Volume 1

Lesson 1 - Heat Pump Fundamentals

Objectives:

- Explain principles of physics that apply to heat transfer and the refrigeration cycle.
- Explain the relationship between heat quantity and heat intensity.
- Explain how indoor air quality affects creature comfort.

Lesson 2 - Heat Pump Systems

Objectives:

- Explain the difference between a heat source and a heat sink.
- Explain and compare the various types of heat pump systems available.
- Explain the concepts of thermal balance point, supplemental heat and coefficient of performance.

Lesson 3 - Heat Pump Principles

Objectives:

- Explain the heating and cooling modes of heat pump operation as well as performance ratings used for each.
- Explain the use of a pressure-enthalpy diagram to illustrate the refrigeration cycle.
- Explain the operation of reversing valve used to control refrigerant flow.

Lesson 4 - Heat Pump Compressors

Objectives:

- Explain the types of compressors used in heat pump systems and the primary functions of a compressor.
- Discuss the advantages and disadvantages of various compressor designs used in heat pump systems.
- Explain overload protectors and their function. Explain volumetric efficiency.

Lesson 5 - Flow Controls and Accessories

Objectives:

- Explain components needed to reverse the refrigeration cycle.
- Explain refrigeration circuit components as they apply to cooling only and heat pump systems.
- Highlight how component use varies from cooling only applications to heat pump applications.

Lesson 6 - Heat Pump Electrical Systems

Objectives:

- Explain the differences among the various types of electrical wiring diagrams used in servicing heat pump systems.
- Explain the use of electrical schematic diagrams to trace various heat pump operating sequences.
- Explain the components that are generally found in control and power circuits.

Lesson 7 - Heat Pump Electrical Components

Objectives:

- Explain the differences among the various types of electrical wiring diagrams used in servicing heat pump systems.

- Explain the use of electrical schematic diagrams to trace various heat pump operating sequences.
- Explain the components that are generally found in control and power circuits.

Lesson 8 - Heat Pump Thermostats
Objectives:

- Explain how the control strategies used for heat pumps differ from those used for cooling-only systems.
- Discuss types of thermostats and explain operating differences between voltage and current anticipation.
- Explain droop, outdoor reset, night setback, and their effect on heat pump performance.

Lesson 9 - Air-to-Air Heat Pump Defrost
Objectives:

- Explain why defrost controls are needed for air-to-air heat pumps and describe common functions of same.
- Explain the heat transfer process that occurs at the outdoor coil, causing humidity to condense and freeze.
- Explain common causes for defrost control failure and compare variations in defrost control designs.

Lesson 10 - Supplemental Electric Heat
Objectives:

- Understand when an application needs supplemental heat. Explain recommended installation procedures.
- Understand the method used to measure power input and to calculate heating output of an electric heater.
- Understand the use of outdoor thermostats, safety switches, fusing, recommended safety practices.

Lesson 11 - Fossil Fuel Backup Heat
Objectives:

- Explain why fossil fuel backup heat is not controlled in the same way as electric resistive supplemental heat.
- Explain control strategies used in various dual-fuel applications, including the safe sequencing of the burner.
- Explain the components used to provide satisfactory operation of heat pump and fossil fuel equipment.

Lesson 12 - Water-Source Heat Pump Systems
Objectives:

- Explain selection criteria for water-side components used in water-source heat pump systems. Explain differences among well systems used in WSHP systems, and the operating characteristics of each.

- Explain installation and service procedures required to provide trouble-free WSHP system operation.

Lesson 13 - Installing and Servicing Water-Source Heat Pumps
Objectives:

- Explain information needed to make a WSHP equipment selection.
- Explain the use of manufacturer service data to evaluate WSHP system operation.
- Explain the procedures used to connect a WSHP to a well loop.
- Explain typical start-up procedure recommendations.

Lesson 14 - Heat Pump Performance Criteria
Objectives:

- Explain the ARI Standards used to establish performance criteria for heat pumps.
- Explain the temperatures and fluid flow rates used to establish ARI equipment performance data.
- Explain the importance of using matched system components as it pertains to equipment performance.

Lesson 15 - Heat Pump Performance Checks
Objectives:

- Explain tools and procedures needed to check the heating and cooling performance of a heat pump system.
- Explain the importance of using OEM product data to check performance and establish a written history of performance.
- Explain methods for checking air distribution and relate same to equipment performance.

Lesson 16 - Heat Pump Installation Procedures
Objectives:

- Explain location criteria for installing packaged and split-system heat pump equipment.
- Explain issues related to installation and connection of heat pump system components.
- Explain recommended procedures for start-up and checkout of newly installed heat pump equipment.

Lesson 17 - Heat Pump Piping
Objectives:

- Explain installation practices that result in an acceptable condensate drain line.
- Explain ARI procedures for sizing the refrigerant tubing used to connect split-system components.
- Explain capacity and oil return issues related to refrigerant line set tubing size.

