tr>
<tr>
<td>Describing the principle of operation of a capillary tubes as used on a heat pump</td>
</tr>
<tr>
<td>Describing the principle of operation of a fixed orifice as used on a heat pump</td>
</tr>
<tr>
<td>Describing the principle of operation of a thermostatic expansion valve used with and with out check valves</td>
</tr>
<tr>
<td>Describing the principle of operation of an electronic expansion valve</td>
</tr>
<tr>
<td>Evaluating and replacing a capillary tube</td>
</tr>
<tr>
<td>Servicing, selecting, and installing a fixed orifice</td>
</tr>
<tr>
<td>Servicing, selecting, and installing a thermostatic expansion valve</td>
</tr>
<tr>
<td>Servicing, selecting, and installing an electronic expansion valve</td>
</tr>
<tr>
<td>Describing a check valve, its function and operation</td>
</tr>
<tr>
<td>Evaluating and replacing a check valve</td>
</tr>
<tr>
<td>Describing the operation of a heat/cool relay</td>
</tr>
<tr>
<td>Describing the operation of the following defrost controls, mechanical, time/temperature, and solid state</td>
</tr>
<tr>
<td>Describing the function of and testing method for an outdoor thermostat</td>
</tr>
<tr>
<td>Describing the sequence of the defrost cycle</td>
</tr>
<tr>
<td>Describing the sequence of operation and the testing methods for a defrost relay</td>
</tr>
<tr>
<td>Install a solid state defrost control</td>
</tr>
<tr>
<td>Stating the purpose of and testing method for a bimetal outdoor coil temperature sensor</td>
</tr>
<tr>
<td>Evaluate and replace a defrost board</td>
</tr>
<tr>
<td>Servicing and installing a thermistor type temperature sensor (PTC &amp; NTC)</td>
</tr>
<tr>
<td>Replacing a printed circuit control board (PC) the indoor and outdoor units</td>
</tr>
<tr>
<td>Describing crankcase heating methods and how they operate</td>
</tr>
<tr>
<td>Describing a heat pump thermostat with emergency heat feature</td>
</tr>
<tr>
<td>Describing the function of and the testing method for a control circuit fuse</td>
</tr>
<tr>
<td>Explain how the set points for outdoor thermostats are established</td>
</tr>
<tr>
<td>Describing the function and the control methods used by an indoor electronic thermostat</td>
</tr>
<tr>
<td>Measure system air flow</td>
</tr>
<tr>
<td>Explain the function of a liquid line bi-flow drier</td>
</tr>
</tbody>
</table>
## Competency and Task List

**Students must have knowledge of Heat Pump system components and be able to demonstrate proficiency in:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing and evaluating a liquid line bi-flow drier</td>
<td></td>
</tr>
<tr>
<td>Installing and evaluating a liquid line drier</td>
<td></td>
</tr>
<tr>
<td>Explain the function of a suction line filter drier</td>
<td></td>
</tr>
<tr>
<td>Installing and evaluating a suction line filter drier</td>
<td></td>
</tr>
<tr>
<td>Identifying the types of micron gauges</td>
<td></td>
</tr>
<tr>
<td>Explain the method for connecting a micron gauge to the system</td>
<td></td>
</tr>
<tr>
<td>Describing and performing the triple evacuation method</td>
<td></td>
</tr>
<tr>
<td>Describing heat pump charging procedures</td>
<td></td>
</tr>
<tr>
<td>Explain charging using the manufacturers literature</td>
<td></td>
</tr>
<tr>
<td>Calculating and demonstrating the weigh-in charging method</td>
<td></td>
</tr>
<tr>
<td>Determine required superheat and subcooling for an operating system</td>
<td></td>
</tr>
<tr>
<td>Explain charging using the superheat method</td>
<td></td>
</tr>
<tr>
<td>Select the proper refrigerant oil for an operating system</td>
<td></td>
</tr>
<tr>
<td>Explain charging using the subcooling method</td>
<td></td>
</tr>
<tr>
<td>Demonstrating charging using the manufacturers literature</td>
<td></td>
</tr>
<tr>
<td>Demonstrating proper charging of HCFC and HFC refrigerants into an operating system</td>
<td></td>
</tr>
<tr>
<td>Demonstrating proper charging of HCFC and HFC refrigerants into an empty system</td>
<td></td>
</tr>
<tr>
<td>Describing the operation of and the testing method for a high pressure switch</td>
<td></td>
</tr>
<tr>
<td>Describing the operation of and the testing method for a low pressure switch</td>
<td></td>
</tr>
<tr>
<td>Describing the procedure to perform a compressor efficiency test</td>
<td></td>
</tr>
</tbody>
</table>

