# SENIOR TECHNICIAN COURSE CATALOG

## 2023 SPAcademy Course Catalog

SPAcademy
A Service Professionals Company

# Contents



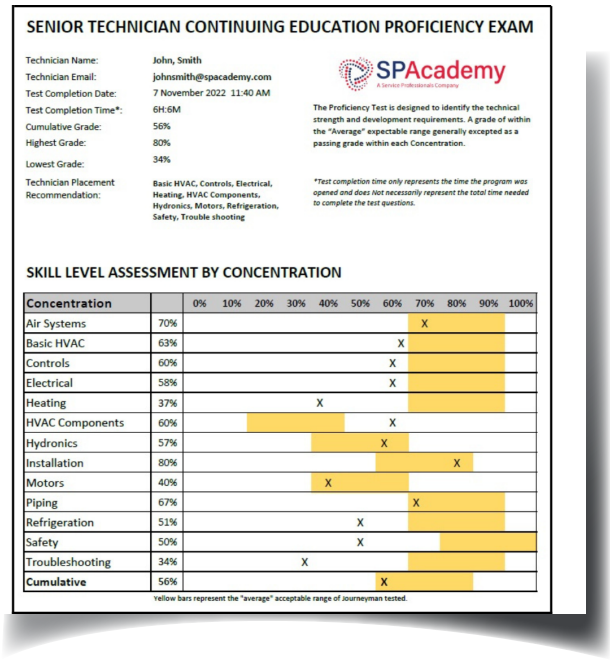
# To Our Valued Team Members

SPAcademy hosts over 1,500 hours of classroom instruction for beginner and experienced reps alike. Our mission is to provide contractors with flexible, cost-effective instruction to encourage recruitment and retention of commercial HVAC technicians nationwide.

Experienced or Journeyman Technicians benefit from the service offerings of SPAcademy. Beginning with a formal skills assessment to determine areas of strength and opportunities for growth, participants will receive a customized development program consisting of targeted online continuing education courses.

SPAcademy's continuing education program is an assessment-based curriculum beginning with an initial proficiency test containing the following competencies:

- Air Systems
- Basic HVAC
- Controls
- Electrical
- Heating
- HVAC Components
- Hydronics
- Installation
- Motors
- Piping
- Refrigeration
- Safety
- Troubleshooting



**SENIOR TECHNICIAN CONTINUING EDUCATION PROFICIENCY EXAM**

| | |
|---|---|
| Technician Name: | John, Smith |
| Technician Email: | johnsmith@spacademy.com |
| Test Completion Date: | 7 November 2022 11:40 AM |
| Test Completion Time*: | 6H:6M |
| Cumulative Grade: | 56% |
| Highest Grade: | 80% |
| Lowest Grade: | 34% |
| Technician Placement Recommendation: | Basic HVAC, Controls, Electrical, Heating, HVAC Components, Hydronics, Motors, Refrigeration, Safety, Trouble shooting |

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The Proficiency Test is designed to identify the technical strength and development requirements. A grade of within the "Average" expectable range generally excepted as a passing grade within each Concentration.

*Test completion time only represents the time the program was opened and does Not necessarily represent the total time needed to complete the test questions.

**SKILL LEVEL ASSESSMENT BY CONCENTRATION**

| Concentration | | 0% | 10% | 20% | 30% | 40% | 50% | 60% | 70% | 80% | 90% | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air Systems | 70% | | | | | | | | X | | | |
| Basic HVAC | 63% | | | | | | | X | | | | |
| Controls | 60% | | | | | | | X | | | | |
| Electrical | 58% | | | | | | | X | | | | |
| Heating | 37% | | | | | X | | | | | | |
| HVAC Components | 60% | | | | | | | X | | | | |
| Hydronics | 57% | | | | | | X | | | | | |
| Installation | 80% | | | | | | | | | X | | |
| Motors | 40% | | | | | X | | | | | | |
| Piping | 67% | | | | | | | | X | | | |
| Refrigeration | 51% | | | | | | X | | | | | |
| Safety | 50% | | | | | | X | | | | | |
| Troubleshooting | 34% | | | | X | | | | | | | |
| **Cumulative** | 56% | | | | | | | X | | | | |

Yellow bars represent the "average" acceptable range of Journeyman tested.

Upon completion of the assessment test a customized program will be created based on the technicians' proficiencies. All course material and assignments are based on the latest education materials from the largest selection of textbooks in the Nation. The continuing education program includes over 1,500 hours of courses and customized material.

**We're committed to developing the curriculums, resources and mentorship programs needed to serve the commercial HVAC service industry**

Nicole Bass

**Nicole Bass**
**President - Service Professionals**

# 1 Air Systems

## COMFORT AND PSYCHROMETRIC (LEVEL 2)

This lesson will take you through learning about comfort as it relates to the human body and will discuss psychometrics, humidity, superheated gases in the air, dry- and wet-bulb temperatures, and dew point temperatures.

The psychrometric chart is reviewed and plotting on the psychrometric chart is covered in detail. The lesson will also discuss total heat along with building air-conditioning specifications, including indoor-outdoor air ratios.

## COMMERCIAL AND INDUSTRIAL HEATING AND AIR-CONDITIONING EQUIPMENT (LEVEL 2)

This lesson will walk you through the components of commercial and industrial heating and air-conditioning equipment. By the end of this lesson, you will:

- Understand basic commercial and industrial control circuitry, including compressor, evaporator fan motor, condenser fan motor, and safety control circuits.
- Understand control circuits that are used in commercial and industrial equipment like specialized compressor motor circuits, water chiller controls, component interlocks, anti-short-cycling devices, and other.
- Understand the basic circuitry of control systems used on light commercial and commercial and industrial applications.
- Identify the methods of control for commercial and industrial systems.
- Describe the control loop as it relates to control circuitry.
- Explain a basic pneumatic control system.
- Explain a direct digital control system.
- Air Distribution and Balance (Level 3)

This lesson will discuss the forced-air system, system pressures, air measuring instruments for duct systems, types of fans, and fan drives. Several duct systems are described, including the plenum system, extended plenum, reducing plenum, and perimeter loop systems, as are duct materials and fastening devices, including galvanized steel, fiberglass, spiral metal, and flexible duct. Combination duct systems are also included.

The lesson will also discuss duct air movement, balancing dampers, duct insulation, and blending conditioned air with room air, registers, and diffusers. Illustrations of various duct system components and fittings are provided for added clarity.

The unit covers sizing duct and measuring air movement for balancing and describes the air friction chart with numerical examples. Zoning, from the perspective of both new installations and add-on installations, is also covered.

## ALL-WEATHER HEATING SYSTEMS (LEVEL 3)

This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment. Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed.

As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

## ENERGY AUDITING (LEVEL 3)

This lesson will provide a complete unit on residential energy auditing, covering weatherization, auditing, visual inspections, measuring, insulation tips, blower door testing, base load inspecting, diagnostic testing, thermal imaging camera scanning, sealing air leaks, duct leakage testing, combustion efficiency, and safety testing, furnace efficiency testing and ratings, furnace preventive maintenance, spillage and backdrafting, flame safeguard controls, excess air, venting, draft, high-efficiency furnace anatomy, HVAC/R system testing, numerical analysis and reporting, base load versus season loads, and energy index reporting.

## INDOOR AIR QUALITY (LEVEL 3)

This will provide important information regarding sources of indoor air pollution, contamination source detection and elimination, ventilation, ultraviolet light, filters, electrostatic precipitators, activated charcoal air purifiers, and ion generators. Duct cleaning and air humidification, including several types of humidifiers, will also be discussed.

Evidence indicates that indoor air may be more seriously polluted than outdoor air. Other research indicates that many people spend as much as 90% of their time indoors. Therefore, much emphasis is being placed on the overall quality of our indoor air.

## AIR SOURCE HEAT PUMPS (LEVEL 4)

This lesson begins with a discussion of reverse-cycle refrigeration and the four-way valve. Types of heat pumps are covered, such as ground/water-to-air (ground loop and well water), solar-assisted, and air-to-air.

Refrigerant line identification, types of metering devices, and liquid-line accessories are also covered, followed by a discussion of the application of the air-to-air heat pump, auxiliary heat, balance point, and the coefficient of performance and controls.

Defrost is discussed in detail. Heat pumps using the scroll compressor and those with variable-speed motors are also discussed. There is an extensive section on troubleshooting problems and on preventive maintenance and HVAC Golden Rules for technicians. Also included are 21 typical technician service calls covering the most frequent service situations a technician will encounter.

## SIMULATIONS GAS FURNACE (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills in gas furnaces.

## SIMULATIONS HEAT PUMP (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills in heat pump systems.

## SIMULATIONS OIL FURNACE (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills oil furnaces.

# 2 Basic HVAC

### BASIC MATH FOR THE TRADES (LEVEL 1)
This course will provide you with an assessment of your general math ability required to be successful in the HVAC trades.

### BASIC REFRIGERATIONS (LEVEL 1)
This lesson includes a history of refrigeration and a basic discussion of the refrigeration process. In this lesson, you will learn:

- Using water as refrigerants as examples, the temperature and pressure relationship is discussed and is followed by a description of the four major refrigeration components: the evaporator, compressor, condenser, and metering device.
- A detailed description of the refrigeration cycle and a brief description of the reciprocating, rotary, scroll, centrifugal, and screw compressors.
- Newer, more popular long-term refrigerants and refrigerant replacements are covered along with refrigerants with phase-out dates in the near future.
- Refrigerant leak detection, recovery and recycling, cylinder color codes, and chemical makeup are discussed.
- The issue of ozone layer depletion is attributed to halogenated chlorofluorocarbon.
- Plotting systems on pressure and enthalpy diagrams.

### ELECTRICAL THEORY (LEVEL 1)
This lesson will provide you with instructions to be able to complete the following:

- Briefly explain the atomic theory and its relationship to physical objects and electron flow.
- Explain the flow of electrons and how it is accomplished.
- Explain electrical potential, current flow, and resistance and how they are measured.
- Explain electrical power and how it is measured.
- Explain Ohm's law and calculate the potential, current, and resistance of an electrical circuit.
- Calculate the electrical power of a circuit and the BTU/hour rating of an electrical resistance heater.
- Calculate the electrical power of a circuit and the BTU/hour rating of an electrical resistance heater.

