Module One (03308-13) focuses on the methods and devices that are used to treat water in HVAC systems. It introduces the main characteristics of water and explains how they affect HVAC system performance, pointing out the problems that could occur if improperly treated water were used. It presents various types of filtration devices and water treatment equipment. It also covers how to use water analysis test kits and emphasizes the importance of following safety precautions when working with water treatment chemicals. It explores in detail how to identify and address specific water-related problems in various types of recirculating water systems.

Objectives

Learning Objective 1
• Describe problems that the properties of water can cause in HVAC systems.
  a. Describe the properties of water that relate to water treatment in HVAC systems.
  b. Identify water quality problems that affect HVAC system performance.
  c. Describe how water test kits are used to collect samples for analysis.
  d. State the common safety precautions related to working with water treatment chemicals.

Learning Objective 2
• Identify types of mechanical water treatment devices and equipment.
  a. Identify types of filtration devices.
  b. Identify types of water treatment equipment.

Learning Objective 3
• Identify and describe how to address water-related problems that occur in specific types of hydronic and steam systems.
  a. Identify and describe how to treat water-related problems that occur in open recirculating water systems.
  b. Identify and describe how to treat water-related problems that occur in closed recirculating water systems.
  c. Identify and describe how to treat water-related problems that occur in steam systems.

Performance Tasks

Performance Task 1 (Learning Objective 1)
• Use a water analysis test kit to test water.

Performance Task 2 (Learning Objective 3)
• Inspect a cooling tower or steam boiler and its related water piping system for signs of water treatment problems.

Teaching Time: 10 hours
(Four 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing

- Standard eye protection
- Face shield and safety goggles/safety glasses with side shields as designated by the instructor or training facility provider
- Work gloves
- Chemical-resistant gloves as designated by the instructor or training facility provider
- Chemical-resistant apron as designated by the instructor or training facility provider
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Respiratory protection as designated by the instructor or training facility provider
- Common hand tools
- Water analysis test kits for quick, on-site analysis (including testing pH, alkalinity, and hardness)
- Comprehensive water analysis test kits with data sheets (optional)
- An electronic pH meter
- One or more duplex strainers
- One or more single basket strainers
- One or more surface type cartridge filters
- One or more depth type cartridge filters
- Several different types of multimedia filters
- One or more bag-type filters
- Open or closed loop condenser, chilled, or hot water piping system(s)

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of on-line resources available for trainees who would like more information on HVAC water treatment. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into four 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

### Session One
Session One introduces the importance of water treatment in HVAC system operation. It explains how water quality is assessed. It reviews the use of water treatment chemicals. It also covers several types of water filtration equipment.

1. **Show the Session One PowerPoint® presentation.**
2. **Use the Kickoff Activity to encourage trainees to think about how using improperly treated water in HVAC systems can have serious consequences.**
3. **Discuss how the properties of water and water quality affect HVAC system performance.**
4. **Explain how test kits are used for water quality analysis.**
5. **Describe safety precautions related to the use of water treatment chemicals.**
6. **Review the features and functions of various types of water filtration equipment.**

### Session Two
Session Two begins with an overview of mechanical equipment that is typically used for water treatment. The remainder of the session focuses on how to address system-specific water treatment problems.

1. **Show the Session Two PowerPoint® presentation.**
2. **Review the features and functions of various types of water treatment equipment.**
3. **Discuss how to recognize and correct water treatment problems that are most common in open recirculating water systems.**
4. **Discuss how to recognize and correct water treatment problems that are most common in closed recirculating water systems.**
5. **Discuss how to recognize and correct water treatment problems that are most common in steam systems.**

### Session Three
Session Three is devoted to laboratories and Performance Tasks 1 and 2.

1. **Note that there is no PowerPoint® presentation associated with these sessions.**
2. **Demonstrate how to use a water analysis test kit and how to inspect a cooling tower or a steam boiler and its related piping system for signs of water treatment problems.**
3. **Trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 in this hands-on session.**

### Session Four
Session Four is a review and testing session. Trainees complete the module Review Questions. Alternatively, these may be assigned as homework at the end of Session Three. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. **Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.**
2. **Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.**
Module Two (03403-13) provides trainees with guidance on how to maintain good indoor air quality (IAQ) and comply with established IAQ standards. It describes how the health and comfort of people are affected by contaminants contained in the air that circulates through a building. It covers in detail how to detect sources of building air contaminants. It explains how control of ventilation, temperature, humidity, and chemical and microbial contaminants helps maintain acceptable IAQ. It explores various methods and HVAC devices and equipment that are used to address IAQ problems. It also discusses liability issues associated with servicing HVAC systems.

### Objectives

**Learning Objective 1**  
- Describe how indoor air quality (IAQ) affects human occupants.  
  a. Define IAQ.  
  b. Describe good IAQ and how the lack of it affects humans.

**Learning Objective 2**  
- Identify sources of building air contaminants and describe how such problems are detected.  
  a. Describe how building construction, materials, and equipment can affect IAQ.  
  b. Describe how human occupancy can affect IAQ.  
  c. Describe how external sources can affect IAQ.  
  d. Explain how an IAQ survey is conducted.  
  e. Describe the air sampling process.

**Learning Objective 3**  
- Explain how acceptable IAQ can be achieved.  
  a. Explain how the building design can affect IAQ.  
  b. Explain how ventilation, temperature, and humidity control affect IAQ.  
  c. Explain how to control chemical and microbial contaminants.

**Learning Objective 4**  
- Identify IAQ-related HVAC equipment and describe specific activities used to address IAQ problems.  
  a. Identify and describe HVAC equipment and devices used to improve IAQ and/or energy consumption.  
  b. Explain how air distribution systems can contribute to poor IAQ and how these problems are addressed.  
  c. Describe the liability that HVAC contractors may accept by servicing HVAC systems.