**Students should have knowledge of & be able to describe & demonstrate the following safety requirements:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder safety procedures</td>
<td></td>
</tr>
<tr>
<td>Fall prevention procedures</td>
<td></td>
</tr>
<tr>
<td>Refrigerant handling</td>
<td></td>
</tr>
<tr>
<td>Nitrogen handling procedures</td>
<td></td>
</tr>
</tbody>
</table>

**Heat Pump troubleshooting & 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:**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anemometer</td>
<td></td>
</tr>
<tr>
<td>Thermometers (wet and dry)</td>
<td></td>
</tr>
<tr>
<td>Gauge manifold assembly</td>
<td></td>
</tr>
<tr>
<td>Recovery equipment</td>
<td></td>
</tr>
<tr>
<td>Vacuum pump</td>
<td></td>
</tr>
<tr>
<td>Micron gauge</td>
<td></td>
</tr>
<tr>
<td>Leak detector</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Cylinder</td>
<td></td>
</tr>
<tr>
<td>Soldering and brazing equipment</td>
<td></td>
</tr>
<tr>
<td>Charging scale and Charging cylinder</td>
<td></td>
</tr>
<tr>
<td>Refrigerant throttling valve</td>
<td></td>
</tr>
<tr>
<td>Ohmmeter</td>
<td></td>
</tr>
<tr>
<td>Ammeter</td>
<td></td>
</tr>
<tr>
<td>Voltmeter</td>
<td></td>
</tr>
<tr>
<td>Valve Core removal tool</td>
<td></td>
</tr>
<tr>
<td>Flaring tool/ tubing cutters</td>
<td></td>
</tr>
<tr>
<td>Tubing benders</td>
<td></td>
</tr>
<tr>
<td>Sling Psychrometer</td>
<td></td>
</tr>
</tbody>
</table>
Competency and Task List

- Electrical Safety
- Electric Heat Theory
- Identifying system Components
- Calculating Watts
- Describing how electric heating elements are rated
- Describing types and how a sequencer controls heating elements and blower operation
- Defining and calculating furnace BTU output
- Defining Coefficient of performance
- Describing sensible and latent heat
- Identifying the formula for sensible heat
- Describing the principles of dehumidification and humidification
- Differentiating between a resistive and inductive load
- Identifying the material used to construct electric heater elements
- Describing the insulating properties of mica and ceramics and their application
- Describing the operation and purpose of, and evaluate/replace a fan interlock switch
- Describing snap discs and their sequence of operation
- Describing the operation of, and evaluate/replace a limit switch
- Evaluating, describing its operation, installing, and setting a pressure differential switch
- Describing the effects of relative humidity on comfort and health
- Explaining and measuring temperature rise
- Identifying the various types of motor mounts used on residential furnace blower assemblies
- Identifying the NEC code requirements for residential thermostat wiring
- Describing and calculate wire sizing as it applies to voltage drop and length of wiring run
- Describing voltage tolerances
- Demonstrating the measurement of and determining the amp draw of electric heating element
- Describing and demonstrating the method of wiring heating elements in a single-phase-system
- Describing and determine the maximum allowable voltage imbalance in a three phase circuit
- Measuring the voltage imbalance in a three phase circuit
- Setting the heat anticipation or cycling rate for an electric furnace thermostat
- Identifying the proper location for and install a conventional thermostat
- Explaining the detailed wiring and operation of a setback programmable thermostat
- Describing “R” values and application of various duct insulation materials
- Determine system maximum allowable operating static pressure
- Describing and demonstrating the method of measuring static pressure
- Explain the procedures for determining CFM
- Stating the recommended air velocities throughout the supply and return duct system
- Stating the recommended air velocities through the return air grilles
- Measure air velocities throughout the supply and return duct system
- Describing the effects of static pressure on air flow
- Measure the effects of static pressure on air flow
- Demonstrating the procedure for finding CFM using an anemometer
- Demonstrating the procedure for finding CFM using temperature rise
- Stating the typical operating characteristics of a direct drive blower
- Performing blower airflow adjustments
- Choosing and installing the proper bearings for a residential belt driven blower assembly
- Describing and demonstrating the method of wiring heating elements in a three-phase system (wye or delta)
- Choosing and using the proper lubricant for residential blower motor maintenance
### Competency and Task List