### FASTENERS (LEVEL 1)
This lesson will discuss the following information on equipment fasteners:

- Nails, staples, rivets, wood screws, tapping screws, and machine screws.
- Thread sizes and other identifying data.
- Other fasteners such as set screws, anchor shields, wall anchors, toggle bolts, threaded rod, angle steel, and masonry fasteners.
- Miscellaneous fasteners such as the cotter pin, pipe hook, pipe strap, perforated strap, nylon strap, grille clip, solderless terminals, and screw-on wire connectors.

# Basic HVAC

### AIR-CONDITIONING SYSTEM REFRIGERANTS AND COMPONENTS (LEVEL 2)

In this lesson, you will learn about air-conditioning system refrigerants and their components, particularly in structural heat gain.

In the summer months, heat flows into the structure through open windows and doors but also through cracks or gaps that may be present in the shell of the structure. In addition, heat enters a structure through the walls themselves as well as through other building panels.

Various methods of cooling and system configurations are presented in this lesson and describe types of evaporators, compressors (reciprocating, rotary, and scroll), condensers, expansion devices, air-side components, and installation procedures for air-conditioning.

### APPLICATION OF MOTORS (LEVEL 2)

This lesson will discuss the various characteristics and designs of motors for particular applications, including electrical specifications, insulation, bearings, mountings, and motor drives.

### CALIBRATING INSTRUMENTS (LEVEL 2)

This lesson will discuss the need to calibrate instruments and the procedures to use in calibrating temperature-measuring, pressure tests, electrical test instruments, refrigeration leak-detection devices, and flue-gas analysis instruments. The lesson will also discuss the general maintenance procedures for instruments used in the HVAC/R field.

### COMFORT AND PSYCHROMETRIC (LEVEL 2)

This lesson will take you through learning about comfort as it relates to the human body and will discuss psychometrics, humidity, superheated gases in the air, dry- and wet-bulb temperatures, and dew point temperatures.

The psychrometric chart is reviewed and plotting on the psychrometric chart is covered in detail. The lesson will also discuss total heat along with building air-conditioning specifications, including indoor-outdoor air ratios.

### COMMERCIAL, PACKAGED ROOFTOP, VARIABLE REFRIGERANT FLOW, AND VARIABLE AIR VOLUME SYSTEM (LEVEL 2)

This lesson will discuss packaged rooftop equipment as well as variable air volume and variable refrigerant volume systems. The section on rooftop equipment discusses the important topic of unit location as well as how to get the unit up to the roof.

System problems with respect to serviceability, environmental issues such as snow accumulation, and condenser air recirculation are all covered to provide the reader with important insight into the location selection process.

Also discussed are penetrating the roof and the importance of dealing with bonded roofs. The proper setting and installation of the roof curb to help prevent leaks and noise transmission into the occupied space are stressed. An integral part of the rooftop unit installation is the rigging of the equipment, so crane basics are discussed in this unit, along with the industry-accepted hand signals that are used to communicate with the crane operator during the rigging process.

### COMPRESSORS (LEVEL 2)

This lesson will discuss the components of the refrigeration system and the jobs of Compressors.

### CONDENSERS (LEVEL 2)

This lesson will discuss the components of the refrigeration system and the jobs of Condensers.

### ELECTRIC MOTORS (LEVEL 2)

This lesson will take a deeper dive into starting and running components and characteristics, motor speeds, and power supplies of electric motors.

More specifically, the lesson includes single- and split-phase motors; the centrifugal switch; electronic relays; capacitor-start motors; capacitor-start, capacitor-run motors; permanent split-capacitor motors; shaded-pole motors; three-phase motors; single-phase hermetic motors; the potential and current relays; the positive-temperature-coefficient start device; two-speed motors; three-phase motors; and variable-speed motors. Also included are DC converters, inverters, and ECM motors.

### EVAPORATORS (LEVEL 2)

This lesson will discuss the components of the refrigeration system and the jobs of evaporators.

### EXPANSION DEVICES (LEVEL 2)

This lesson will discuss the components of the refrigeration system and the jobs of Expansion devices.

### ALL-WEATHER HEATING SYSTEMS (LEVEL 3)

This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment.

Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed.

As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

### ELECTRIC HEATING SYSTEMS (LEVEL 3)

This lesson will discuss heating devices and furnaces as portable electric heaters, radiant heating panels, electric baseboard heating, unit heaters, electric hydronic boilers, and central forced-air electric furnaces.

The lesson will also discuss the automatic control of forced-air electric furnaces, including multiple stages, thermostats, low-voltage circuits, and fan motor circuits, and airflow for these furnaces, including the sensible heat formula.

Several wiring diagrams are included as well as a section on preventive maintenance, HVAC Golden Rules, and typical service technician calls.

### ELECTRICAL VS MECHANICAL PROBLEMS (LEVEL 3)

This lesson will discuss the following troubleshooting topics between electrical and mechanical problems:

- Use the proper safety procedures when troubleshooting HVAC control systems.
- Determine and use the correct electrical instrument to check the electrical characteristics (potential, current, and resistance) in an HVAC electrical system.
- Troubleshoot any electrical component in an HVAC electrical system.
- Isolate electrical circuits that are operating incorrectly by reading electrical wiring diagrams and using electrical meters.
- Troubleshoot a line-voltage control system.
- Troubleshoot a residential packaged unit.
- Troubleshoot a residential gas heating and electric air-conditioning split system.
- Troubleshoot a heat pump.

### ENERGY AUDITING (LEVEL 3)

This lesson will provide a complete unit on residential energy auditing, covering weatherization, auditing, visual inspections, measuring, insulation tips, blower door testing, base load inspecting, diagnostic testing, thermal imaging camera scanning, sealing air leaks, duct leakage testing, combustion efficiency, and safety testing, furnace efficiency testing and ratings, furnace preventive maintenance, spillage and backdrafting, flame safeguard controls, excess air, venting, draft, high-efficiency furnace anatomy, HVAC/R system testing, numerical analysis and reporting, base load versus season loads, and energy index reporting.

### DOMESTIC REFRIGERATORS AND FREEZERS (LEVEL 4)

This lesson will discuss a combination of domestic refrigerators and freezers. It begins with a brief description of the refrigeration process and proceeds with a discussion of the various types of evaporators and evaporator defrost.

Compressors, condensers, and metering devices, and refrigerator and freezer cabinets are discussed. Wiring and controls, the defrost cycle, sweat prevention heaters, fan motors, and ice makers are covered. Discussed in detail is domestic refrigerator and freezer service.

There is a section on HVAC Golden Rules for technicians, and several typical service technician calls are presented.

### AIR SOURCE HEAT PUMPS (LEVEL 4)

This lesson begins with a discussion of reverse-cycle refrigeration and the four-way valve. Types of heat pumps are covered, such as ground/water-to-air (ground loop and well water), solar-assisted, and air-to-air.

Refrigerant line identification, types of metering devices, and liquid-line accessories are also covered, followed by a discussion of the application of the air-to-air heat pump, auxiliary heat, balance point, and the coefficient of performance and controls. Defrost is discussed in detail. Heat pumps using the scroll compressor and those with variable-speed motors are also discussed.

There is an extensive section on troubleshooting problems and on preventive maintenance and HVAC Golden Rules for technicians. Also included are 21 typical technician service calls covering the most frequent service situations a technician will encounter.

# 3 Controls

### ADVANCED AUTOMATIC CONTROLS—DIRECT DIGITAL CONTROLS (DDCS) AND PNEUMATICS (LEVEL 3)

This lesson will discuss control terminology, applications, and electronic control circuits. The lesson will also cover pneumatic controls and direct digital controls and programmable thermostats.

### AIR DISTRIBUTION AND BALANCE (LEVEL 3)

This lesson will discuss the forced-air system, system pressures, air measuring instruments for duct systems, types of fans, and fan drives.

Several duct systems are described, including the plenum system, extended plenum, reducing plenum, and perimeter loop systems, as are duct materials and fastening devices, including galvanized steel, fiberglass, spiral metal, and flexible duct. Combination duct systems are also included.

The lesson will also discuss duct air movement, balancing dampers, duct insulation, and blending conditioned air with room air, registers, and diffusers. Illustrations of various duct system components and fittings are provided for added clarity.

The unit covers sizing duct and measuring air movement for balancing and describes the air friction chart with numerical examples. Zoning, from the perspective of both new installations and add-on installations, is also covered.

### ADVANCED HYDRONICS (LEVEL 4)

This lesson is a deep dive into the world of hydronic theory.

## AUTOMATIC CONTROL COMPONENTS AND APPLICATIONS

### AUTOMATIC DEVICE APPLICATIONS (LEVEL 1)

This lesson discusses space temperature controls (low and high voltage), sensing the temperature of solids, pressure-sensing devices, oil pressure safety controls, air pressure controls, devices that control fluid flow, and maintenance of mechanical and electromechanical controls are topics covered in this unit.

### INTRODUCTION TO AUTOMATIC CONTROLS (LEVEL 1)

This lesson discusses types of automatic controls, devices that respond to thermal change, the bimetal device, control by fluid expansion, the thermocouple, and electronic sensing devices.

### TROUBLESHOOTING

Unit 41 covers mechanical and electrical troubleshooting for air-conditioning systems. Use of the gauge manifold, taking temperature readings, and charging units with refrigerant are included under mechanical troubleshooting.

Compressor overload problems, compressor electrical checks, and troubleshooting circuit electrical protectors are covered under electrical troubleshooting.

### TROUBLESHOOTING BASIC CONTROLS (LEVEL 1)

This lesson describes procedures for troubleshooting basic and complex circuits, thermostats, switches and loads, and high-voltage circuits controlled by thermostats.

The lesson also describes procedures for measuring amperage and voltage in low-voltage circuits and discusses pictorial and line diagrams. There will be examples of typical service technician calls at the end of the lesson.