### Performance Tasks

**Performance Task 1** (Learning Objective 2)  
- Use selected radon monitors and/or test kits.

**Performance Task 2** (Learning Objectives 2 and 3)  
- Perform a building indoor air quality (IAQ) inspection/evaluation.

**Performance Task 3** (Learning Objective 2)  
- Make air measurements using at least one of the following devices:  
  - CO₂ detector/sensor  
  - CO detector/sensor

**Performance Task 4** (Learning Objective 4)  
- Use a manufacturer’s humidifier capacity chart to find the humidifier capacity needed for various building types and sizes.

### Teaching Time: 12.5 hours

(Five 2.5-Hour Classroom Sessions)  
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

*Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.*

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Classroom Equipment and Materials**

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- *HVAC Level Four PowerPoint* Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Copies of the HVAC Checklist – Short Form provided in *Appendix B*, from the EPA Building Air Quality guide
- Two or more humidifier capacity charts from different humidifier manufacturers
- Copies of the Module Examination and Performance Profile Sheets

**Equipment and Materials for Laboratories and Performance Testing**

- Standard eye protection
- Work gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- One or more of each of the following devices:
  - Passive radon test kit
  - Alpha particle detector (alpha track)
  - Electret ion chamber detector
  - Continuous radon monitor
  - A building with an operational HVAC system
- Copies of the building plans and specifications for the building to be evaluated (optional)

**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on indoor air quality. A search for additional information may be assigned as homework to interested trainees.

Instructors are encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint* presentations throughout the program. Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors.

Abatement Technologies, Inc. ([www.abatement.com](http://www.abatement.com)) provides a number of videos on duct cleaning procedures and equipment that can be viewed online. Instructors are encouraged to review these videos and incorporate any of them that they choose into the classroom presentation about air duct cleaning.
The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to the importance of good indoor air quality (IAQ) and identifies and describes sources of contaminants that degrade the air quality in a building.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to consider the consequences of poor IAQ and to become engaged in learning about what HVAC technicians can do to achieve and maintain good IAQ.
3. Discuss indoor environmental quality issues that affect IAQ.
4. Describe how building materials and furnishings, HVAC and other building equipment, and cleaning compounds and pesticides affect IAQ.
5. Describe how human occupancy affects IAQ.
6. Describe how IAQ is affected by contaminant sources located outside a building, and explain how and why to perform radon testing.
7. Explain how to perform the various elements of a building IAQ inspection/survey.

**SESSION TWO**

Session Two explains how to perform air sampling and testing for specific contaminants. Means and methods for achieving acceptable IAQ are described. Solving IAQ problems through the use of energy-efficient systems and equipment is discussed in detail.

1. Show the Session Two PowerPoint® presentation.
2. Explain how to use gas detectors and analyzers for air sampling and testing for specific contaminants, and discuss how to interpret test results and take appropriate corrective actions.
3. Describe how the design of a building affects IAQ.
4. Explain how ventilation control and thermal comfort control are used to achieve acceptable IAQ.
5. Describe how chemical and microbial contaminants are controlled to achieve acceptable IAQ.
6. Describe the role of building and equipment maintenance in maintaining acceptable IAQ.
7. Describe how the following systems and equipment are used to solve IAQ problems: automated building management systems, air handling units, unit ventilators, and air filtration equipment.
**Session Three**

Session Three continues the discussion of energy-efficient systems and equipment that are used to solve IAQ problems. Maintaining good IAQ in forced-air duct systems is described in detail. In addition, liability issues related to HVAC system servicing are discussed. The session includes an instructor demonstration and a laboratory/practice activity for trainees that corresponds to Performance Task 4.

1. Show the Session Three PowerPoint® presentation.
2. Describe how humidifiers and dehumidifiers are used to solve IAQ problems.
3. Demonstrate how to use a manufacturer’s humidifier capacity chart to find the humidifier capacity needed for various building types and sizes.
4. Observe trainees as they use a manufacturer’s humidifier capacity chart to find the humidifier capacity needed for various building types and sizes. This activity corresponds to Performance Task 4.
5. Describe how UV light air purification systems are used to solve IAQ problems.
6. Describe how supply and return duct leaks affect IAQ in forced-air duct systems, and explain how to seal air duct leaks.
7. Describe the contact vacuuming, air washing, and power brushing methods of duct cleaning.

**Session Four**

Session Four is devoted to laboratories and Performance Tasks 1, 2, and 3.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate the five steps for performing a building indoor air quality (IAQ) inspection/evaluation. Included among these steps are demonstrating how to use selected radon monitors and/or test kits and how to make air measurements using at least one of the following devices:
   - CO₂ detector/sensor
   - CO detector/sensor
3. Trainees practice and/or complete the tasks associated with Performance Tasks 1, 2, and 3 in this hands-on session.

**Session Five**

Session Five is a review and testing session. Have trainees complete the Module Review Questions. Go over the Module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Three (03404-13) explores the energy conservation technologies and devices used in residential and commercial HVAC systems. It covers the operation of various energy recycling and reclamation systems equipment. It also discusses the operation of electric utility energy demand reduction and energy storage systems, including the operation of ice storage systems.

### Objectives

**Learning Objective 1**
- Identify and describe the operation of various energy recycling and reclamation systems and equipment.
  - a. Identify and describe the operation of energy- and heat-recovery ventilators.
  - b. Identify and describe the operation of fixed- and rotary-plate air-to-air heat exchangers.
  - c. Identify and describe the operation of condenser heat recovery systems.
  - d. Identify and describe the operation of coil energy recovery loops.
  - e. Identify and describe the operation of heat pipe exchangers.
  - f. Identify and describe the operation of thermosiphon heat exchangers.
  - g. Identify and describe the operation of twin-tower enthalpy recovery loops.
  - h. Identify and describe the operation of flue-gas heat recovery systems.
  - i. Identify and describe the operation of steam heat recovery systems.