**Electric Heat**

<table>
<thead>
<tr>
<th>Students should have knowledge of and be able to demonstrate proficiency in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describing and demonstrating the procedure to replace the belt and adjust air flow on a belt driven blower assembly</td>
</tr>
<tr>
<td>Describing, fabricating and install various types of duct connectors</td>
</tr>
<tr>
<td>Describing the application of and preform the installation of turning vanes</td>
</tr>
<tr>
<td>Describing the construction and efficiencies of varying filtering media and systems</td>
</tr>
<tr>
<td>Electric Heat Troubleshooting and Problem Solving</td>
</tr>
<tr>
<td>Evaluating and replacing a heating element and a sequencer</td>
</tr>
<tr>
<td>Describing installation and service procedures for central heating system</td>
</tr>
<tr>
<td>Stating the minimum required clearances for service and safety of an electric furnace</td>
</tr>
<tr>
<td>Evaluating, describing its operation, and install a duct heater</td>
</tr>
<tr>
<td>Describing procedures for retrofit of a system to electric heat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder safety procedures</td>
</tr>
<tr>
<td>Describe and perform “Lock out and Tag” procedures</td>
</tr>
<tr>
<td>Identifying the safety ground</td>
</tr>
<tr>
<td>Identifying the “Hot” conductor</td>
</tr>
<tr>
<td>Identifying “Neutral” conductor</td>
</tr>
<tr>
<td>Describe and install a GFCI circuit breaker</td>
</tr>
<tr>
<td>Describe and demonstrate safety grounding procedures for electric motors</td>
</tr>
<tr>
<td>Describe the application of and test a fusible link</td>
</tr>
<tr>
<td>Electrical Shock, prevention and first aid</td>
</tr>
<tr>
<td>Electrical Burns, prevention and first aid</td>
</tr>
<tr>
<td>Describe and demonstrate emergency first aid procedures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electric Heat troubleshooting and problem solving:</th>
</tr>
</thead>
<tbody>
<tr>
<td>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 should be part of the Troubleshooting and Problem Solving question area.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Knowledge of the following test instruments and or tools is required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohmmeter</td>
</tr>
<tr>
<td>Multimeter</td>
</tr>
<tr>
<td>Ammeter</td>
</tr>
<tr>
<td>Voltmeter</td>
</tr>
<tr>
<td>Wattmeter</td>
</tr>
<tr>
<td>Megger meter</td>
</tr>
<tr>
<td>Capacitor analyzer</td>
</tr>
</tbody>
</table>
Competency and Task List

Students should have prior 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 must have knowledge of light commercial air conditioning systems, their components, and be able to demonstrate proficiency in:
- Defining enthalpy and entropy
- Change of state between liquids, vapor, and solids
- Describing and defining the following; conduction, convection and radiant heat transfer
- Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin
- Condensation of a vapor, and its effect on heat
- Vaporization of a liquid, and its effect on heat
- Describing the thermodynamics of refrigerants
- Describing and defining the following; BTU, latent heat, sensible heat
- Describing and defining the following; subcooled liquid, superheated vapor
- Describing the state of refrigerant, and explain what occurs in each major component during normal operation
- Using saturation tables
- Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic
- Identifying and defining; CFC’s, HCFC’s, HFC’s, HFO’s & HC’s
- Describing temperature glide
- Describing fractionation and its causes
- Explain the procedures to retrofit a system from a CFC to an HFC, & an HCFC to an HFC
- Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point
- Defining wet bulb depression
- Measuring wet and dry-bulb temperatures
- Describing the principles of dehumidification and humidification
Competency and Task List