### COMMERCIAL AND INDUSTRIAL HEATING AND AIR-CONDITIONING EQUIPMENT (LEVEL 2)

This lesson will walk you through the components of commercial and industrial heating and air-conditioning equipment. By the end of this lesson, you will:

- Understand basic commercial and industrial control circuitry, including compressor, evaporator fan motor, condenser fan motor, and safety control circuits.
- Understand control circuits that are used in commercial and industrial equipment like specialized compressor motor circuits, water chiller controls, component interlocks, anti-short-cycling devices, and others.
- Understand the basic circuitry of control systems used on light commercial and commercial and industrial applications.
- Identify the methods of control for commercial and industrial systems.
- Describe the control loop as it relates to control circuitry.
- Explain a basic pneumatic control system.
- Explain a direct digital control system.

### MOTOR CONTROLS (LEVEL 2)

This lesson will discuss the components used to close or open the power supply circuit to a motor, such as relays, contactors, and starters.

The lesson will also discuss inherent and external motor protection, the service factor, other temperature-sensing, and magnetic overload devices, and procedures for restarting the motor.

### ICE-MAKING SYSTEMS (LEVEL 3)

This lesson will discuss the ice-making package equipment and includes flake, cube, cylindrical, crescent-shaped, and cell-type cube-making machines.

The lesson will also discuss microprocessors, microprocessor input/output troubleshooting, water filtration and treatment, and cleaning and sanitizing ice machines, in addition to service technician calls.

### NORMAL OPERATING CONDITIONS (LEVEL 3)

This lesson will discuss the typical operating conditions for the various components of standard and high-efficiency air-conditioning systems.

Equipment efficiency ratings— EER and SEER—are described, as are electrical operating conditions and ratings, including the power supply, compressor running amperage, full-load current, current draw, and the two-speed compressor.

### PERFORMING A SUCCESSFUL SERVICE CALL (LEVEL 3)

This lesson will teach the necessary methods for performing a successful service call. HVAC Tech Method documents are provided as additional tools of reference.

### DOMESTIC REFRIGERATORS AND FREEZERS (LEVEL 4)

This lesson will discuss a combination of domestic refrigerators and freezers. It begins with a brief description of the refrigeration process and proceeds with a discussion of the various types of evaporators and evaporator defrost.

Compressors, condensers, metering devices, and refrigerator and freezer cabinets are discussed. Wiring and controls, the defrost cycle, sweat prevention heaters, fan motors, and ice makers are covered.

Discussed in detail is the domestic refrigerator and freezer service. There is a section on HVAC Golden Rules for technicians, and several typical service technician calls are presented.

### SIMULATIONS COMMERCIAL AC (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills in commercial air-conditioning systems.

### TROUBLESHOOTING WITH A MULTIMETER (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills and ability to troubleshoot with a multimeter.

# 4 Electrical

### APPLICATION OF MOTORS (LEVEL 2)
This lesson will discuss the various characteristics and designs of motors for particular applications, including electrical specifications, insulation, bearings, mountings, and motor drives.

### ADVANCED AUTOMATIC CONTROLS—DIRECT DIGITAL CONTROLS (DDCS) AND PNEUMATICS (LEVEL 3)
This lesson will discuss control terminology, applications, and electronic control circuits. The lesson will also cover pneumatic controls and direct digital controls and programmable thermostats.

## AUTOMATIC CONTROL COMPONENTS AND APPLICATIONS

### AUTOMATIC DEVICE APPLICATIONS (LEVEL 1)
This lesson discusses space temperature controls (low and high voltage), sensing the temperature of solids, pressure-sensing devices, oil pressure safety controls, air pressure controls, devices that control fluid flow, and maintenance of mechanical and electromechanical controls are topics covered in this unit.

### BASIC ELECTRICITY SAFETY (LEVEL 1)
This lesson will discuss the basic information on electricity safety. You will be able to do the following:
- Explain the effect of electric current on the human body.
- Understand the injuries that are possible from an electrical shock.
- Know the basic procedures in the event of an electrical shock.
- Understand the importance of properly grounding tools and appliances.
- Safely use electrical hand tools and electrical meters.
- Follow the principles of safety when installing and servicing heating and air-conditioning equipment.

### COMPONENTS, SYMBOLS, AND CIRCUITRY OF AIR-CONDITIONING WIRING DIAGRAMS (LEVEL 1)
This lesson provides you with instructions to be able to complete the following in regard to heating, cooling, and refrigeration systems:
- Explain what electrical loads are and their general purpose.
- Give examples of common loads.
- Identify the symbols of common loads.
- Explain the purpose of relays and contactors.
- Identify the symbols of relays and contactors.
- Explain the purpose of switches and the types used.
- Identify the symbols of switches.
- Identify the symbols and purpose of other miscellaneous controls.
- Identify the different types of wiring diagrams used in the industry and the purpose of each.

### ELECTRICAL METERS (LEVEL 1)
This lesson provides instructions to be able to understand the following elements of electrical meters:
- Describe the use of the volt-ohm meter and clamp-on ammeter in the heating, cooling, and refrigeration industry.
- Explain the operation of the basic electric analog meter.
- Explain how analog electric meters transfer a known value in an electrical circuit to the meter movement.
- Describe the operation of an analog voltmeter.
- Describe the operation of an analog and digital clamp-on ammeter.
- Describe the operation of an analog ohmmeter.
- Explain the operation of a digital volt-ohm meter.
- Give the advantages and disadvantages of analog and digital meters.
- Describe the conditions of resistance that can exist in an electrical circuit in reference to continuity.
- Describe the source of energy for the operation of the analog voltmeter, ammeter, and ohmmeter.

### ELECTRICAL MOTOR COMPONENTS (LEVEL 1)
This lesson provides instructions to be able to complete the following components of electrical motors:
- Identify and explain the operation of motor starting relays and other starting components that are used on single-phase hermetic compressor motors.
- Select the correct potential relay for an application with information available on the potential relay to be replaced.
- Troubleshoot and install motor starting relays on hermetic compressor motors.
- Lubricate and identify the types of bearings used in electric motors.
- Identify the type of motor drives used on industry applications.
- Calculate the variables in a V-belt drive application to obtain the desired equipment rpm.
- Recognize and adjust a V-belt application to the proper tension and alignment.
- Explain torque and the purpose of different types of single-phase motors.
- Explain the operation of a basic electric motor.
- Understand how to operate, install, reverse the rotation (if possible), and diagnose problems in a shaded-pole motor.
- Understand the purpose of capacitors in the operation of a single-phase motor and be able to explain the difference between a starting and running capacitor.
- Correctly diagnose the condition of any capacitor and, using capacitor rules, be able to substitute a capacitor if a direct replacement is not available.
- Explain how to operate, install, troubleshoot, and repair (if possible) split-phase and capacitor-start motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) permanent split-capacitor motors.

- Explain how to operate, install, troubleshoot, and repair (if possible) capacitor-start–capacitor-run motors.
- Understand how to operate, install, reverse, and troubleshoot three-phase motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) electronically commutated motors.
- Identify the common, start, and run terminals of a single-phase compressor motor.
- Explain, the operation and be able to troubleshoot and repair the brushless dc motor.

### ELECTRICAL SAFETY (LEVEL 1)
This course will discuss general information on electrical safety, including important information to know by the U.S. Department of Labor.

### ELECTRICAL THEORY (LEVEL 1)
This lesson will provide you with instructions to be able to complete the following:
- Briefly explain the atomic theory and its relationship to physical objects and electron flow.
- Explain the flow of electrons and how it is accomplished.
- Explain electrical potential, current flow, and resistance and how they are measured.
- Explain electrical power and how it is measured.
- Explain Ohm's law and calculate the potential, current, and resistance of an electrical circuit.
- Calculate the electrical power of a circuit and the BTU/hour rating of an electrical resistance heater.
- Calculate the electrical power of a circuit and the BTU/hour rating of an electrical resistance heater.

### INTRODUCTION TO AUTOMATIC CONTROLS (LEVEL 1)
This lesson discusses types of automatic controls, devices that respond to thermal change, the bimetal device, control by fluid expansion, the thermocouple, and electronic sensing devices.

### COMPRESSORS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Compressors.

### ELECTRIC MOTORS (LEVEL 2)
This lesson will take a deeper dive into starting and running components and characteristics, motor speeds, and power supplies of electric motors.

More specifically, the lesson includes single- and split-phase motors; the centrifugal switch; electronic relays; capacitor-start motors; capacitor-start, capacitor-run motors; permanent split-capacitor motors; shaded-pole motors; three-phase motors; single-phase hermetic motors; the potential and current relays; the positive-temperature-coefficient start device; two-speed motors; three-phase motors; and variable-speed motors. Also included are DC converters, inverters, and ECM motors.

### MOTOR CONTROLS (LEVEL 2)
This lesson will discuss the components used to close or open the power supply circuit to a motor, such as relays, contactors, and starters.

The lesson will also discuss inherent and external motor protection, the service factor, other temperature-sensing, and magnetic overload devices, and procedures for restarting the motor.

### ELECTRIC HEATING SYSTEMS (LEVEL 3)
This lesson will discuss heating devices and furnaces such as portable electric heaters, radiant heating panels, electric baseboard heating, unit heaters, electric hydronic boilers, and central forced-air electric furnaces.

The lesson will also discuss the automatic control of forced-air electric furnaces, including multiple stages, thermostats, low-voltage circuits, fan motor circuits, and airflow for these furnaces, including the sensible heat formula.

Several wiring diagrams are included as well as a section on preventive maintenance, HVAC Golden Rules, and typical service technician calls.

### ELECTRICAL VS MECHANICAL PROBLEMS (LEVEL 3)
This lesson will discuss the following troubleshooting topics between electrical and mechanical problems:
- Use the proper safety procedures when troubleshooting HVAC control systems.
- Determine and use the correct electrical instrument to check the electrical characteristics (potential, current, and resistance) in an HVAC electrical system.
- Troubleshoot any electrical component in an HVAC electrical system.
- Isolate electrical circuits that are operating incorrectly by reading electrical wiring diagrams and using electrical meters.
- Troubleshoot a line-voltage control system.
- Troubleshoot a residential packaged unit.
- Troubleshoot a residential gas heating and electric air-conditioning split system.
- Troubleshoot a heat pump.