**Learning Objective 2**
- Identify and describe the operation of electric utility energy demand reduction and energy storage systems.
  - a. Identify and describe the operation of electric utility demand reduction systems.
  - b. Identify and describe the operation of ice storage systems.

### Performance Tasks
This is a knowledge-based module; there are no performance tasks.

### Teaching Time: 7.5 hours
(Three 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites
**Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.**

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This is a knowledge-based module. As such, trainees are not required to work with or in the vicinity of functioning HVAC equipment. However, electrical and mechanical safety must be emphasized at all times. Trainees should be reminded to always wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC systems.

**Classroom Equipment and Materials**
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Copies of the Module Examination

**Additional Resources**
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on energy conservation equipment. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One begins by introducing factors that have led to an increased use of heat recovery and/or energy-saving devices in HVAC systems. It goes on to describe various energy recycling and reclamation systems and equipment.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and to expand their awareness of heat generation and recovery within a building.
3. Discuss how energy-recovery ventilators (ERVs) and heat-recovery ventilators (HRVs) improve indoor air quality and efficiency.
4. Explain how fixed-plate and rotary air-to-air heat exchangers work.
5. Describe how different types of condenser heat recovery systems work.
6. Explain how a coil energy recovery loop preheats or pre-cools incoming air in an HVAC system.

**SESSION TWO**

Session Two concludes the discussion of energy recycling and reclamation equipment. It also covers the operation of electric utility energy demand reduction systems and energy storage systems.

1. Show the Session Two PowerPoint® presentation.
2. Explain how a heat pipe heat exchanger increases the dehumidification capacity of a system and reduces its energy consumption.
3. Discuss how sealed-tube thermosiphon and coil-loop thermosiphon heat exchangers work.
4. Describe the operation of twin-tower enthalpy recovery loops.
5. Explain how a flue-gas heat recovery system preheats a boiler’s feedwater supply.
6. Discuss various types of steam heat recovery systems.
7. Identify and discuss demand-side management approaches used by electric utilities to reduce energy consumption.
8. Describe an ice storage system and explain how the system operates.

**SESSION THREE**

Session Three is a review and testing session. Have trainees complete the module Review Questions. Alternatively, these may be assigned as homework at the end of Session Two. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Four (03405-13) provides trainees with guidance related to building management systems. Developing the necessary skills to understand the applications, principles, and troubleshooting of building management systems are vital to the future success of trainees in the HVAC trade.

Objectives

Learning Objective 1
- Identify and describe the operation of basic digital controllers.
  a. Identify the four primary control point classifications.
  b. Describe analog and discrete input and output devices.
  c. Describe closed control loops and the related algorithms.

Learning Objective 2
- Describe the architecture of a building management system.
  a. Describe a DDC peer-to-peer network.
  b. Describe the functions of a packaged unit digital controller.
  c. Describe BMS control of an applied VAV system.

Learning Objective 3
- Describe various user-related tasks that can be achieved through a building management system.
  a. Describe the ways in which users interface with and access the system.
  b. Identify various tasks that are not related to temperature control that can be accomplished through the system.

Learning Objective 4
- Describe various building management system control strategies.
  a. Describe occupied building temperature control strategies.
  b. Describe unoccupied building temperature control strategies.
  c. Describe other building control strategies that are not related to temperature control.

Learning Objective 5
- Define the concept of interoperability and describe the various related protocols.
  a. Describe the four primary protocols in use.
  b. Define and describe web browser system integration.
  c. Project the course of interoperability in building management.

Performance Task

Performance Task 1 (Learning Objective 3)
- Interpret operating data received through building management system software.

Teaching Time: 12.5 hours
(Five 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
Core Curriculum; HVAC Level One; HVAC Level Two, HVAC Level Three.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing

- One or more computers with access to the HVAC system through building management software

Additional Resources

There are a number of online resources available for trainees who would like more information on building management systems. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into five 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One discusses basic digital controllers and introduces system architecture.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to familiarize trainees with building management systems software.
3. Discuss control point classification.
4. Address the input and output devices.
5. Discuss closed control loop algorithms.
6. Introduce peer-to-peer networks and packaged unit digital controllers.

**SESSION TWO**

Session Two discusses system architecture related to applied systems. Various system user interfaces are also presented. The session concludes with coverage of a wide variety of additional functions provided by a BMS.

1. Show the Session Two PowerPoint® presentation.
2. Talk about the application of a BMS to applied HVAC systems.
3. Explain the various BMS user interfaces.
4. Review the many valuable functions of a BMS.

**SESSION THREE**

Session Three discusses system control strategies and interoperability.

1. Show the Session Three PowerPoint® presentation.
2. Discuss occupied and unoccupied building temperature control.
3. Discuss accessory and other equipment control strategies.
4. Present the different building system protocols that affect interoperability.
5. Address web browser system integration.
6. Discuss the potential future of interoperability.

**SESSION FOUR**

Session Four is devoted to a laboratory and the completion of Performance Task 1.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate the interpretation of operating data received through building management system software.
3. Trainees practice and complete Performance Task 1.

**SESSION FIVE**

Session Five is a review and testing session. Have trainees complete the module Review Questions. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Five (03402-13) provides trainees with information and skills needed to balance air systems. Developing air balancing skills is vital to the future success of trainees in the HVAC/R trade. To that end, a portion of this module is devoted to hands-on practice and the successful completion of its required performance tasks.

### Objectives

#### Learning Objective 1
- Describe the properties of air and the laws related to its temperature, pressure, and volume.
  a. Describe the basic properties of air that are related to airflow and balancing.
  b. Explain Dalton’s, Boyle’s, and Charles’ laws.