- Plotting the refrigeration cycle on a pressure enthalpy chart
- Defining SEER and EER
- Describing a Head Master and its operation
- Describing the function, selection and installation of auxiliary heat exchangers
- Select the proper refrigerant oil add to an operating system
- Adjusting blower fan speed
- Sizing, designing, and installing refrigerant lines
- Installing a condensing unit
- Installing an air handler
- Describing the required CFM for system operation and calculate air flow
- Installing a condensate drain
- Defining reclaim
- Defining and demonstrating refrigerant recycling
- Defining and demonstrating refrigerant recovery
- Explaining the proper use and handling of nitrogen in the leak detection process
- Explaining the method for and pinpointing a leak
- Explaining the proper use of each type of leak detector and their applicability
- Describing the six types of leak detectors and demonstrating the proper use
- Identifying proper charging of a compound refrigerant into an operating system
- Identifying proper charging of a compound refrigerant into an empty system
- Determine superheat and subcooling on an operating system
- Describing and preforming a compressor efficiency test
- Select the proper refrigerant oil and add it to an operating system
- Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters
- Demonstrating charging a mini-split system with two or more evaporators
- Demonstrating charging using the manufacturers literature
- Identifying proper charging a blended refrigerant by weight into an empty system
- Identifying proper charging of a blended refrigerant into an operating system
- Demonstrating charging using the subcooling method
- Demonstrating charging using the superheat method
- Stating the reason why capillary tube systems require a critical charge
- Describing a capillary / distributor tube sizing and selection procedure
- Calculating and demonstrating the weigh-in charging method
- Describing the triple evacuation method
- Demonstrating the triple evacuation method
- Soldering and brazing using correct techniques
- Evacuating and measuring system evacuation level
- Explaining vacuum pump selection
- Identifying the types of micron gauges and how they should be connected to measure evacuation levels
- Defining vacuum and vacuum levels as required in the HVACR industry
- Obtaining gauge pressure using compound gauges and convert to absolute
- Describing the operation and use of a gauge manifold assembly
- Identifying and differentiate between the various types of service valves
- Defining compression ratio
- Describing the automatic pump-down system and its operation
- Describing an air cooled condenser, its function, and operating parameters
- Installing water cooled system and adjusting a water regulating valve

Students must have knowledge of light commercial air conditioning systems, their components, and be able to demonstrate proficiency in:
Competency and Task List

Students must have knowledge of light commercial air conditioning systems, their components, and be able to demonstrate proficiency in:

- Describing the function of, and install a lockout relay in a circuit
- Describing the operation of and install a contactor
- Describing, test, and install a run and start capacitor
- Describing and install a compressor potential start relay
- Describing the operation of and test a high pressure switch
- Describing the operation of and test a low pressure switch
- Describing and wire the terminal connections of a thermostat temperature control
- Describing and test thermistor type temperature sensors (PTC & NTC)
- Describing the function, check the operation, and wire an oil pressure safety control
- Installing and adjusting a low ambient temperature control
- Test a blower or fan motor and its circuit
- Describing the operation of and test a hot gas bypass valve
- Describing the operation of and adjust an inline, and pilot operated evaporator pressure regulator
- Describing and installing a replaceable core liquid line drier
- Describing and install a replaceable core suction line filter drier
- Describing dry type evaporators and their operation
- Describing the piping configuration for a multiple evaporator systems
- Describing the function and purpose of a multiple compressor system
- Compressor capacity control methods and operation
- Describing a chilled water system and its operation
- Describing cooling towers and their operating limitations
- Describing the operation and function of a flooded evaporator and its metering device
- Describing the function, check the operation, and wire a demand ventilation control
- Describing the function, check the operation, and wire communications type thermostat
- Describing the function, check the operation, and install a variable volume air handler
- Describing the function, check the operation, and install a variable air volume (VAV) unit

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

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.
Competency and Task List

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
- Anemometer
- Soldering and brazing equipment
- Valve Core removal tool
- Flaring tool/ tubing cutters
- Tubing benders
### Competency and Task List