### PERFORMING A SUCCESSFUL SERVICE CALL (LEVEL 3)
This lesson will teach the necessary methods for performing a successful service call. HVAC Tech Method documents are provided as additional tools of reference.

### BASIC CIRCUITS (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills on basic circuits.

### ELECTRICAL SIMULATIONS TEST (LEVEL 4)
This unit will test your knowledge of electrical systems through a simulation assessment.

### OPERATION, MAINTENANCE, AND TROUBLESHOOTING OF CHILLED-WATER AIR-CONDITIONING SYSTEMS (LEVEL 4)
This lesson will provide information on compression-type chiller start-up, chiller operation, air-cooled and water-cooled chiller maintenance, and absorption chilled-water system start-up, operation, and maintenance. The lesson will also include examples of typical service technician calls.

# 5 Heating

### AIR SOURCE HEAT PUMPS
This lesson begins with a discussion of reverse-cycle refrigeration and the four-way valve.

Types of heat pumps are covered, such as ground/water-to-air (ground loop and well water), solar-assisted, and air-to-air.

Refrigerant line identification, types of metering devices, and liquid-line accessories are also covered, followed by a discussion of the application of the air-to-air heat pump, auxiliary heat, balance point, and the coefficient of performance and controls. Defrost is discussed in detail.

Heat pumps using the scroll compressor and those with variable-speed motors are also discussed. There is an extensive section on troubleshooting problems and on preventive maintenance and HVAC Golden Rules for technicians.

Also included are 21 typical technician service calls covering the most frequent service situations a technician will encounter.

### COMFORT AND PSYCHROMETRIC (LEVEL 2)
This lesson will take you through learning about comfort as it relates to the human body and will discuss psychometrics, humidity, superheated gases in the air, dry- and wet-bulb temperatures, and dew point temperatures.

The psychrometric chart is reviewed and plotting on the psychrometric chart is covered in detail. The lesson will also discuss total heat along with building air-conditioning specifications, including indoor-outdoor air ratios.

### ELECTRIC HEATING SYSTEMS (LEVEL 3)
This lesson will discuss heating devices and furnaces such as portable electric heaters, radiant heating panels, electric baseboard heating, unit heaters, electric hydronic boilers, and central forced-air electric furnaces.

The lesson will also discuss the automatic control of forced-air electric furnaces, including multiple stages, thermostats, low-voltage circuits, fan motor circuits, and airflow for these furnaces, including the sensible heat formula.

Several wiring diagrams are included as well as a section on preventive maintenance, HVAC Golden Rules, and typical service technician calls.

### ELECTRICAL VS MECHANICAL PROBLEMS (LEVEL 3)
This lesson will discuss the following troubleshooting topics between electrical and mechanical problems:

- Use the proper safety procedures when troubleshooting HVAC control systems.
- Determine and use the correct electrical instrument to check the electrical characteristics (potential, current, and resistance) in an HVAC electrical system.
- Troubleshoot any electrical component in an HVAC electrical system.
- Isolate electrical circuits that are operating incorrectly by reading electrical wiring diagrams and using electrical meters.
- Troubleshoot a line-voltage control system.
- Troubleshoot a residential packaged unit.
- Troubleshoot a residential gas heating and electric air-conditioning split system.
- Troubleshoot a heat pump.

### GAS-FIRED HEATING SYSTEMS (LEVEL 3)
This lesson will discuss the types of gas furnaces, gas fuels, combustion, components in a gas furnace, safety devices, gas valves, automatic combination gas valves, gas pressure regulators, heat exchangers, burners, orifices, fan and limit switches, flame rectification, electronic ignition modules, integrated furnace controllers (IFCs), two-stage gas furnaces, modulating gas furnaces, venting, piping, and calculating the proper airflow across the heat ex- changers.

Standing pilot, intermittent pilot, direct burner, direct spark, and hot surface igniter systems are also covered in detail. There are several wiring diagrams and several pages of troubleshooting procedures. High-efficiency furnaces are also discussed, including direct-spark ignition, hot surface ignition, pulse, and condensing furnaces.

There is a section on HVAC Golden Rules for technicians, a section on preventive maintenance, and several typical service technician calls.

### HYDRONIC HEATING THEORY (LEVEL 3)
This lesson will provide an introduction to hydronic heat that is followed by a description of many components in a hot water heating system.

Description and charts are used to show how a centrifugal pump performance curve is determined. This is followed by descriptions and diagrams of several hydronic heating piping systems and of a tankless domestic hot water heater.

The lesson also includes a section on preventive maintenance, HVAC Golden Rules for technicians, and several typical technician service calls.

### OIL-FIRED HEATING SYSTEMS (LEVEL 3)
This lesson will discuss the physical characteristics of oil furnaces, types of fuel oils, parts of a gun-type oil burner, wiring diagrams, and safety controls.

Fuel oil supply systems, the combustion chamber, heat exchangers, and determining the correct airflow across the heat exchanger are also covered, as is the condensing oil furnace. Several pages are devoted to service procedures and preventive maintenance.

HVAC Golden Rules for service technicians and several typical service technician calls are also included.

### ADVANCED HYDRONICS (LEVEL 4)
This lesson is a deep dive into the world of hydronic theory.

### ALL-WEATHER HEATING SYSTEMS (LEVEL 4)
This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment.

Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed.

As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

### GEOTHERMAL HEAT PUMPS (LEVEL 4)
This lesson will discuss the concepts of reverse-cycle refrigeration, open-loop systems, and closed-loop systems.

Also included are ground-loop configurations and flows, system materials, heat exchange fluids, and geothermal wells and water sources. The lesson will conclude with information regarding troubleshooting and several typical service technician calls.

### SIMULATIONS GAS BOILER (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in gas boiler systems.

### SIMULATIONS GAS FURNACE (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in gas furnaces.

### SIMULATIONS HEAT PUMP (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in heat pump systems.

### SIMULATIONS OIL FURNACE (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills oil furnaces.

**Learn as if you were not reaching your goal and as though you were scared of missing it**

**Confucius**

# 6 HVAC Components

## COMPONENTS, SYMBOLS, AND CIRCUITRY OF AIR-CONDITIONING WIRING DIAGRAMS (LEVEL 1)

This lesson provides you with instructions to be able to complete the following in regard to heating, cooling, and refrigeration systems:

- Explain what electrical loads are and their general purpose.
- Give examples of common loads.
- Identify the symbols of common loads.
- Explain the purpose of relays and contactors.
- Identify the symbols of relays and contactors.
- Explain the purpose of switches and the types used.
- Identify the symbols of switches.
- Identify the symbols and purpose of other miscellaneous controls.
- Identify the different types of wiring diagrams used in the industry and the purpose of each.

## ELECTRICAL MOTOR COMPONENTS (LEVEL 1)

This lesson provides instructions to be able to complete the following components of electrical motors:

- Identify and explain the operation of motor starting relays and other starting components that are used on single-phase hermetic compressor motors.
- Select the correct potential relay for an application with information available on the potential relay to be replaced.
- Troubleshoot and install motor starting relays on hermetic compressor motors.
- Lubricate and identify the types of bearings used in electric motors.
- Identify the type of motor drives used on industry applications.
- Calculate the variables in a V-belt drive application to obtain the desired equipment rpm.
- Recognize and adjust a V-belt application to the proper tension and alignment.
- Explain torque and the purpose of different types of single-phase motors.
- Explain the operation of a basic electric motor.
- Understand how to operate, install, reverse the rotation (if possible), and diagnose problems in a shaded-pole motor.
- Understand the purpose of capacitors in the operation of a single-phase motor and be able to explain the difference between a starting and running capacitor.
- Correctly diagnose the condition of any capacitor and, using capacitor rules, be able to substitute a capacitor if a direct replacement is not available.
- Explain how to operate, install, troubleshoot, and repair (if possible) split-phase and capacitor-start motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) permanent split-capacitor motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) capacitor-start–capacitor-run motors.
- Understand how to operate, install, reverse, and troubleshoot three-phase motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) electronically commutated motors.

- Identify the common, start, and run terminals of a single-phase compressor motor.
- Explain, the operation and be able to troubleshoot and repair the brushless dc motor.

### INTRODUCTION TO AUTOMATIC CONTROLS (LEVEL 1)
This lesson discusses types of automatic controls, devices that respond to thermal change, the bimetal device, control by fluid expansion, the thermocouple, and electronic sensing devices.

### AIR-CONDITIONING SYSTEM REFRIGERANTS AND COMPONENTS (LEVEL 2)
In this lesson, you will learn about air-conditioning system refrigerants and their components, particularly in structural heat gain.

In the summer months, heat flows into the structure through open windows and doors but also through cracks or gaps that may be present in the shell of the structure. In addition, heat enters a structure through the walls themselves as well as through other building panels.

Various methods of cooling and system configurations are presented in this lesson and describe types of evaporators, compressors (reciprocating, rotary, and scroll), condensers, expansion devices, air-side components, and installation procedures for air-conditioning.

### CALIBRATING INSTRUMENTS (LEVEL 2)
This lesson will discuss the need to calibrate instruments and the procedures to use in calibrating temperature-measuring, pressure test, and electrical test instruments, refrigeration leak-detection devices, and flue gas analysis instruments.

The lesson will also discuss the general maintenance procedures for instruments used in the HVAC/R field.

### COMMERCIAL AND INDUSTRIAL HEATING AND AIR-CONDITIONING EQUIPMENT (LEVEL 2)
This lesson will walk you through the components of commercial and industrial heating and air-conditioning equipment. By the end of this lesson, you will:

- Understand basic commercial and industrial control circuitry, including compressor, evaporator fan motor, condenser fan motor, and safety control circuits.
- Understand control circuits that are used in commercial and industrial equipment like specialized compressor motor circuits, water chiller controls, component interlocks, anti-short-cycling devices, and others.
- Understand the basic circuitry of control systems used on light commercial and commercial and industrial applications.
- Identify the methods of control for commercial and industrial systems.
- Describe the control loop as it relates to control circuitry.
- Explain a basic pneumatic control system.
- Explain a direct digital control system.