#### Learning Objective 2
- Describe the study of psychrometrics and how to use the psychrometric chart.
  a. Describe psychrometrics and the related properties of air.
  b. Describe the structure of the psychrometric chart.
  c. Explain how to use the psychrometric chart to determine specific air properties.

#### Learning Objective 3
- Describe the air balancing process and identify the required tools and instruments.
  a. Describe air balancing and define common terminology.
  b. Identify the tools and instruments used in air balancing.
  c. Describe the fan laws and explain how to make changes to the supply air volume.

#### Learning Objective 4
- Explain how to balance an air distribution system.
  a. Describe the steps to take prior to beginning an air balancing task.
  b. Explain how to measure temperature rise and drop and then use the acquired information.
  c. Explain how to measure system and terminal airflow and adjust as required.
  d. Explain how to balance using the thermometer methods.

### Performance Tasks

#### Performance Task 1 (Learning Objectives 3 and 4)
- Select and properly use test instruments for balancing air distribution systems.

#### Performance Task 2 (Learning Objective 4)
- Measure the temperature rise and drop across ducted heating and cooling equipment.

#### Performance Task 3 (Learning Objective 3)
- Adjust supply fan speed to provide higher or lower air volume.

#### Performance Task 4 (Learning Objective 4)
- Measure airflow at air supply outlets.

#### Performance Task 5 (Learning Objective 4)
- Adjust dampers in branch supply ducts and at air terminals and diffusers.

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### Teaching Time: 15 hours

(Six 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites

- Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

### Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work on or near operating HVAC equipment. In those instances, trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of operating systems. Any work performed on functioning equipment must be done under the direct supervision of the instructor.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Psychrometric charts
- Sling psychrometer
- Electronic psychrometer
- Differential pressure gauge
- U-tube manometer with accessory probes and fittings
- Inclined-tube manometer with accessory probes and fittings
- Electronic manometer with accessory probes and fittings
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
- Standard eye protection
- Work gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Air balance forms for the systems to be balanced (instructor-created or acquired)
- Engineering data for the air terminals in use
- Multimeters
- Clamp-on ammeters or ammeter accessories for multimeters
- Common hand tools
- Digital or pocket thermometers
- Velometer(s)
- Anemometer(s)
- Flow hood(s)
- One or more functional, ducted heating and/or cooling systems

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on system air balancing. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One discusses air properties and presents the science of psychrometrics.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to introduce trainees to the importance of system air balancing.
3. Describe the basic properties of air and discuss the various laws related to air.
4. Introduce the science of psychrometrics.
5. Describe the structure of a psychrometric chart and describe how to determine various air properties.

**SESSION TWO**

Session Two describes the air balancing process and identifies the tools used in air balancing.
1. Show the Session Two PowerPoint® presentation.
2. Describe air balancing and define common terminology.
3. Identify the tools and instruments used in air balancing.
4. Describe the fan laws and explain how to make changes to supply air volume.

**SESSION THREE**

Session Three describes how to balance an air distribution system.
1. Show the Session Three PowerPoint® presentation.
2. Describe the steps to take before beginning a system air balance.
3. Explain how to measure temperature rise and drop and how to use that information.
4. Explain how to measure and adjust system and terminal airflow.
5. Explain how to balance airflow using the thermometer-based methods.

**SESSIONS FOUR AND FIVE**

Sessions Four and Five are devoted to laboratories and Performance Tasks 1 through 5. A total of two sessions are devoted to demonstrating and practicing these essential skills.
1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate how to select and use tools and instruments for air balancing.
3. Demonstrate how to measure temperature rise and drop in ducted HVAC systems.
4. Demonstrate how to increase or decrease air volume by adjusting supply air fan speed.
5. Demonstrate how to measure airflow at air supply outlets.
6. Demonstrate how to adjust various supply air duct dampers.
7. Trainees practice and/or complete the tasks associated with Performance Tasks 1 through 5 in this hands-on sequence of sessions.

**SESSION SIX**

Session Six is a review and testing session. Have trainees complete the module Review Questions. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.
1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Six (03406-13) provides trainees with information and skills needed to start up and shut down commercial HVAC equipment, including boilers and chillers. Developing these skills is vital to the future success of trainees in the HVAC/R trade. To that end, a portion of this module is devoted to hands-on practice and the successful completion of its required Performance Tasks.

<table>
<thead>
<tr>
<th>Objectives</th>
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<td><strong>Learning Objective 1</strong></td>
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<tr>
<td>• Explain how to properly shut down and start up boilers.</td>
</tr>
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<td>a. Explain how to shut down and prepare boilers for dry storage.</td>
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<td>b. Explain how to shut down and prepare boilers for wet storage.</td>
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<tr>
<td>c. Explain how to prepare and start up a steam boiler.</td>
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<td>d. Explain how to prepare and start up a hot water boiler.</td>
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<td><strong>Learning Objective 2</strong></td>
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<tr>
<td>• Explain how to start up and shut down various chillers and water systems.</td>
</tr>
<tr>
<td>a. Explain how to start up and shut down a reciprocating chiller system.</td>
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<tr>
<td>b. Explain how to start up and shut down a centrifugal or screw chiller system.</td>
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<td>c. Explain how to start up and shut down cooling towers.</td>
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<tr>
<td>d. Describe the process of inspecting and cleaning various heat exchange components.</td>
</tr>
</tbody>
</table>

| Learning Objective 3 |
| • Explain how to start up and shut down air handling and packaged rooftop systems. |
| a. Explain how to start up and shut down air handling units and their associated air distribution systems. |
| b. Explain how to start up and shut down packaged rooftop units. |

| Performance Tasks |
| **Performance Task 1** (Learning Objective 3) |
| • Start up and shut down an air handling unit and prepare it for normal operation. |
| **Performance Task 2** (Learning Objectives 1, 2, and 3) |
| • Start up and shut down at least one of the following: |
| – Steam boiler |
| – Hot-water boiler |
| – Reciprocating chiller |
| – Screw chiller |
| – Centrifugal chiller |
| – Cooling tower |
| – Evaporative condenser |

**Teaching Time: 15 hours**
(Six 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**
Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

**Before You Begin**
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
**Safety Considerations**
This module requires that trainees work with, or in the vicinity of, operating HVAC equipment. In those instances, trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of operating systems. Any work performed on functioning equipment must be done under the direct supervision of the instructor.

### Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Copies of the Module Examination and Performance Profile Sheets

### Equipment and Materials for Laboratories and Performance Testing
- Face mask
- Goggles
- Protective clothing
- Standard eye protection
- Work gloves
- Rubber gloves
- Proper footwear as designated by the instructor or training facility provider
- Hearing protection as designated by the instructor or training facility provider
- Product-specific service literature (from different equipment manufacturers)
- Equipment startup checklists
- Acid/moisture test kits
- Air filters
- pH test kits
- Complete combustion test kit
- Refrigerant gauge manifolds
- Multimeters
- Ammeters or ammeter accessories for multimeters
- Common hand tools
- Digital thermometers
- U-tube manometers
- Operational air handlers
- One or more of the following operational systems:
  - Steam boiler
  - Hot-water boiler
  - Reciprocating chiller
  - Screw chiller
  - Centrifugal chiller
  - Cooling tower
  - Evaporative condenser

### Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on system startup and shutdown. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are encouraged to locate additional audiovisual aids available on the Internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into six 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

### Session One
Session One describes how to properly start up and shut down boilers and prepare them for storage.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to introduce trainees to the focus of this module.
3. Explain how to shut down and prepare boilers for storage.
4. Explain how to prepare and start up a steam boiler.
5. Explain how to prepare and start up a hot water boiler.

### Session Two
Session Two describes how to start up and shut down various chillers and water systems.

1. Show the Session Two PowerPoint® presentation.
2. Explain how to start up and shut down centrifugal, reciprocating, and screw chiller systems.
3. Explain how to start up and shut down cooling towers.
4. Describe the process of inspecting and cleaning various heat exchanger components.

### Sessions Four and Five
Sessions Four and Five are devoted to laboratories and Performance Tasks 1 and 2. A total of two sessions are devoted to demonstrating and practicing these essential skills due to their complex nature.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Demonstrate how to prepare, start up, and shut down an air handling unit.
3. Demonstrate how to start up and shut down at least one of the types of listed equipment.
4. Trainees practice and/or complete the tasks associated with Performance Tasks 1 and 2 in a series of hands-on sessions.

### Session Six
Session Six is a review and testing session. Have trainees complete the module Review Questions. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Seven (03401-13) focuses on the interpretation of construction drawings and specifications associated with HVAC installations in new construction. It explores the many different types of drawings that HVAC technicians and installers work with. It covers the use of specifications and submittals for HVAC equipment installation. It also covers the performance of the takeoff process for HVAC equipment and materials.

Objectives

Learning Objective 1
• Describe the types of drawings HVAC technicians work with and how they are used.
  a. Explain the initial approach to viewing a set of drawings.
  b. Describe site plans and their purpose.
  c. Describe plan views, elevations, detail drawings, and section drawings and their purposes.
  d. Describe plumbing, mechanical, and electrical drawings and their purposes.
  e. Describe shop drawings and their purpose.
  f. Describe as-built drawings and their purpose.
  g. Describe schedules and their purpose.
  h. Describe the Request for Information (RFI) and how it is prepared.
  i. Explain the importance of building codes to the design process.

Learning Objective 2
• Describe the uses of specifications and submittals in construction projects.
  a. Describe specifications and their purpose.
  b. Describe submittals and their purpose.

Learning Objective 3
• Describe the takeoff process and how it is performed.
  a. Identify and describe the tools and materials used in the takeoff process.
  b. Explain how to conduct a takeoff.

Performance Tasks

Performance Task 1 (Learning Objective 1)
• Identify and interpret the following on an architectural drawing:
  – Floor plans and details
  – Elevations
  – Foundation plan
  – Reflected ceiling plan

Performance Task 2 (Learning Objective 1)
• Identify and interpret at least four of the following on a plumbing plan drawing:
  – Sanitary plumbing plans
  – Domestic water plumbing plans
  – Riser diagrams
  – Schedules
  – Specification references
  – Legends

Performance Task 3 (Learning Objective 1)
• Identify and interpret the following on a mechanical plan drawing:
  – Hot- and chilled-water coil piping
  – HVAC piping
  – Chiller piping/installation
  – Refrigeration piping schematics
  – Air handling unit installation/connecting ductwork
  – Hot- and chilled-water flow diagrams
  – Schedules
  – Specification references
  – Legends

Performance Task 4 (Learning Objective 1)
• Identify and interpret the following on an electrical plan drawing:
  – Riser diagrams
  – Schedules
  – Specification references
  – Legends

Performance Task 5 (Learning Objective 1)
• Interpret HVAC-related shop drawings.

Performance Task 6 (Learning Objective 3)
• Perform an HVAC equipment and material takeoff and prepare the takeoff forms.

Teaching Time: 12.5 hours
(Five 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.
Prerequisites

Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

Before You Begin

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.

Safety Considerations

This module does not require that trainees work with or in the vicinity of functioning HVAC equipment. However, the recommended Kickoff Activity does include a field trip to a building that houses such systems. Electrical and mechanical safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC systems.

Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four
- PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Copies of the list of Search Items for the Session One Wrap Up Exercise
- Multiple copies of HVAC equipment and material takeoff forms
- Copies of the Module Examination and Performance Profile Sheets
- Multiple copies separated into packages of various types of construction drawings, schedules, submittals, takeoff sheets, and reference documents for the Session One Wrap Up exercise. Each package should include at least one example of each of the following:
  - Mechanical plan that includes refrigeration piping schematics
  - Site/plot plan
- Plumbing plan showing the layout of water supply lines and natural gas piping
- Elevation drawing that indicates the material used for the exterior finish of a building
- Electrical plan that includes a power riser diagram
- Reflected ceiling plan showing the locations of supply diffusers, exhaust grilles, and access panels
- Mechanical plan showing the location of the main HVAC system components
- Section drawing showing a cut-away view of an air handling unit installation
- Floor plan showing the direction in which doors swing
- Detail drawing of a diffuser
- Tools for performing an HVAC equipment and material takeoff, such as:
  - Colored pencils
  - Automatic mechanical counters
  - Drafting scales
  - Calculators

Equipment and Materials for Laboratories and Performance Testing

Sets of building plans for different projects, each of which includes the following types of drawings and/or drawing components:

- Architectural drawings showing the following:
  - Floor plans and details
  - Elevations
  - Foundation plan
  - Reflected ceiling plan
- Plumbing drawings showing at least four of the following:
  - Sanitary plumbing plans
  - Domestic water plumbing plans
  - Riser diagrams
  - Schedules
  - Specification references
  - Legends
- Mechanical drawings showing the following:
  - Hot- and chilled-water coil piping
  - HVAC piping
  - Chiller piping/installation
  - Refrigeration piping schematics
  - Air handling unit installation/connecting ductwork
  - Hot- and chilled-water flow diagrams
  - Schedules
  - Specification references
  - Legends
- Electrical drawings showing the following:
  - Riser diagrams
  - Schedules
  - Specification references
  - Legends
- Various types of HVAC-related shop drawings (two or more)
**Additional Resources**

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on construction drawings and specifications. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
### Session One

Session One introduces several of the many types of drawings that HVAC technicians work with and explains how each type of drawing is used. Specific types of drawings covered in this session include: site plans; plan views, elevations, detail drawings, and section drawings; and plumbing, mechanical, and electrical drawings.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to show trainees how a set of drawings relates to an actual building, and to emphasize the importance of properly interpreting a set of plans and specifications.
3. Explain the initial approach to viewing sets of drawings.
4. Describe the following types of drawings and their purposes: site plans; plan views, elevations, detail drawings, and section drawings; and plumbing, mechanical, and electrical drawings.

### Session Two

Session Two concludes the discussion of the types of HVAC drawings by describing shop drawings and as-built drawings and how they are used. It also covers the use of schedules and the Request for Information (RFI). In addition, it reviews the importance of building codes to the design process.

1. Show the Session Two PowerPoint® presentation.
2. Describe shop and as-built drawings and explain how they are used.
3. Describe schedules and discuss their purpose.
4. Describe the Request for Information (RFI) and explain how it is prepared.
5. Discuss the importance of building codes to the design process.

### Sessions Three and Four

Sessions Three and Four are devoted to laboratories and Performance Tasks 1 through 6.

1. Note that there is no PowerPoint® presentation associated with these sessions.
2. Provide trainees with sets of plans from multiple projects to create questions for other teams to answer.
3. Demonstrate how to perform an HVAC equipment and material takeoff and prepare the takeoff forms.
4. Trainees practice and/or complete the tasks associated with Performance Tasks 1 through 6 in two hands-on sessions.

### Session Five

Session Five is a review and testing session. Have trainees complete the module Review Questions. Alternatively, these may be assigned as homework at the end of Session Four. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Eight (03407-13) focuses on the selection of proper heating and cooling equipment along with proper design of air distribution and refrigerant piping systems. It emphasizes how a good understanding of the many factors that influence HVAC system design enables HVAC contractors to select the most effective equipment while minimizing installation costs.

Objectives

Learning Objective 1
- Describe the design process and explain how to evaluate a structure for load estimating.
  a. Describe the design process.
  b. Explain how to evaluate a structure for load estimating.

Learning Objective 2
- Explain how to complete a heating and cooling load estimate.
  a. Describe how heat is gained or lost through a building structure.
  b. Identify specific cooling and heating load factors.

Learning Objective 3
- Explain how to select equipment based on the load estimate and describe common support systems to be considered.
  a. Explain how to select cooling equipment.
  b. Explain how to select heating equipment.
  c. Explain how to select heat pumps.
  d. Describe common support systems to be considered.

Learning Objective 4
- Explain how to design air distribution systems.
  a. Identify basic duct design considerations.
  b. Identify various duct system layouts.
  c. Identify various duct system components.
  d. Describe how to design and size duct systems.
  e. Identify system design factors unique to commercial buildings.

Performance Tasks

Performance Task 1 (Learning Objectives 1 and 2)
- Using plans provided by the instructor, perform a load estimate using a standardized method.

Performance Task 2 (Learning Objective 3)
- Use manufacturer’s product data to select the appropriate heating and cooling equipment based on a load estimate and airflow requirements.

Performance Task 3 (Learning Objective 4)
- Determine the number, location, and sizes of supply outlets and return inlets needed in a building.

Performance Task 4 (Learning Objective 4)
- Use standard duct sizing tables, a duct design calculator, or a software application to size the trunk and branch ducts for a selected low-volume air distribution system.

Performance Task 5 (Learning Objective 4)
- Calculate the total system friction loss (external static pressure) for a selected air distribution system.

Teaching Time: 22.5 hours
(Nine 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites

Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
### Safety Considerations

This is a knowledge-based module with training conducted exclusively in the classroom environment.

