

## NCCER HVAC CURRICULUM

*The following is a brief description of subjects contained in all four levels of the HVAC program as well as the core curricula that all level one students are expected to pass.*

### CORE CURRICULUM

*The core curricula provides a basic introduction to construction work for all crafts. The core curriculum consists of 9 modules taught through in-person instruction and supplemented by online programming.*

#### **Basic Safety**

Presents basic jobsite safety information to prepare workers for the construction environment. Describes the common causes of workplace incidents and accidents and how to avoid them. Introduces common personal protective equipment (PPE), including equipment required for work at height, and its proper use. Information related to safety in several specific environments, including welding areas and confined spaces, is also provided.

#### **Introduction to Construction Math**

Reviews basic math skills related to the construction trades and demonstrates how they apply to the trades. Covers multiple systems of measurement, decimals, fractions, and basic geometry.

#### **Introduction to Hand Tools**

Introduces common hand tools used in a variety of construction crafts. Identifies tools and how to safely use them. Proper hand tool maintenance is also presented.

#### **Introduction to Power Tools**

Identifies and describes the operation of many power tools common in the construction environment. Provides instruction on proper use, as well as on safe-handling guidelines and basic maintenance.

#### **Introduction to Construction Drawings**

Introduces the basic elements of construction drawings. The common components of drawings are presented, as well as the most common drawing types. The use of drawing scales and how to measure drawings is also covered.

#### **Basic Rigging**

Provides basic information related to rigging and rigging hardware, such as slings, rigging hitches, and hoists. Emphasizes safe working habits in the vicinity of rigging operations.

#### **Basic Communication Skills**

Provides good techniques for effective communication on the job. Includes examples that emphasize the importance of both written and verbal communication skills. Describes the importance of reading skills in the construction industry and covers proper techniques to use in a variety of different written communication formats.

#### **Basic Employability Skills**

Describes the opportunities offered by the construction trades. Discusses critical thinking and essential problem-solving skills for the construction industry. Also identifies and discusses positive social skills and their value in the workplace.

## **Introduction to Material Handling**

Describes the hazards associated with handling materials and provides techniques to avoid both injury and property damage. Common material-handling equipment is also introduced.

## **HVAC – LEVEL ONE**

### **Introduction to HVAC**

Covers the basic principles of heating, ventilating, and air conditioning, career opportunities in HVAC, and how apprenticeship programs are constructed. Basic safety principles, as well as trade licensure and EPA guidelines, are also introduced.

### **Trade Mathematics**

Explains how to solve HVAC/R trade-related problems involving the measurement of lines, area, volume, weights, angles, pressure, vacuum, and temperature. Also includes a review of scientific notation, powers, roots, and basic algebra and geometry.

### **Basic Electricity**

Introduces the concept of power generation and distribution, common electrical components, AC and DC circuits, and electrical safety as it relates to the HVAC field. Introduces reading and interpreting wiring diagrams.

### **Introduction to Heating**

Covers the fundamentals of heating systems and the combustion process. The different types and designs of gas furnaces and their components, as well as basic procedures for their installation and service, are provided.

### **Introduction to Cooling**

Explains the fundamental operating concepts of the refrigeration cycle and identifies both primary and secondary components found in typical HVAC/R systems. Common refrigerants are introduced as well. Describes the principles of heat transfer and the essential pressure-temperature relationships of refrigerants. Basic control concepts for simple systems are also introduced.

### **Introduction to Air Distribution Systems**

Describes the factors related to air movement and its measurement in common air distribution systems. The required mechanical equipment and materials used to create air distribution systems are also presented. Basic system design principles for both hot and cold climates are introduced.

### **Basic Copper and Plastic Piping Practices**

Explains how to identify types of copper tubing and fittings used in the HVAC/R industry and how they are mechanically joined. The identification and application of various types of plastic piping, along with their common assembly and installation practices, are also presented.

### **Soldering and Brazing**

Introduces the equipment, techniques, and materials used to safely join copper tubing through both soldering and brazing. The required PPE, preparation, and work processes are covered in detail. The procedures for brazing copper to dissimilar materials are also provided.

### **Basic Carbon Steel Piping Practices**

Explains how to identify various carbon steel piping materials and fittings. The joining and installation of threaded and grooved carbon steel piping systems is covered, with detailed coverage of threading and grooving techniques included.

## HVAC – LEVEL TWO

### **Alternating Current**

Presents the basic concepts of alternating current generation and use. It also discusses how single-phase and three-phase alternating current is used to power resistive and inductive circuits in HVAC/R equipment. Various types of transformers used in HVAC systems are identified. The basic operation of single-phase and three-phase motors is explained. In addition, the process of safely testing AC-powered devices is covered.

### **Compressors**

Presents refrigerant compressors. Since the compressor is considered the heart of any HVAC system, its good health and well-being are crucial to overall system performance and reliability. Compressors can take many forms, but they all perform the same basic function. They create the pressure differential in the system that allows the refrigerant to move through the metering device and through the condenser and evaporator coils where heat is exchanged. Because the compressor is the most expensive component in most HVAC systems, it is important that technicians be able to correctly diagnose and correct problems that can affect compressor operation to avoid a costly compressor replacement.