Volume 2
Lesson 18 - Electrical Troubleshooting
Objectives:

- Explain the importance of proper PPE and the correct test instruments for the type of system being evaluated.
- Explain the proper procedures for checking testing tools and for checking electrical systems.
- Explain the use of a wiring schematic as a diagnostic tool, review “hopscotching” troubleshooting technique.

Lesson 19 - Troubleshooting Exercises
Objectives:

- Explain the use of troubleshooting flow charts to identify, locate, and repair electrical faults.

- Explain the process used to identify various heat pump wiring diagrams.
- Explain heat pump cycle troubleshooting procedures used to diagnose electrical faults.

Lesson 20 - Refrigerant-Side Troubleshooting (Cooling Air-to-Air) Part 1
Objectives:

- Explain the proper use of instruments used to gather refrigerant circuit heat measurements.
- Explain the use of a Mollier diagram to plot a refrigeration cycle and evaluate system performance.
- Review the step-by-step process for evaluating the cooling cycle using refrigerant circuit heat measurements.

Lesson 21 - Refrigerant-Side Troubleshooting (Cooling Air-to-Air) Part 2
Objectives:

- Explain the process of comparing actual operating performance to design operating characteristics.
- Explain common refrigerant circuit faults that will be encountered by service technicians.
- Explain problems associated with the practice of mismatching indoor and outdoor sections.

Lesson 22 - Refrigerant-Side Troubleshooting (Heating Air-to-Air) Part 1
Objectives:

- Explain the proper procedure for connecting test instruments to a heat pump for recording heating cycle performance data.
- Explain the use of manufacturer performance data to evaluate the heating cycle of a heat pump system.

Lesson 23 - Refrigerant-Side Troubleshooting (Heating Air-to-Air) Part 2
Objectives:

- Review the proper connection of a refrigerant gauge manifold set for measurement of heating cycle performance.
- Explain the impact of improperly connecting a refrigerant gauge manifold set to heat pump equipment.
- Review the use of OEM performance data when evaluating heating cycle performance.

Lesson 24 - Troubleshooting Refrigerant Circuit Components
Objectives:

- Explain diagnostic procedures used to prevent the condemnation and replacement of good components.
- Explain common mechanical failures and the procedures for determining their existence.
- Explain corrective measures needed for various common system faults.

Lesson 25 - Troubleshooting Water-Source Heat Pumps
Objectives:

- Explain wiring diagrams and schematics used for water-source heat pump systems.
- Explain issues relating to water-side and air-side systems used in water-source applications.
- Explain troubleshooting techniques used when working on a water-source heat pump system.

Lesson 26 - High-Efficiency Air-to-Air Heat Pumps
Objectives:

- Explain the features/characteristics of new-generation high-efficiency air-to-air heat pump systems.
- Explain the value of variable-speed blowers used to increase the efficiency of air-to-air heat pump systems.
- Explain variations in techniques used to troubleshoot high-efficiency air-to-air heat pump systems.

Lesson 27 - Water-Source Heat Pumps for Special Applications
Objectives:

- Explain the functions of electronic controllers and safety cut-outs used in WSHP applications.
- Explain special functions—e.g., heat recovery, humidity control, range of water temperatures, etc.
- Compare special functions and common functions of water-source heat pump systems.

Lesson 28 - Heat Load Calculations
Objectives:

- Explain the terms used to describe heat transfer and how they apply to making a heat load calculation.
- Explain key items of concern that must be considered by a system designer when making a site survey.
- Explain the basics of ACCA *Manual J* load calculation data and the process used to make a load calculation.

Lesson 29 - Indoor Air Distribution
Objectives:

- Explain environmental factors that affect creature comfort (temperature, air movement, humidity, etc.).
- Explain “occupied zone” and the ASHRAE comfort range as they apply to heat pump system designs.
- Explain duct design considerations that pertain to equipment performance and to creature comfort.

Lesson 30 - Duct Design
Objectives:

- Explain materials used in ductwork fabrication (metal, flexible duct, duct board, insulation, vapor barrier, etc.).
- Explain constant-volume and variable-volume blower types, compare static capabilities of each blower type.
- Explain terms used in ductwork design (external static pressure, available pressure, equivalent length, etc.).

Lesson 31 - Diagnosing Air Flow Problems
Objectives:

- Explain methods used to measure air flow and the proper use of instruments designed to take measurements.
- Explain the relationship between pressures created when air is moved through a ductwork system.

- Explain the effect of fittings that are not aerodynamic and troubleshooting techniques used to locate problems.

Lesson 32 - Customer Relations
Objectives:

- Explain the role of “ambassador” played by a service technician when calling on a customer.
- Explain the process of making a successful service call as it pertains to communicating a positive message to the customer.
- Explain the importance of a detailed service invoice.

Appendix - Glossary of Terms