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### Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- Residential data takeoff form with a corresponding floor plan
- Two or more examples of manufacturer’s product data for cooling equipment, including packaged units and components of split systems
- One or more fan curves/fan performance charts
- A secondary drain pan switch
- One or more handheld duct design calculators
- One or more copies of ACCA Manual J, Load Calculation for Residential Winter and Summer Air Conditioning
- One or more copies of FEMA 412 Installing Seismic Restraints for Mechanical Equipment
- One or more copies of SMACNA’s Seismic Restraint Manual: Guidelines for Mechanical Systems
- A copy of ACCA Manual N, Load Calculation for Commercial Winter and Summer Air Conditioning
- Copies of the Module Examination and Performance Profile Sheets

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### Equipment and Materials for Laboratories and Performance Testing

- Copies of manufacturer’s product data for residential heating and cooling equipment
- Copies of engineering data for air distribution grilles and registers
- One or more sets of simple house plans, less the mechanical plans
- One or more of any of the following, depending on the chosen approach to the laboratory:
  - Standard duct sizing tables
  - A duct design calculator
  - A duct sizing software application installed on a computer, smart phone, or tablet

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### Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

- **HVAC Duct Construction Standards – Metal and Flexible.** Chantilly, VA: Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

There are a number of online resources available for trainees who would like more information on heating and cooling system design. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for 03407-13

HEATING AND COOLING SYSTEM DESIGN

The Lesson Plan for this module is divided into nine 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

SESSION ONE
Session One provides an overview of HVAC design processes. It also initiates coverage of load estimating, focusing on heat transfer.
1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to consider why accurate estimates are essential when designing heating and cooling systems and selecting the equipment to be installed in the systems.
3. Describe HVAC design processes and explain how to survey and evaluate a building for load estimating.
4. Describe how heat is transferred through the structure of a building.

SESSION TWO
Session Two continues the discussion of load estimating, focusing on cooling and heating load factors. It also covers equipment selection and support systems.
1. Show the Session Two PowerPoint® presentation.
2. Describe the cooling and heating load factors involved in load estimating.
3. Explain how to select cooling equipment, heating equipment, heat pumps, and support systems based on a load estimate.

SESSION THREE
Session Three initiates coverage of air distribution system design. It focuses on duct design and air distribution system layouts. It describes the construction, assembly, and installation of the main trunk and branch ducts of various types of duct in detail.
1. Show the Session Three PowerPoint® presentation.
2. Describe basic duct design considerations, including pressure relationships within ducts, friction losses, dynamic losses, static regain, external static pressure, and required airflow.
3. Describe air distribution system layouts used in differing climates.
4. Describe the ways in which duct systems are classified.
5. Compare and contrast low-velocity and high-velocity duct systems.
6. Identify the main components of an air distribution system.
7. Describe the locations/applications in which ductwork is installed, the types of materials used for ducts, and devices that are used in conjunction with ductwork.
8. Describe the construction, assembly, and installation of the following types of duct: square or rectangular metal duct, round metal duct, fiberglass ductboard, and flexible round duct.
9. Explain how to determine the pressure loss and the equivalent-length-of-straight duct value for duct system fittings.
10. Review the purpose, selection, and installation of supply air outlets, return air inlets, and volume dampers.
**SESSION FOUR**

Session Four concludes the discussion of air distribution system design. It covers the steps of the duct design process. It explains duct system sizing and design in detail. It also reviews commercial building design factors.

1. Show the Session Four PowerPoint® presentation.
2. Describe the seven steps of the duct design process.
3. Explain how to select supply outlets and return inlets and how to calculate their volume and size.
4. Describe the equal friction method of sizing ductwork.
5. Explain how to calculate the capacity ratio of a new system’s air volume requirements to total capacity of an existing duct system; how to calculate the capacity ratio for each supply outlet or return grille; and how to determine whether additional outlets are needed to meet the air volume requirements for an upgraded system.
6. Describe the ways in which metal duct can be insulated, and under what conditions this is necessary.
7. Review system design factors that are unique to commercial buildings.

**SESSIONS FIVE - EIGHT**

Sessions Five through Eight are devoted to laboratories and Performance Tasks 1 through 5.

1. Note that there is no PowerPoint® presentation associated with these sessions.
2. Perform a demonstration of the following tasks:
   - Perform a load estimate using a standardized method
   - Use manufacturer’s product data to select appropriate heating and cooling equipment
   - Determine the number, location, and sizes of supply outlets and return inlets
   - Size the trunk and branch ducts for a low-volume air distribution system
   - Calculate the total system friction loss for an air distribution system.
3. Trainees practice and/or complete the tasks associated with Performance Tasks 1 through 5 in this series of four sessions.

**SESSION NINE**

Session Nine is a review and testing session. Have trainees complete the module Review Questions. Alternatively, these may be assigned as homework at the end of Session Eight. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Nine (03408-13) focuses on commercial and industrial applications of refrigeration. It covers the equipment, control systems, and refrigerants used for these purposes. It compares and contrasts the methods and components used in commercial and industrial applications with those used in comfort cooling systems.

### Objectives

#### Learning Objective 1
- Describe methods used to freeze, store, and transport food products.
  - a. Describe methods used to freeze food products.
  - b. Describe methods used to store food products.
  - c. Describe methods used to transport refrigerated food products.

#### Learning Objective 2
- Identify and describe various commercial and industrial refrigeration system components.
  - a. Identify and describe various compressor configurations.
  - b. Describe the application, control, and installation of air-cooled condensers.
  - c. Identify and describe various evaporator and display case configurations.
  - d. Identify and describe various refrigeration system accessories.
  - e. Identify and describe various refrigerant control devices.