### EVAPORATORS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of evaporators.

### EXPANSION DEVICES (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Expansion devices.

### COMPRESSORS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Compressors.

### CONDENSERS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Condensers.

### ADVANCED AUTOMATIC CONTROLS—DIRECT DIGITAL CONTROLS (DDCS) AND PNEUMATICS (LEVEL 3)
This lesson will discuss control terminology, applications, and electronic control circuits. The lesson will also cover pneumatic controls and direct digital controls and programmable thermostats.

### AIR DISTRIBUTION AND BALANCE (LEVEL 3)
This lesson will discuss the forced-air system, system pressures, air measuring instruments for duct systems, types of fans, and fan drives.

Several duct systems are described, including the plenum system, extended plenum, reducing plenum, and perimeter loop systems, as are duct materials and fastening devices, including galvanized steel, fiberglass, spiral metal, and flexible duct. Combination duct systems are also included.

The lesson will also discuss duct air movement, balancing dampers, duct insulation, and blending conditioned air with room air, registers, and diffusers. Illustrations of various duct system components and fittings are provided for added clarity.

The unit covers sizing duct and measuring air movement for balancing and describes the air friction chart with numerical examples. Zoning, from the perspective of both new installations and add-on installations, is also covered.

### ELECTRIC HEATING SYSTEMS (LEVEL 3)
This lesson will discuss heating devices and furnaces such as portable electric heaters, radiant heating panels, electric baseboard heating, unit heaters, electric hydronic boilers, and central forced-air electric furnaces.

The lesson will also discuss the automatic control of forced-air electric furnaces, including multiple stages, thermostats, low-voltage circuits, fan motor circuits, and airflow for these furnaces, including the sensible heat formula.

Several wiring diagrams are included as well as a section on preventive maintenance, HVAC Golden Rules, and typical service technician calls.

# Investing in the training and success of your people will provide the highest economic return

**Bob Pratt**

### GAS-FIRED HEATING SYSTEMS (LEVEL 3)

This lesson will discuss the types of gas furnaces, gas fuels, combustion, components in a gas furnace, safety devices, gas valves, automatic combination gas valves, gas pressure regulators, heat exchangers, burners, orifices, fan and limit switches, flame rectification, electronic ignition modules, integrated furnace controllers (IFCs), two-stage gas furnaces, modulating gas furnaces, venting, piping, and calculating the proper airflow across the heat ex- changers.

Standing pilot, intermittent pilot, direct burner, direct spark, and hot surface igniter systems are also covered in detail. There are several wiring diagrams and several pages of troubleshooting procedures. High-efficiency furnaces are also discussed, including direct-spark ignition, hot surface ignition, pulse, and condensing furnaces. There is a section on HVAC Golden Rules for technicians, a section on preventive maintenance, and several typical service technician calls.

### ICE-MAKING SYSTEMS (LEVEL 3)

This lesson will discuss the ice-making package equipment and includes flake, cube, cylindrical, crescent-shaped, and cell-type cube-making machines.

The lesson will also discuss microprocessors, microprocessor input/output troubleshooting, water filtration and treatment, and cleaning and sanitizing ice machines, in addition to service technician calls.

### INDOOR AIR QUALITY (LEVEL 3)

This will provide important information regarding sources of indoor air pollution, contamination source detection and elimination, ventilation, ultraviolet light, filters, electrostatic precipitators, activated charcoal air purifiers, and ion generators.

Duct cleaning and air humidification, including several types of humidifiers, will also be discussed. Evidence indicates that indoor air may be more seriously polluted than outdoor air. Other research indicates that many people spend as much as 90% of their time indoors. Therefore, much emphasis is being placed on the overall quality of our indoor air.

### NORMAL OPERATING CONDITIONS (LEVEL 3)

This lesson will discuss the typical operating conditions for the various components of standard and high-efficiency air-conditioning systems.

Equipment efficiency ratings— EER and SEER—are described, as are electrical operating conditions and ratings, including the power supply, compressor running amperage, full-load current, current draw, and the two-speed compressor.

### COOLING TOWERS AND PUMPS (LEVEL 4)

This lesson will discuss the functions and types of cooling towers. Specifically, you will learn about flow patterns, the tower sump, makeup water, blowdown, and balancing the water flow. Pumps used in cooling towers will also be discussed in detail.

### HIGH PRESSURE, LOW PRESSURE, AND ABSORPTION CHILLED-WATER SYSTEMS (LEVEL 4)

This lesson discusses both high- and low-pressure compression cycle chillers and absorption chillers. Reciprocating compressors, including cylinder unloading, scroll, rotary screw, and centrifugal compressors are covered.

Also presented are direct-expansion and flooded evaporators, water- and air-cooled condensers, thermostatic expansion valves, the orifice, float-type metering devices, electronic expansion valves, and purge units.

The topics covered within the material relative to absorption air-conditioning chillers are theory, solution strength, pumps, capacity control, crystallization, purge systems, heat exchangers, and motors and drives. Several motor start systems, overload protection, and other circuitry are discussed.

### OPERATION, MAINTENANCE, AND TROUBLESHOOTING OF CHILLED-WATER AIR-CONDITIONING SYSTEMS (LEVEL 4)

This lesson will provide information on compression-type chiller start-up, chiller operation, air-cooled and water-cooled chiller maintenance, and absorption chilled-water system start-up, operation, and maintenance. The lesson will also include examples of typical service technician calls.

# 7 Hydronics

### ALL-WEATHER HEATING SYSTEMS (LEVEL 3)
This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment.

Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed. As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

### HYDRONIC HEATING THEORY (LEVEL 3)
This lesson will provide an introduction to hydronic heat that is followed by a description of many components in a hot water heating system.

Description and charts are used to show how a centrifugal pump performance curve is determined. This is followed by descriptions and diagrams of several hydronic heating piping systems and of a tankless domestic hot water heater.

The lesson also includes a section on preventive maintenance, HVAC Golden Rules for technicians, and several typical technician service calls.

### ADVANCED HYDRONICS (LEVEL 4)
This lesson is a deep dive into the world of hydronic theory.

### COOLING TOWERS AND PUMPS (LEVEL 4)
This lesson will discuss the functions and types of cooling towers. Specifically, you will learn about flow patterns, the tower sump, makeup water, blowdown, and balancing the water flow. Pumps used in cooling towers will also be discussed in detail.

### OPERATION, MAINTENANCE, AND TROUBLESHOOTING OF CHILLED-WATER AIR-CONDITIONING SYSTEMS (LEVEL 4)
This lesson will provide information on compression-type chiller start-up, chiller operation, air-cooled and water-cooled chiller maintenance, and absorption chilled-water system start-up, operation, and maintenance. The lesson will also include examples of typical service technician calls.

### SIMULATIONS GAS BOILER (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in gas boiler systems.

# 8 Installation

### FASTENERS (LEVEL 1)
This lesson will discuss the following information on equipment fasteners:

- Nails, staples, rivets, wood screws, tapping screws, and machine screws.
- Thread sizes and other identifying data.
- Other fasteners such as set screws, anchor shields, wall anchors, toggle bolts, threaded rods, angle steel, and masonry fasteners.
- Miscellaneous fasteners such as the cotter pin, pipe hook, pipe strap, perforated strap, nylon strap, grille clip, solderless terminals, and screw-on wire connectors.

### PIPING OPERATIONS (LEVEL 1)
This lesson will provide the basic entities of the following:

- Basic piping operations and techniques including cutting, bending, soldering, brazing, swaging, and flaring.
- General information regarding tubing and piping materials, such as types, sizes, insulation, and line sets.
- Soldering and brazing procedures are presented in detail, along with procedures for properly setting up and storing torches used for air-acetylene and oxyacetylene applications.
- Information regarding steel and plastic pipe applications as well as alternative mechanical methods for joining sections of tubing for plumbing and other low-pressure applications.

### AIR-CONDITIONING SYSTEM REFRIGERANTS AND COMPONENTS (LEVEL 2)
In this lesson, you will learn about air-conditioning system refrigerants and their components, particularly in structural heat gain. In the summer months, heat flows into the structure through open windows and doors but also through cracks or gaps that may be present in the shell of the structure.

In addition, heat enters a structure through the walls themselves as well as through other building panels. Various methods of cooling and system configurations are presented in this lesson and describe types of evaporators, compressors (reciprocating, rotary, and scroll), condensers, expansion devices, air-side components, and installation procedures for air-conditioning.

### ALL-WEATHER HEATING SYSTEMS (LEVEL 3)
This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment.

Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed.

As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

### ADVANCED HYDRONICS (LEVEL 4)
This lesson is a deep dive into the world of hydronic theory.

### REFRIGERANT, INSTALLATION
This lesson provides information on the installation of refrigeration systems, including vapor and liquid refrigerant charging, weighing refrigerant, and the use of charging devices.

### TOOLS AND EQUIPMENT (LEVEL 1)
This lesson discusses the basics of the following HVAC tools and equipment.

- Heating, air-conditioning, refrigeration air systems and balancing, and energy auditing tools and equipment.
- General hand tools, specialized hand tools, specialized digital tools, web-based instruments and tools, and specialized service and installation equipment.

### SYSTEM INSTALLATION AND START-UP (LEVEL 3)
This lesson will discuss the installation techniques for package and split air-conditioning systems, including the duct.

The lesson will also discuss the square and rectangular duct and fasteners, round metal duct, insulation, duct board, vibration isolation, condensate drain piping, refrigerant piping, refrigerant charge, line sets, leak testing, precharged line sets, altered line sets, and equipment start-up.