<table>
<thead>
<tr>
<th>Students should have prior knowledge of:</th>
<th>Students must have knowledge of light commercial refrigeration systems, their components, and be able to demonstrate proficiency in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The laws of Thermodynamics</td>
<td>Defining enthalpy and entropy</td>
</tr>
<tr>
<td>Recovery and recycling processes</td>
<td>Change of state between liquids, vapor, and solids</td>
</tr>
<tr>
<td>Refrigerant leak detection and types of leak detectors</td>
<td>Describing and defining the following; conduction, convection and radiant heat transfer</td>
</tr>
<tr>
<td>Refrigerant piping</td>
<td>Describing, defining, and converting the following temperature measurements; Fahrenheit, Celsius, Rankine, and Kelvin</td>
</tr>
<tr>
<td>Soldering and brazing</td>
<td>Condensation of a vapor, and its effect on heat</td>
</tr>
<tr>
<td>Refrigerant types</td>
<td>Vaporization of a liquid, and its effect on heat</td>
</tr>
<tr>
<td>Leak detectors</td>
<td>Describing the thermodynamics of refrigerants</td>
</tr>
<tr>
<td></td>
<td>Define Cryogenics</td>
</tr>
<tr>
<td></td>
<td>Define and state the applications of High, Medium, and Low temperature refrigeration</td>
</tr>
<tr>
<td></td>
<td>Define “Expendable Refrigerant”</td>
</tr>
<tr>
<td></td>
<td>Describing and defining the following; BTU, latent heat, sensible heat</td>
</tr>
<tr>
<td></td>
<td>Describing and defining the following; subcooled liquid, superheated vapor</td>
</tr>
<tr>
<td></td>
<td>Describing the state of refrigerant, and explain what occurs in each major component during normal operation</td>
</tr>
<tr>
<td></td>
<td>Using saturation tables</td>
</tr>
<tr>
<td></td>
<td>Identifying and defining the following types of blends; Binary, Ternary, Azeotropic, and Near Azeotropic</td>
</tr>
<tr>
<td></td>
<td>Identifying and defining; CFC’s, HCFC’s, HFC’s, HFO’s &amp; HC’s</td>
</tr>
<tr>
<td></td>
<td>Describing temperature glide</td>
</tr>
<tr>
<td></td>
<td>Describing fractionation and its causes</td>
</tr>
<tr>
<td></td>
<td>Explain the procedures to retrofit a system from a CFC to an HFC, &amp; an HCFC to an HFC</td>
</tr>
<tr>
<td></td>
<td>Describing and defining the following; wet bulb temperature, dry bulb temperature, and dew point</td>
</tr>
<tr>
<td></td>
<td>Defining wet bulb depression</td>
</tr>
<tr>
<td></td>
<td>Measuring wet and dry-bulb temperatures</td>
</tr>
<tr>
<td></td>
<td>Describing the principles of dehumidification and humidification</td>
</tr>
<tr>
<td></td>
<td>Define and explain the use of high humidity evaporator coils</td>
</tr>
</tbody>
</table>
Competency and Task List

Students must have knowledge of light commercial refrigeration systems, their components, and be able to demonstrate proficiency in:

Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:

- Compressors (reciprocating, scroll, rotary, and screw)
- Condensers air cooled
- Condensers water cooled
- Metering devices (capillary tube, thermostatic expansion valve, automatic expansion valve, electronic expansion valve)
- Refrigerant distributors and feeder tubes
- Evaporators
- Receivers
- Discharge line
- Liquid line
- Suction line
- Liquid line filter
- Sight glass
- Suction line filter
- Vibration eliminator
- Accumulator
- Head pressure controls
- Low pressure controls
- Pump down solenoid
- Oil separator
- Crankcase heater
- Economizer
- Lockout relay
- Thermostat
- Oil pressure safety control
- Current start relay
- Defrost heater
- Defrost terminator
- Mechanical or electronic defrost timer
- Crankcase pressure regulator (CPR)
- Liquid line solenoid valve
- Evaporator pressure regulator (EPR)
- Pressure regulator (OPR)
- Ambient temperature controls
- Water regulating valve