### **Refrigerants and Oils**

Discusses the refrigerants and oils used in modern refrigeration and air conditioning systems. Today, new technologies and stringent environmental laws are driving changes in the HVAC industry. Older refrigerants that damage the environment are being phased out and replaced with more environmentally-friendly refrigerants. These new refrigerants often require new compressor lubricating oils. These modern refrigerants and oils also have new handling and service requirements with which technicians must be familiar.

### **Leak Detection, Evacuation, Recovery, and Charging**

Provides trainees with guidance related to servicing the refrigerant circuit of HVAC systems. The four essential service tasks – leak detection, evacuation, recovery, and charging – are covered in detail. In addition, information related to the US EPA's requirements for providing these services in an environmentally sound manner are also provided. Developing the necessary skills to provide these services are vital to the future success of trainees in the HVAC/R trade. To that end, a significant amount of this module is devoted to hands-on practice and the successful completion of its required performance tasks.

### **Metering Devices**

Introduces metering devices used in the mechanical refrigeration cycle. The primary function of metering devices is presented, along with related components such as the distributor. The operation of a capillary tube, fixed-orifice, and expansion-type metering devices is explored in detail. In addition, the process of selecting and installing thermal expansion valves specifically is covered.

### **Heat Pumps**

Introduces heat pumps, a very efficient form of electric heat. Compared to straight electric heat, heat pumps can consistently operate at higher energy efficiency. This module presents the operation of heat pump systems in detail with additional emphasis on the most common form of supplemental heat, electric resistance heating elements. The installation considerations of both split and packaged heat pump systems are also reviewed.

### **Basic Maintenance**

An introduction to common tasks associated with the basic maintenance of HVAC/R systems. Specific tasks, such as lubrication and belt installation, are discussed in detail. In addition, the module describes the general procedures for performing inspections and periodic maintenance of gas furnaces and common cooling/heat pump systems, including how to complete the required documentation.

### **Chimneys, Vents, and Flues**

Covers the chimneys, vents, and flues that are used with fuel-burning furnaces and boilers. All fuel-burning appliances must have adequate air for complete combustion and must have a means to safely remove the products of combustion. Different types of fuel-fired furnaces and boilers have different and unique requirements for venting the products of combustion.

### **Sheet Metal Duct Systems**

Covers sheet metal duct systems. While other materials can be used to fabricate air ducts, sheet metal has been and continues to be one of the most popular materials for this purpose. Major advantages of sheet metal duct systems include low resistance to airflow, strength, and durability. In addition to using time-tested assembly methods, modern sheet metal duct systems need to be sealed to prevent leakage of conditioned air and insulated to prevent heat loss or heat gain through the walls of the duct.

### **Fiberglass and Fabric Duct Systems**

Reviews the application and methods of fabricating fiberglass duct systems. In addition, the installation guidelines for installing a fiberglass system are presented, along with the methods to repair damaged components. The module concludes with coverage of fabric-based duct systems, which have become increasingly popular in a variety of applications.

### **Commercial Airside Systems**

Introduces the air distribution systems used in commercial structures such as schools and office buildings that are divided into comfort heating and cooling zones. The module covers the various types of systems, as well as the air terminals and air source equipment used in these systems. Accessories commonly used with commercial systems are also covered.

### **Air Quality Equipment**

Introduces the factors related to indoor air quality and human comfort. Since humidity is a common comfort factor for all types of buildings, the equipment used to control humidity is presented in detail. The module also covers the air filtration materials and the introduction of outside air into the indoor environment.

### **Introduction to Hydronic Systems**

Introduces hydronic heating systems. In hydronic heating systems, fluids (typically water) are used to transfer heat. Fuels such as gas or oil are used to heat the water in a boiler. Pumps then circulate that heated water throughout the structure where terminal devices such as radiators release the heat into different areas.

## **HVAC – LEVEL THREE**

### **Fasteners, Hardware, and Wiring Terminations**

Covers a variety of fasteners, hardware, and wiring terminations used in HVAC systems, including the installation of these components.

### **Control Circuit and Motor Troubleshooting**

Provides information and skills to troubleshoot control circuits and electric motors found in heating and cooling equipment.

### **Troubleshooting Cooling**

Provides guidance related to troubleshooting cooling systems.

**Troubleshooting Heat Pumps**

Provides a thorough review of heat pump systems, operating cycle, and troubleshooting procedures for components.

**Troubleshooting Gas Heating**

Covers information and skills needed to troubleshoot gas-fired furnaces and boilers.

**Troubleshooting Oil Heating**

Describes the construction and operation of oil-fired heating systems and their components. Includes servicing and testing of oil furnaces and procedures for isolating and correcting oil furnace malfunctions.

**Troubleshooting Accessories**

Delivers information and skills needed to troubleshoot various air treatment accessories used with heating and cooling equipment.