# 9 Motors

## ELECTRICAL MOTOR COMPONENTS (LEVEL 1)

This lesson provides instructions to be able to complete the following components of electrical motors:

- Identify and explain the operation of motor starting relays and other starting components that are used on single-phase hermetic compressor motors.
- Select the correct potential relay for an application with information available on the potential relay to be replaced.
- Troubleshoot and install motor starting relays on hermetic compressor motors.
- Lubricate and identify the types of bearings used in electric motors.
- Identify the type of motor drives used on industry applications.
- Calculate the variables in a V-belt drive application to obtain the desired equipment rpm.
- Recognize and adjust a V-belt application to the proper tension and alignment.
- Explain torque and the purpose of different types of single-phase motors.
- Explain the operation of a basic electric motor.
- Understand how to operate, install, reverse the rotation (if possible), and diagnose problems in a shaded-pole motor.
- Understand the purpose of capacitors in the operation of a single-phase motor and be able to explain the difference between a starting and running capacitor.
- Correctly diagnose the condition of any capacitor and, using capacitor rules, be able to substitute a capacitor if a direct replacement is not available.
- Explain how to operate, install, troubleshoot, and repair (if possible) split-phase and capacitor-start motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) permanent split-capacitor motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) capacitor-start–capacitor-run motors.
- Understand how to operate, install, reverse, and troubleshoot three-phase motors.
- Explain how to operate, install, troubleshoot, and repair (if possible) electronically commutated motors.
- Identify the common, start, and run terminals of a single-phase compressor motor.
- Explain, the operation and be able to troubleshoot and repair the brushless dc motor.

## APPLICATION OF MOTORS (LEVEL 2)

This lesson will discuss the various characteristics and designs of motors for particular applications, including electrical specifications, insulation, bearings, mountings, and motor drives.

## ELECTRIC MOTORS (LEVEL 2)

This lesson will take a deeper dive into starting and running components and characteristics, motor speeds, and power supplies of electric motors.

More specifically, the lesson includes single- and split-phase motors; the centrifugal switch; electronic relays; capacitor-start motors; capacitor-start, capacitor-run motors; permanent split-capacitor motors; shaded-pole motors; three-phase motors; single-phase hermetic motors; the potential and current relays; the positive-temperature-coefficient start device; two-speed motors; three-phase motors; and variable-speed motors. Also included are DC converters, inverters, and ECM motors.

## MOTOR CONTROLS (LEVEL 2)

This lesson will discuss the components used to close or open the power supply circuit to a motor, such as relays, contactors, and starters.

The lesson will also discuss inherent and external motor protection, the service factor, other temperature-sensing, and magnetic overload devices, and procedures for restarting the motor.

## TROUBLESHOOTING ELECTRIC MOTORS (LEVEL 2)

This lesson will discuss mechanical and electrical electric motor troubleshooting, including drive assemblies, belt tension, pulley alignment, open and shorted windings, shorts to ground, capacitor problems, wiring and connectors, and hermetic motors.

Additionally, you will learn about the six typical service technician calls relating to problems with electric motors.

## SIMULATIONS MOTOR COMPONENTS (LEVEL 4)

The simulations contained in this lesson are designed to sharpen your skills and understanding of motor components.

# 10 Piping

## PIPING OPERATIONS (LEVEL 1)
This lesson will provide the basic entities of the following:

- Basic piping operations and techniques including cutting, bending, soldering, brazing, swaging, and flaring.
- General information regarding tubing and piping materials, such as types, sizes, insulation, and line sets.
- Soldering and brazing procedures are presented in detail, along with procedures for properly setting up and storing torches used for air-acetylene and oxyacetylene applications.
- Information regarding steel and plastic pipe applications as well as alternative mechanical methods for joining sections of tubing for plumbing and other low-pressure applications.

## HYDRONIC HEATING THEORY (LEVEL 3)
This lesson will provide an introduction to hydronic heat that is followed by a description of many components in a hot water heating system.

Description and charts are used to show how a centrifugal pump performance curve is determined. This is followed by descriptions and diagrams of several hydronic heating piping systems and of a tankless domestic hot water heater.

The lesson also includes a section on preventive maintenance, HVAC Golden Rules for technicians, and several typical technician service calls.

## ADVANCED HYDRONICS (LEVEL 4)
This lesson is a deep dive into the world of hydronic theory.

## COOLING TOWERS AND PUMPS (LEVEL 4)
This lesson will discuss the functions and types of cooling towers. Specifically, you will learn about flow patterns, the tower sump, makeup water, blowdown, and balancing the water flow. Pumps used in cooling towers will also be discussed in detail.

## GEOTHERMAL HEAT PUMPS (LEVEL 4)
This lesson will discuss the concepts of reverse-cycle refrigeration, open-loop systems, and closed-loop systems.

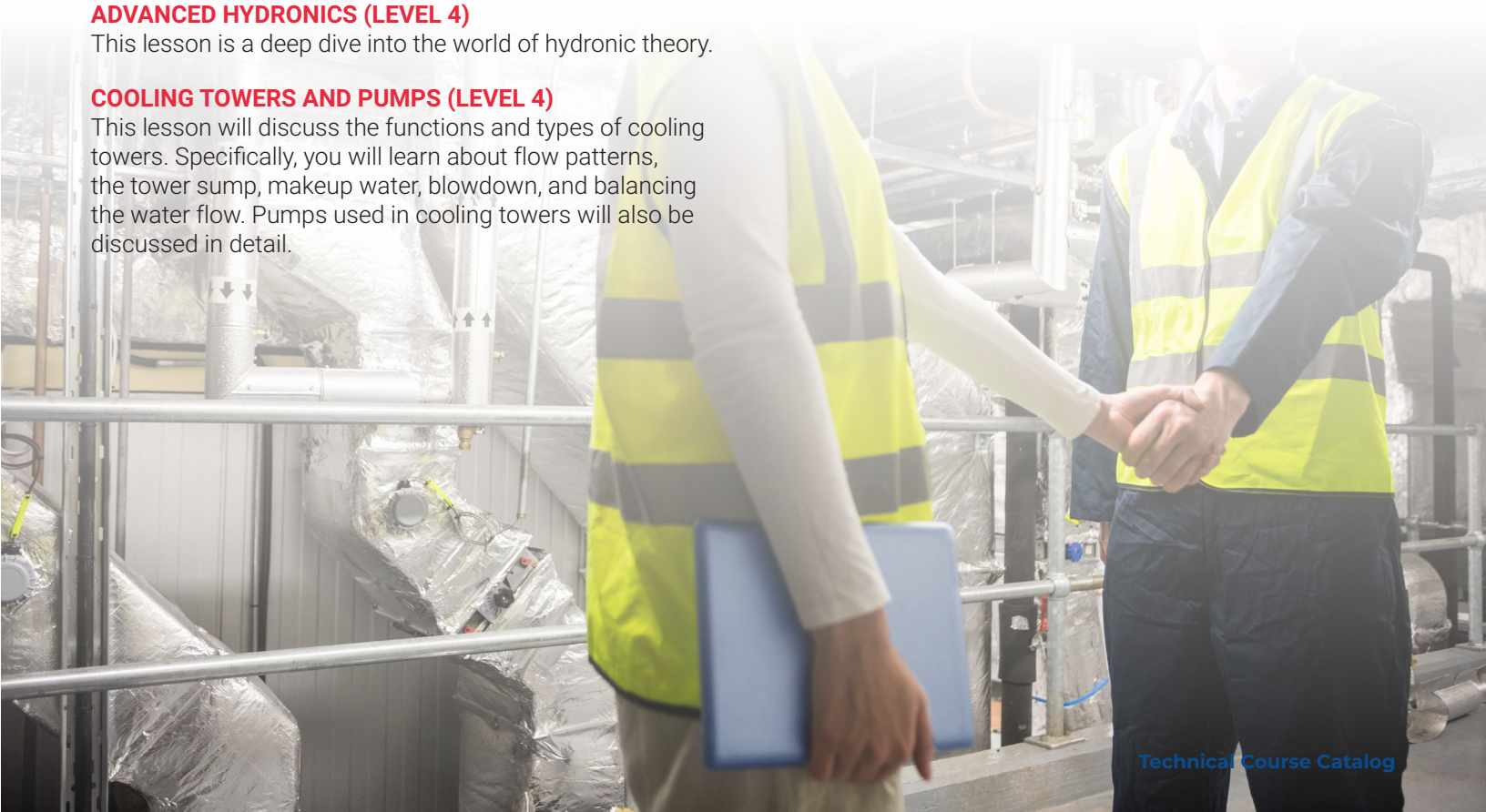
Also included are ground-loop configurations and flows, system materials, heat exchange fluids, and geothermal wells and water sources.

The lesson will conclude with information regarding troubleshooting and several typical service technician calls.

## HIGH PRESSURE, LOW PRESSURE, AND ABSORPTION CHILLED-WATER SYSTEMS (LEVEL 4)
This lesson discusses both high- and low-pressure compression cycle chillers and absorption chillers. Reciprocating compressors, including cylinder unloading, scroll, rotary screw, and centrifugal compressors are covered.

Also presented are direct-expansion and flooded evaporators, water- and air-cooled condensers, thermostatic expansion valves, the orifice, float-type metering devices, electronic expansion valves, and purge units.

The topics covered within the material relative to absorption air-conditioning chillers are theory, solution strength, pumps, capacity control, crystallization, purge systems, heat exchangers, and motors and drives. Several motor start systems, overload protection, and other circuitry are discussed.



# 11 Refrigeration

### BASIC REFRIGERATIONS (LEVEL 1)

This lesson includes a history of refrigeration and a basic discussion of the refrigeration process. In this lesson, you will learn:

- Using water as refrigerants as examples, the temperature and pressure relationship is discussed and is followed by a description of the four major refrigeration components: the evaporator, compressor, condenser, and metering device.
- A detailed description of the refrigeration cycle and a brief description of the reciprocating, rotary, scroll, centrifugal, and screw compressors.
- Newer, more popular long-term refrigerants and refrigerant replacements are covered along with refrigerants with phase-out dates in the near future.
- Refrigerant leak detection, recovery and recycling, cylinder color codes, and chemical makeup are discussed.
- The issue of the ozone layer depletion attributed to halogenated chlorofluorocarbon.
- Plotting systems on pressure and enthalpy diagrams.

### EPA 608 STUDY MATERIALS (LEVEL 1)

This lesson provides you with study practice tests to assess your understanding of EPA-based materials.