Plotting the refrigeration cycle on a pressure enthalpy chart
- Defining SEER and EER
- Describing a cascade system its application and operation
- Describing the purpose and applicability of a defrost cycle
- Describing defrost cycle initiation and termination
- Describing the basic cycles and operation of ice makers
- Describing a Head Master and its operation
- Describing the function, selection and installation of auxiliary heat exchangers
- Select the proper refrigerant oil add to an operating system
- Adjusting blower fan speed
Competency and Task List

Sizing, designing, and installing refrigerant lines
Describing a service valve and its operation
Determine refrigerant line pressure drop and explain the effects of pressure drop on a system
Describing proper soldering and brazing techniques
Describing the function, selection and installation of a vibration eliminator
Describing the design structure, function, operation, and selection of refrigerant distributors and feeder tubes
Installing a medium temperature condensing unit
Installing a low temperature evaporator with electric defrost
Describing the required CFM for evaporator operation and calculate air flow
Installing a condensate drain for a low temperature system
Describing a drain and drain pan heater and their operation
Defining reclaim
Defining and demonstrating refrigerant recycling
Defining and demonstrating refrigerant recovery
Explaining the proper use and handling of nitrogen in the leak detection process
Explaining the method for and pinpointing a leak
Explaining the proper use of each type of leak detector and their applicability
Describing the six types of leak detectors and demonstrating the proper use
Identifying proper charging of a compound refrigerant into an operating system
Identifying proper charging of a compound refrigerant into an empty system
Determine superheat and subcooling on an operating system
Describing and preforming a compressor efficiency test
Select the proper refrigerant oil and add it to an operating system
Describing the following oils and their applications; Mineral, Alkylbenzene, Glycols, and Esters
Demonstrating charging a mini-split system with two or more evaporators
Demonstrating charging using the manufacturers literature
Identifying proper charging a blended refrigerant by weight into an empty system
Identifying proper charging of a blended refrigerant into an operating system
Demonstrating charging using the subcooling method
Describing the proper procedure for measuring and adjusting evaporator superheat
Stating the reason why capillary tube systems require a critical charge
Describing a capillary / distributor tube sizing and selection procedure
Calculating and demonstrating the weigh-in charging method
Describing the triple evacuation method
Demonstrating the triple evacuation method
Soldering and brazing using correct techniques
Evacuating and measuring system evacuation level
Explaining vacuum pump selection
Identifying the types of micron gauges and how they should be connected to measure evacuation levels
Obtaining gauge pressure using compound gauges and convert to absolute
Competency and Task List

Students must have knowledge of light commercial refrigeration systems, their components, and be able to demonstrate proficiency in:

- Describing the operation and use of a gauge manifold assembly
- Identifying and differentiate between the various types of service valves
- Defining compression ratio
- Describing the automatic pump-down system and its operation
- Describing an air cooled condenser, its function, and operating parameters
- Installing water cooled system and adjusting a water regulating valve
- Describing the function of, and install a lockout relay in a circuit
- Describing the operation of and install a contactor
- Describing, test, and install a run and start capacitor
- Describing and install a compressor potential start relay
- Describing the operation of and test a high pressure switch
- Describing the operation of and test a low pressure switch
- Install and adjust a low pressure switch used for temperature control
- Describing and wire the terminal connections of a thermostat temperature control
- Describing and test thermistor type temperature sensors (PTC & NTC)
- Describing the function, check the operation, and wire an oil pressure safety control
- Installing and adjusting a low ambient temperature control
- Test a blower or fan motor and its circuit
- Describing the operation of and testing a hot gas bypass valve
- Describing the operation of and adjust an inline, and pilot operated evaporator pressure regulator
- Describing and installing a replaceable core liquid line drier
- Describing and install a replaceable core suction line filter drier
- Describing dry type evaporators and their operation
- Describing the piping configuration for a multiple evaporator systems
- Describing the function and purpose of a multiple compressor system
- Compressor capacity control methods and operation
- Describing a chilled water system and its operation
- Describing cooling towers and their operating limitations
- Describing the operation and function of a flooded evaporator and its metering device
## Competency and Task List