**Zoning, Ductless, and Variable Refrigerant Flow Systems**

Introduces the information and skills needed to troubleshoot and repair zoned, ductless, and variable refrigerant flow systems.

**Commercial Hydronic Systems**

Reviews basic properties of water and describes how water pressure is related to the movement of water through piping systems. Describes various types and components of commercial hot-water heating and chilled-water cooling systems, and examines how those systems function.

**Steam Systems**

Focuses on the use of steam for storing and moving energy in HVAC systems. Reviews the fundamentals of water that relate to steam and describes the basic steam system cycle. Discusses a steam system's operational components – steam boilers and their accessories and controls; steam system loads, including heat exchangers/converters and terminal devices. Steam system valves and piping are covered in detail, including common types of piping arrangements, the components of a condensate return/feedwater system, steam and condensate pipe sizing; and pressure-reducing valves and thermostatic valves.

**Retail Refrigeration System**

Covers the applications, principles, and troubleshooting of retail refrigeration systems.

**Customer Relations**

Presents the importance of establishing good relations with customers and provides guidance on how to achieve that goal. Focuses on ways for a technician to make a good first impression and describes how to communicate in a positive manner with customers. The elements of a service call and dealing with different types of problem customers are also covered.

**HVAC – LEVEL FOUR****Water Treatment**

Explains water problems encountered in heating and cooling systems and identifies water treatment methods and equipment. Covers basic water testing procedures and chemistry.

### **Indoor Air Quality**

Defines the issues associated with indoor air quality and its effect on the health and comfort of building occupants. Provides guidelines for performing an IAQ survey and covers the equipment and methods used to monitor and control indoor air quality.

### **Energy Conservation Equipment**

Covers heat recovery/reclaim devices, as well as other energy recovery equipment used to reduce energy consumption in HVAC systems.

### **Building Management Systems**

Explains how computers and microprocessors are used to manage zoned HVAC systems. Provides coverage of various network protocols and systems controllers and introduces trainees to the various means of connection and system interface.

### **System Air Balancing**

Covers air properties and gas laws, as well as the use of psychrometric charts. Describes the tools, instruments, and procedures used to balance an air distribution system.

### **System Startup and Shutdown**

Presents the procedures for the startup and shutdown of hot water, steam heating, chilled water, and air handling systems. Also covers the startup and shutdown of typical cooling towers and packaged HVAC units. The procedures for both short-term and long-term shutdowns are included.

### **Construction Drawings and Specifications**

Teaches how to interpret drawings used in commercial construction, including mechanical drawings, specifications, shop drawings, and as-builts. Explains how to perform takeoff procedures for equipment, fittings, ductwork, and other components.

### **Heating and Cooling System Design**

Identifies factors that affect heating and cooling loads. Explains the process by which heating and cooling loads are calculated, and how load calculations are used in the selection of heating and cooling equipment. Covers basic types of duct systems and their selection, sizing, and installation requirements.

### **Commercial and Industrial Refrigeration Systems**

Expands on the study of product and process refrigeration equipment by describing systems used in cold storage and food processing applications, as well as transportation refrigeration. Various types of defrost systems are covered in detail.

### **Alternative and Specialized Heating and Cooling Systems**

Describes alternative devices used to reduce energy consumption, including wood, coal, and pellet-fired systems, waste-oil heaters, geothermal heat pumps, solar heating, in-floor radiant heating, and direct-fired makeup units. Also introduces application-specific computer room environmental and air turnover systems.

### **Fundamentals of Crew Leadership**

Teaches skills needed to become an effective crew leader, as well as knowledge and abilities required to transition from craftworker to crew leader. The module also covers workforce diversity and organization, basic leadership skills, safety, and project control.



## THE NCCER PROGRAM

NCCER (National Center for Construction Education & Research) maintains a portable and widely recognized credentialing and certification system through its Registry. This Registry assures portability of skills by providing transcripts, certificates and wallet cards to students who successfully complete the NCCER Curriculum through an accredited sponsor. These valuable industry credentials benefit students as they seek employment and build their careers. To be entered in NCCER's Automated National Registry, you must complete and sign a Registration and Release Form. This form will be completed on the first night of class in each semester and requires your Social Security Number and your signature.

NCCER has developed a consistent program of accreditation, instructor certification, standardized curriculum, registry, assessment and certification, which are key elements in developing a skilled workforce of craft professionals.

NCCER is the accrediting body for the industry and establishes the benchmark for quality training and assessments. By partnering with industry and academia, NCCER has developed a system for program accreditation that is similar to those found in institutions of higher learning. This process ensures that students receive quality training based on uniform standards and criteria.

The NCCER Curriculum, in cooperation with publishing partner Pearson, has developed and publishes a world-class curriculum created by "Subject Matter Experts" representing contractors and schools from around the country. "Subject Matter Experts" ensure exceptional training programs that meet or exceed national industry standards. The NCCER Curriculum, which includes more than 60 craft areas, is taught worldwide by contractors, associations, construction users, and secondary and post-secondary schools. In addition, multiple State Departments of Education recognize the curriculum along with the U.S. Department of Labor - Office of Apprenticeship.