### LEAK DETECTION, SYSTEM EVACUATION, AND SYSTEM CLEANUP (LEVEL 1)

This lesson will take you through the basics of the following:

- Basic and advanced leak detection, system cleanup, and methods of system evacuation using the latest technology in digital equipment.
- Purpose and theory of evacuation and covers measuring the vacuum, the vacuum pump, deep vacuum, multiple evacuations, leak detection while in a vacuum, and removing moisture within a vacuum.
- General evacuation procedures, systems with Schrader valves, gauge manifold hoses, system valves, using dry nitrogen, and refrigerant recovery and recycling using the latest technology in digital equipment.
- System leak detection and system cleanup procedures.

### AIR-CONDITIONING SYSTEM REFRIGERANTS AND COMPONENTS (LEVEL 2)

In this lesson, you will learn about air-conditioning system refrigerants and their components, particularly in structural heat gain.

In the summer months, heat flows into the structure through open windows and doors but also through cracks or gaps that may be present in the shell of the structure. In addition, heat enters a structure through the walls themselves as well as through other building panels.

Various methods of cooling and system configurations are presented in this lesson and describe types of evaporators, compressors (reciprocating, rotary, and scroll), condensers, expansion devices, air-side components, and installation procedures for air-conditioning.

### COMMERCIAL AND INDUSTRIAL HEATING AND AIR-CONDITIONING EQUIPMENT (LEVEL 2)

This lesson will walk you through the components of commercial and industrial heating and air-conditioning equipment. By the end of this lesson, you will:

- Understand basic commercial and industrial control circuitry, including compressor, evaporator fan motor, condenser fan motor, and safety control circuits.
- Understand control circuits that are used in commercial and industrial equipment like specialized compressor motor circuits, water chiller controls, component interlocks, anti-short-cycling devices, and other.
- Understand the basic circuitry of control systems used on light commercial and commercial and industrial applications.
- Identify the methods of control for commercial and industrial systems.
- Describe the control loop as it relates to control circuitry.
- Explain a basic pneumatic control system.
- Explain a direct digital control system.
- Commercial, Packaged Rooftop, Variable

### REFRIGERANT FLOW, AND VARIABLE AIR VOLUME SYSTEM (LEVEL 2)

This lesson will discuss packaged rooftop equipment as well as variable air volume and variable refrigerant volume systems.

The section on rooftop equipment discusses the important topic of unit location as well as how to get the unit up to the roof. System problems with respect to serviceability, environmental issues such as snow accumulation, and condenser air recirculation are all covered to provide the reader with important insight into the location selection process.

Also discussed are penetrating the roof and the importance of dealing with bonded roofs. The proper setting and installation of the roof curb to help prevent leaks and noise transmission into the occupied space are stressed.

An integral part of the rooftop unit installation is the rigging of the equipment, so crane basics are discussed in this unit, along with the industry-accepted hand signals that are used to communicate with the crane operator during the rigging process.

## COMPRESSORS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Compressors.

## CONDENSERS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Condensers.

## EVAPORATORS (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of evaporators.

## EXPANSION DEVICES (LEVEL 2)
This lesson will discuss the components of the refrigeration system and the jobs of Expansion devices.

## ALL-WEATHER HEATING SYSTEMS (LEVEL 3)
This lesson will provide an introduction to heat gain and heat loss calculations that are used to properly size heating and air-conditioning equipment.

Now, more than ever, we have increased our awareness concerning the protection of our environment and our natural resources and the impact our actions have on our carbon footprint. One thing that we can all do is ensure that our air-conditioning and heating systems are properly sized for the space they are intended to condition.

The lesson explains the basic concepts of heat and loss in structures as well as how to calculate heat gain and loss. There are many factors that go into such a calculation, and those factors are presented here along with numerical examples that are easily followed.

As part of the process, many ACCA tables and charts are used to obtain thermal resistance, R, values as well as thermal conductivity, U, values. The charts and tables used in this unit have been taken from the industry-accepted ACCA manuals and modified for easy student use.

## ELECTRICAL VS MECHANICAL PROBLEMS (LEVEL 3)
This lesson will discuss the following troubleshooting topics between electrical and mechanical problems:

- Use the proper safety procedures when troubleshooting HVAC control systems.
- Determine and use the correct electrical instrument to check the electrical characteristics (potential, current, and resistance) in an HVAC electrical system.
- Troubleshoot any electrical component in an HVAC electrical system.
- Isolate electrical circuits that are operating incorrectly by reading electrical wiring diagrams and using electrical meters.
- Troubleshoot a line-voltage control system.
- Troubleshoot a residential packaged unit.
- Troubleshoot a residential gas heating and electric air-conditioning split system.
- Troubleshoot a heat pump.

## ICE-MAKING SYSTEMS (LEVEL 3)
This lesson will discuss the ice-making package equipment and includes flake, cube, cylindrical, crescent-shaped, and cell-type cube-making machines.

The lesson will also discuss microprocessors, microprocessor input/output troubleshooting, water filtration and treatment, and cleaning and sanitizing ice machines, in addition to service technician calls.

## NORMAL OPERATING CONDITIONS (LEVEL 3)
This lesson will discuss the typical operating conditions for the various components of standard and high-efficiency air-conditioning systems.

Equipment efficiency ratings— EER and SEER—are described, as are electrical operating conditions and ratings, including the power supply, compressor running amperage, full-load current, current draw, and the two-speed compressor.

## ADVANCED HYDRONICS (LEVEL 4)
This lesson is a deep dive into the world of hydronic theory.

## AIR SOURCE HEAT PUMPS (LEVEL 4)
This lesson begins with a discussion of reverse-cycle refrigeration and the four-way valve.

Types of heat pumps are covered, such as ground/water-to-air (ground loop and well water), solar-assisted, and air-to-air.

Refrigerant line identification, types of metering devices, and liquid-line accessories are also covered, followed by a discussion of the application of the air-to-air heat pump, auxiliary heat, balance point, and the coefficient of performance and controls. Defrost is discussed in detail.

Heat pumps using the scroll compressor and those with variable-speed motors are also discussed. There is an extensive section on troubleshooting problems and on preventive maintenance and HVAC Golden Rules for technicians.

Also included are 21 typical technician service calls covering the most frequent service situations a technician will encounter.

# Refrigeration

### COOLING TOWERS AND PUMPS (LEVEL 4)

This lesson will discuss the functions and types of cooling towers. Specifically, you will learn about flow patterns, the tower sump, makeup water, blowdown, and balancing the water flow. Pumps used in cooling towers will also be discussed in detail.

### DOMESTIC REFRIGERATORS AND FREEZERS (LEVEL 4)

This lesson will discuss a combination of domestic refrigerators and freezers. It begins with a brief description of the refrigeration process and proceeds with a discussion of the various types of evaporators and evaporator defrost. Compressors, condensers, metering devices, and refrigerator and freezer cabinets are discussed.

Wiring and controls, the defrost cycle, sweat prevention heaters, fan motors, and ice makers are covered. Discussed in detail is the domestic refrigerator and freezer service.

There is a section on HVAC Golden Rules for technicians, and several typical service technician calls are presented.

### GEOTHERMAL HEAT PUMPS (LEVEL 4)

This lesson will discuss the concepts of reverse-cycle refrigeration, open-loop systems, and closed-loop systems.

Also included are ground-loop configurations and flows, system materials, heat exchange fluids, and geothermal wells and water sources.

The lesson will conclude with information regarding troubleshooting and several typical service technician calls.

### HIGH PRESSURE, LOW PRESSURE, AND ABSORPTION CHILLED-WATER SYSTEMS (LEVEL 4)

This lesson discusses both high- and low-pressure compression cycle chillers and absorption chillers. Reciprocating compressors, including cylinder unloading, scroll, rotary screw, and centrifugal compressors are covered.

Also presented are direct-expansion and flooded evaporators, water- and air-cooled condensers, thermostatic expansion valves, the orifice, float-type metering devices, electronic expansion valves, and purge units.

The topics covered within the material relative to absorption air-conditioning chillers are theory, solution strength, pumps, capacity control, crystallization, purge systems, heat exchangers, and motors and drives. Several motor start systems, overload protection, and other circuitry are discussed.

> **In today's business environment the biggest obstacle to success is not lack of opportunity, but a lack of skilled well-trained technicians to serve our customers**
>
> **Bob Pratt**

# 12 Safety

### BASIC ELECTRICITY SAFETY (LEVEL 1)

This lesson will discuss the basic information on electricity safety. You will be able to do the following:

- Explain the effect of electric current on the human body.
- Understand the injuries that are possible from an electrical shock.
- Know the basic procedures in the event of an electrical shock.
- Understand the importance of properly grounding tools and appliances.
- Safely use electrical hand tools and electrical meters.
- Follow the principles of safety when installing and servicing heating and air-conditioning equipment.

### ELECTRICAL SAFETY (LEVEL 1)

This course will discuss general information on electrical safety, including important information to know by the U.S. Department of Labor.

### GENERAL SAFETY KNOWLEDGE (LEVEL 1)

Safety is the first element of success as an HVAC technician. This lesson will provide you with the necessary safety precautions, particularly when working with pressure vessels and piping, electrical, heat, cold, mechanical equipment, heavy objects, and chemicals.

### LADDER AND PLATFORM SAFETY (LEVEL 1)

In this lesson, you will learn about the specifics of ladder and platform safety. After completing this course, you should be able to do the following tasks:

- List the safety considerations in erective and working on scaffolds.
- Choose the right ladder for a job and use it safely.
- List the safety considerations in working with internal combustion engines and engine-driven machines.
- List the safety considerations in working with compressed air and pneumatic tools.

### SUPPLEMENTAL ELECTRICAL SAFETY MATERIAL (LEVEL 1)

This course will provide you with supplemental material on electrical safety, including important information to know by the U.S. Department of Labor.

# 13 Troubleshooting

### LEAK DETECTION, SYSTEM EVACUATION, AND SYSTEM CLEANUP (LEVEL 1)

This lesson will take you through the basics of the following:

- Basic and advanced leak detection, system cleanup, and methods of system evacuation using the latest technology in digital equipment.
- Purpose and theory of evacuation and covers measuring the vacuum, the vacuum pump, deep vacuum, multiple evacuations, leak detection while in a vacuum, and removing moisture within a vacuum.
- General evacuation procedures, systems with Schrader valves, gauge manifold hoses, system valves, using dry nitrogen, and refrigerant recovery and recycling using the latest technology in digital equipment.
- System leak detection and system cleanup procedures.