<table>
<thead>
<tr>
<th>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</th>
<th>Describe and perform “Lock out and Tag” procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System leak-test pressures and nitrogen regulator installation and adjustment</td>
</tr>
<tr>
<td></td>
<td>Explain and demonstrate the proper method of connecting a micron gauge to the system</td>
</tr>
</tbody>
</table>

### 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.

<table>
<thead>
<tr>
<th>Knowledge of the following test instruments and or tools is required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammeter</td>
</tr>
<tr>
<td>Oil pressure gauge</td>
</tr>
<tr>
<td>Ohmmeter</td>
</tr>
<tr>
<td>Oil pump</td>
</tr>
<tr>
<td>Voltmeter</td>
</tr>
<tr>
<td>Nitrogen Cylinder</td>
</tr>
<tr>
<td>Micron gauge</td>
</tr>
<tr>
<td>Vacuum pump</td>
</tr>
<tr>
<td>Sling Psychrometer</td>
</tr>
<tr>
<td>Refrigerant throttling valve</td>
</tr>
<tr>
<td>Thermometers (wet and dry)</td>
</tr>
<tr>
<td>Recovery equipment</td>
</tr>
<tr>
<td>Leak detector</td>
</tr>
<tr>
<td>Charging scale and charging cylinder</td>
</tr>
<tr>
<td>Gauge manifold assembly</td>
</tr>
<tr>
<td>Soldering and brazing equipment</td>
</tr>
</tbody>
</table>
Competency and Task List

Students must have knowledge of heating systems, their components, and be able to demonstrate proficiency in:

- Describing and explaining the function of upflow, downflow, and horizontal furnaces
- Explaining combustion Theory and Heating Fuels
- Explaining the Properties of Heating Fuels
- Define BTU
- Define AFUE
- Describing and using the formula for sensible heat
- Describing the principles of humidification
- Describing the principles of dehumidification
- Explaining the BTU content of natural gas and propane gas
- Describing the fuel pressures in natural gas and liquefied petroleum (LP) gas piping
- Describing and measuring operating fuel pressures in natural gas and liquefied petroleum (LP) furnaces
- Describing the typical flue gas temperatures of gas-fired furnaces
- Describing the chemical names of natural gas and propane gas
- Determining the quantity of combustion air required to burn 1 cubic foot of natural gas and propane gas
- Defining and differentiating between primary air and excess air
- Stating the maximum percentage of Carbon Dioxide produced by the perfect combustion of natural gas
- Stating the maximum percentage of Carbon Dioxide produced by the perfect combustion of propane gas
- Explaining the ignition temperatures of natural gas and propane gas
- Describing and stating the causes of burner “Flashback”
- Describing and stating the causes of a lifting flame.
- Stating the reason for appropriate polarity wiring on solid state circuits
- Stating the generally accepted standard gas manifold pressure for a residential furnace
- Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:
  - Gas valves used with residential furnaces
  - Gas pressure regulating valves
  - Orifice
  - In-shot burner
  - Pilot burner
  - Heat exchanger
  - Flue baffles
  - Residential gas shutoff valve
  - Thermocouple
  - Thermopile
  - Ignition module
  - Spark igniter
  - Hot surface igniter
  - Flame sensor
  - Combination fan and limit switch
  - Door safety switch
  - Blower motor relay
  - Vent blower motor
  - Vent pressure switch
  - Vent motor relay
## Competency and Task List

**Gas Heat**

<table>
<thead>
<tr>
<th>Students must have knowledge of heating systems, their components, and be able to demonstrate proficiency in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:</td>
</tr>
<tr>
<td><em>Single stage thermostat</em></td>
</tr>
<tr>
<td><em>Dual stage thermostat</em></td>
</tr>
<tr>
<td><em>Run and start capacitor</em></td>
</tr>
<tr>
<td><em>Gas piping drip-leg</em></td>
</tr>
</tbody>
</table>

Identifying the different types of venting systems

Properly sizing, cutting, threading, and connecting gas piping

Installing a fire-stop support plate

Adjusting blower fan speed for proper temperature rise

Describing the procedure to measure static pressure

Sizing wire with regards to voltage drop and length of wiring run

Describing and demonstrating proper soldering procedures for electrical wiring

Setting the heat anticipation or cycling rate for a furnace thermostat

Describing and demonstrating proper installation of a single and two stage thermostats