### CALIBRATING INSTRUMENTS (LEVEL 2)

This lesson will discuss the need to calibrate instruments and the procedures to use in calibrating temperature-measuring, pressure tests, electrical test instruments, refrigeration leak-detection devices, and flue gas analysis instruments.

The lesson will also discuss the general maintenance procedures for instruments used in the HVAC/R field.

### AIR DISTRIBUTION AND BALANCE (LEVEL 3)

This lesson will discuss the forced-air system, system pressures, air measuring instruments for duct systems, types of fans, and fan drives.

Several duct systems are described, including the plenum system, extended plenum, reducing plenum, and perimeter loop systems, as are duct materials and fastening devices, including galvanized steel, fiberglass, spiral metal, and flexible duct. Combination duct systems are also included.

The lesson will also discuss duct air movement, balancing dampers, duct insulation, and blending conditioned air with room air, registers, and diffusers. Illustrations of various duct system components and fittings are provided for added clarity.

The unit covers sizing duct and measuring air movement for balancing and describes the air friction chart with numerical examples. Zoning, from the perspective of both new installations and add-on installations, is also covered.

### ELECTRICAL VS MECHANICAL PROBLEMS (LEVEL 3)

This lesson will discuss the following troubleshooting topics between electrical and mechanical problems:

- Use the proper safety procedures when troubleshooting HVAC control systems.
- Determine and use the correct electrical instrument to check the electrical characteristics (potential, current, and resistance) in an HVAC electrical system.
- Troubleshoot any electrical component in an HVAC electrical system.
- Isolate electrical circuits that are operating incorrectly by reading electrical wiring diagrams and using electrical meters.
- Troubleshoot a line-voltage control system.
- Troubleshoot a residential packaged unit.
- Troubleshoot a residential gas heating and electric air-conditioning split system.
- Troubleshoot a heat pump.

### ENERGY AUDITING (LEVEL 3)

This lesson will provide a complete unit on residential energy auditing, covering weatherization, auditing, visual inspections, measuring, insulation tips, blower door testing, base load inspecting, diagnostic testing, thermal imaging camera scanning, sealing air leaks, duct leakage testing, combustion efficiency, and safety testing, furnace efficiency testing and ratings, furnace preventive maintenance, spillage and back drafting, flame safeguard controls, excess air, venting, draft, high-efficiency furnace anatomy, HVAC/R system testing, numerical analysis and reporting, base load versus season loads, and energy index reporting.

### HYDRONIC HEATING THEORY (LEVEL 3)

This lesson will provide an introduction to hydronic heat that is followed by a description of many components in a hot water heating system.

Description and charts are used to show how a centrifugal pump performance curve is determined. This is followed by descriptions and diagrams of several hydronic heating piping systems and of a tankless domestic hot water heater.

The lesson also includes a section on preventive maintenance, HVAC Golden Rules for technicians, and several typical technician service calls.

### AIR SOURCE HEAT PUMPS (LEVEL 4)
This lesson begins with a discussion of reverse-cycle refrigeration and the four-way valve.

Types of heat pumps are covered, such as ground/water-to-air (ground loop and well water), solar-assisted, and air-to-air.

Refrigerant line identification, types of metering devices, and liquid-line accessories are also covered, followed by a discussion of the application of the air-to-air heat pump, auxiliary heat, balance point, and the coefficient of performance and controls. Defrost is discussed in detail.

Heat pumps using the scroll compressor and those with variable-speed motors are also discussed. There is an extensive section on troubleshooting problems and on preventive maintenance and HVAC Golden Rules for technicians.

Also included are 21 typical technician service calls covering the most frequent service situations a technician will encounter.

### BASIC CIRCUITS (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in basic circuits.

### DOMESTIC REFRIGERATORS AND FREEZERS (LEVEL 4)
This lesson will discuss a combination of domestic refrigerators and freezers.

It begins with a brief description of the refrigeration process and proceeds with a discussion of the various types of evaporators and evaporator defrost. Compressors, condensers, metering devices, and refrigerator and freezer cabinets are discussed.

Wiring and controls, the defrost cycle, sweat prevention heaters, fan motors, and ice makers are covered. Discussed in detail is the domestic refrigerator and freezer service.

There is a section on HVAC Golden Rules for technicians, and several typical service technician calls are presented.

### GEOTHERMAL HEAT PUMPS (LEVEL 4)
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Also included are ground-loop configurations and flows, system materials, heat exchange fluids, and geothermal wells and water sources.

The lesson will conclude with information regarding troubleshooting and several typical service technician calls.

### HIGH PRESSURE, LOW PRESSURE, AND ABSORPTION CHILLED-WATER SYSTEMS (LEVEL 4)
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Also presented are direct-expansion and flooded evaporators, water- and air-cooled condensers, thermostatic expansion valves, the orifice, float-type metering devices, electronic expansion valves, and purge units.

The topics covered within the material relative to absorption air-conditioning chillers are theory, solution strength, pumps, capacity control, crystallization, purge systems, heat exchangers, and motors and drives. Several motor start systems, overload protection, and other circuitry are discussed.

### OPERATION, MAINTENANCE, AND TROUBLESHOOTING OF CHILLED-WATER AIR-CONDITIONING SYSTEMS (LEVEL 4)
This lesson will provide information on compression-type chiller start-up, chiller operation, air-cooled and water-cooled chiller maintenance, and absorption chilled-water system start-up, operation, and maintenance. The lesson will also include examples of typical service technician calls.

### SIMULATIONS COMMERCIAL AC (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in commercial air-conditioning systems.

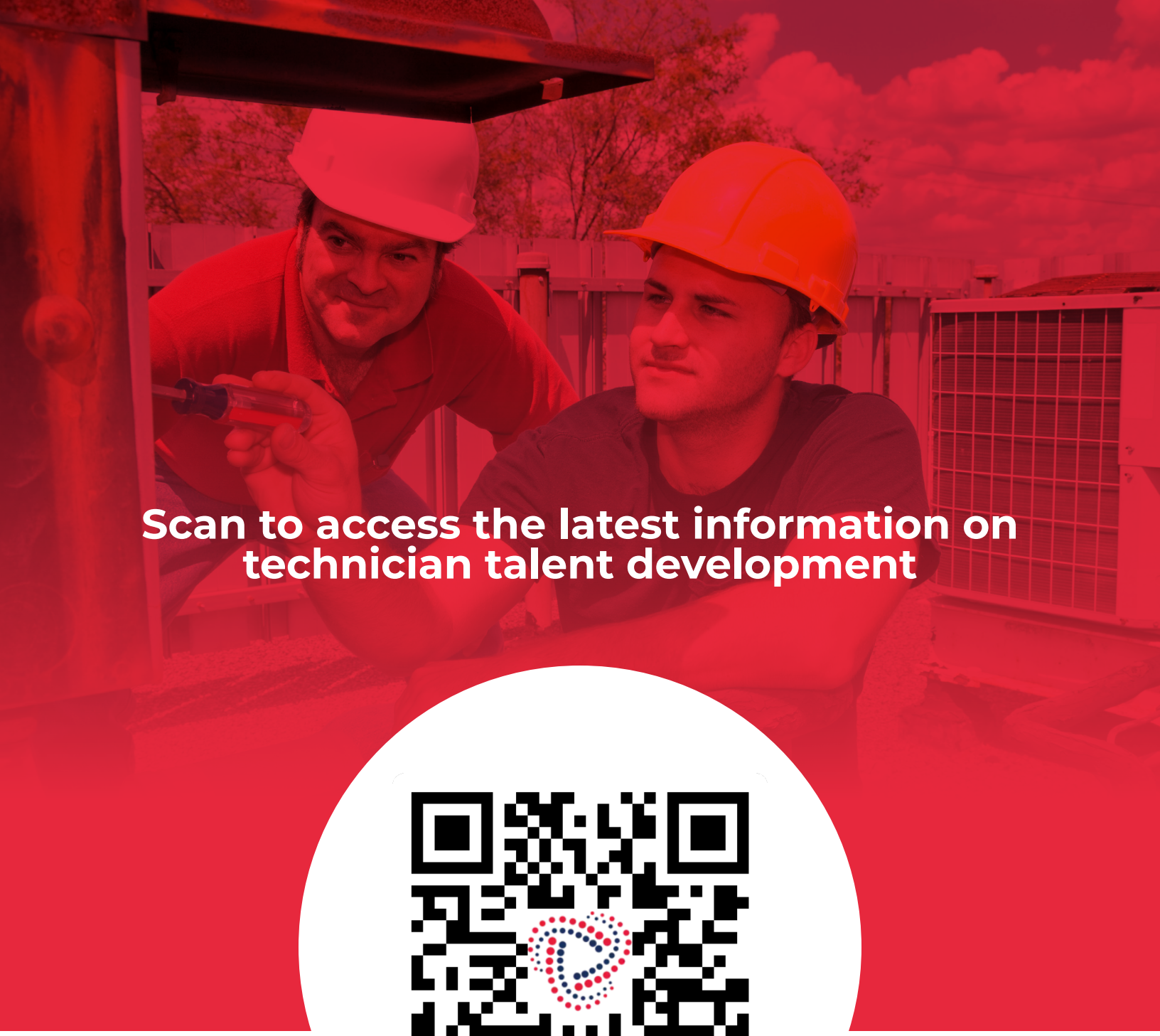
### SIMULATIONS COMMERCIAL FREEZER (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in commercial freezers.

### SIMULATIONS GAS BOILER (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in gas boiler systems.

### SIMULATIONS GAS FURNACE (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in gas furnaces.

### SIMULATIONS HEAT PUMP (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills in heat pump systems.

### SIMULATIONS MOTOR COMPONENTS (LEVEL 4)
The simulations contained in this lesson are designed to sharpen your skills and understanding of motor components.



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