Describing and demonstrating proper installation of a communication type thermostat

Adjusting airflow on a belt-driven blower assembly

Describing the procedure to de-rate a gas furnace at altitudes of 2,000 feet and above

Describing and demonstrating proper use of a Combustion analyzer

Identifying the different types of conduit used for power

Installing duct connectors and hangers

Describing and demonstrating proper installation of a duct mounted Carbon Monoxide detector

---

**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.

<table>
<thead>
<tr>
<th>Students should have knowledge of and be able to describe and demonstrate the following safety requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladder safety procedures</td>
</tr>
<tr>
<td>Clearances to combustibles for venting materials</td>
</tr>
<tr>
<td>Maximum level of Carbon monoxide in ppm in a flue gas sample</td>
</tr>
</tbody>
</table>

Proper safety procedures to follow on discovery of a gas leak
Competency and Task List

**Gas Heat**

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

- Combustion analyzer
- Ohmmeter
- Combustible gas detector
- Voltmeter
- Carbon Monoxide detector
- Manometer
- Pipe Reamers
- Velometer
- Ammeter
- Pipe tap and die set
- Pipe cutter
- Pipe Reamers
Competency and Task List

Describing and explaining the function of upflow, downflow, and horizontal furnaces
Describing Combustion Theory and Heating Fuels
Describing the Properties of Various Heating Fuels
Defining BTU
Defining AFUE
Describing and using the sensible heat formula
Describing the principles of humidification
Describing the principles of dehumidification
Explaining the BTU content and specific gravities of various fuel oils
Describing the oil pressures (and vacuum levels) on an operating oil-fired heating system
Measuring the oil pressures (and vacuum levels) on an operating oil-fired heating system
Measuring the flue gas temperatures of furnaces
Determining the amount of combustion air required to safely burn oil in a furnace
Defining primary and secondary air
Differentiating between primary air and excess air
Describing the causes of burner “Flashback”
Describing the causes of a lifting flame.
Stating the reason for appropriate polarity wiring on solid state circuits
Stating the generally accepted standard oil pressure for a residential furnace
Describing, explaining the function, evaluating, cleaning, and replacing (when feasible) of the following components:
Oil valves used with residential furnaces
oil pressure regulating valves
Orifice
Heat exchanger
Flue baffles
Fuel oil pump
Cadmium sulfide cell
Burner primary safety control
Ignition module
Spark igniter
High voltage ignition transformer
Flame sensor
Combination fan and limit switch
Door safety switch
Blower motor relay
Vent blower motor
Vent pressure switch
Vent motor relay
Single stage thermostat
Dual stage thermostat
Run and start capacitor
Describing a blower housing cut-off plate
Identifying the different types of venting systems
Sizing and installing the venting systems
Installing fuel lines
Describing the purpose and operation of delayed action solenoid valve

Students must have knowledge of oil heating systems, their components, and be able to demonstrate proficiency in:
## Competency and Task List

**Students must have knowledge of oil heating systems, their components, and be able to demonstrate proficiency in:**

- Describing the function of a barometric draft control
- Describing the testing and adjustment procedure of a barometric draft control
- Describing the function of and the testing method for a fuel unit cut-off
- Describing the procedure to perform a smoke test on an oil furnace
- Installing a fire-stop support plate
- Adjusting blower fan speed for proper temperature rise
- Describing the procedure for measuring static pressure
- Sizing wires with regards to voltage drop and length of wiring run
- Describing and demonstrating proper soldering procedures for electrical wiring
- Describing and demonstrating proper installation of a single and two stage thermostats
- Describing and demonstrating proper installation of a communication type thermostat
- Describing the procedure for adjusting air flow on a belt-driven blower assembly
- Describing the procedure to de-rate a gas furnace at altitudes of 2,000 feet and above
- Describing and demonstrating proper use of a combustion analyzer
- Identifying the different types of conduit used for power
- Installing duct connectors and hangers
- Describing and demonstrating proper installation of a duct-mounted Carbon Monoxide detector

**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
- 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

**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
- Velometer
- Pressure Gauges
- Voltmeter