#### Learning Objective 3
- Identify and describe various types of defrost systems.
  - a. Identify and describe off-cycle defrost systems.
  - b. Identify and describe electric defrost systems.
  - c. Identify and describe hot-gas defrost systems.

#### Learning Objective 4
- Describe the main characteristics of ammonia-based refrigeration systems.
  - a. Describe the properties and safety considerations of ammonia as a refrigerant.
  - b. Describe ammonia systems and the basic components.

### Performance Tasks

#### Performance Task 1 (Learning Objectives 2 and 3)
- Install or make repairs to a packaged refrigeration condensing unit.

#### Performance Task 2 (Learning Objectives 2 and 3)
- Install or make repairs to a packaged unit cooler in a refrigeration system.

#### Performance Task 3 (Learning Objective 2)
- Identify at least three of the following devices (selection provided by the instructor) commonly used in refrigeration systems:
  - Crankcase pressure regulator
  - Evaporator pressure regulator
  - Condenser head pressure regulator
  - Hot gas bypass regulator
  - Pressure-controlled cylinder unloader
  - Solenoid-controlled cylinder unloader

### Teaching Time: 20 hours
(Eight 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

### Prerequisites
*Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.*

### Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.
Safety Considerations
This module requires that trainees work with and in the vicinity of functioning refrigeration equipment. Electrical and mechanical safety must be emphasized at all times. Trainees should be carefully observed to ensure that they wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC systems. All work performed on functioning HVAC equipment must be completed under the direct supervision of the instructor.

Classroom Equipment and Materials
- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentation Slides
- DVD player
- LCD projector and screen
- Computer
- Internet access during class (optional)
- Calculators
- A temperature-controlled condenser fan speed control and/or a pressure-controlled condenser fan speed control
- Oil differential check valve
- Oil level control
- Oil separator
- Safety data sheet (MSDS/SDS) for ammonia
- Copies of the Module Examination and Performance Profile Sheets

Equipment and Materials for Laboratories and Performance Testing
- Standard eye protection
- Hearing protection as designated by the instructor or training facility provider
- Proper footwear as designated by the instructor or training facility provider
- Work gloves
- Common hand tools
- Refrigerant gauge manifolds
- Multimeters
- Ammeters or ammeter accessories for multimeters
- Refrigerant
- Digital thermometers
- Numbered tags to attach to the selected control devices
- Functional walk-in cooler or freezer, with installed refrigeration equipment
- At least three of the following control devices:
  - Crankcase pressure regulator/valve
  - Evaporator pressure regulator/valve
  - Condenser head pressure regulator/three-way modulating valve
  - Hot gas bypass regulator/valve
  - Pressure-controlled cylinder unloader
  - Solenoid-controlled cylinder unloader

Additional Resources
This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on commercial and industrial refrigeration. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
Session Outline for 03408-13

COMMERCIAL/INDUSTRIAL REFRIGERATION

The Lesson Plan for this module is divided into eight 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One examines the use of commercial refrigeration and freezing methods to preserve food and other perishable commodities. It also covers equipment that is used to store and transport refrigerated or frozen food products.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to encourage trainees to consider the many applications of commercial refrigeration.
3. Describe commercial freezing methods and their applications.
4. Describe the use of chill rooms and freezer rooms for food storage.
5. Identify and describe the different modes of transporting refrigerated products.

**SESSION TWO**

Session Two initiates the examination of the various components of a refrigeration system. It focuses on compressors and condensers.

1. Show the Session Two PowerPoint® presentation.
2. Describe the types of compressors used in commercial refrigeration systems, as well as the physical arrangements of compressors within the system.
3. Describe concerns related to oil and refrigerant flow in multiple compressor applications.
4. Describe the types of condensers and the condenser ratings used in commercial and industrial refrigeration systems.
5. Describe pressure control methods for air-cooled condensers in refrigeration systems.
6. Explain the purpose of increasing liquid line refrigerant subcooling and describe four methods used to increase subcooling.
7. Discuss factors to consider when installing air-cooled condensers or condensing units; review general guidelines for installing remote air-cooled condensers.

**SESSION THREE**

Session Three continues the discussion of refrigeration system components. It focuses on evaporators and display cases and also covers refrigeration system accessories.

1. Show the Session Three PowerPoint® presentation.
2. Describe the features, installation, operation, and typical applications of evaporators used in commercial refrigeration systems.
3. Describe the purpose, features, installation, operation, and maintenance of common commercial refrigeration system accessories and specialty valves.
Session Four concludes the discussion of refrigeration system components, focusing on control devices. It also covers defrost systems and ammonia refrigeration.

1. Show the Session Four PowerPoint® presentation.

2. Describe the purpose, features, installation, operation, and maintenance of common commercial refrigeration system accessories and specialty valves.

3. Describe the components, installation, operation, and typical applications of the various defrost systems.

4. Describe the characteristics of anhydrous ammonia and the safety considerations associated with its use.

5. Describe the various types of common ammonia-based refrigeration systems.

6. Describe the types, arrangement, and installation of various ammonia refrigeration system components.

Session Four

Sessions Five through Seven are devoted to laboratories and Performance Tasks 1, 2, and 3.

1. Note that there is no PowerPoint® presentation associated with these sessions.

2. Provide a walk-in cooler or freezer, or similar refrigeration equipment, for trainees to service and test.

3. Create faults in equipment for trainees to diagnose and solve.

4. Provide an assortment of refrigeration circuit components for trainees to identify.

5. Trainees practice and/or complete the tasks associated with Performance Tasks 1, 2, and 3 in this series of hands-on sessions.

Session Eight

Session Eight is a review and testing session. Have trainees complete the module Review Questions. Alternatively, these may be assigned as homework at the end of Session Seven. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.

2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Module Ten (03409-13) provides trainees with guidance related to alternative and specialized heating and cooling systems. Developing the necessary skills to understand the applications, principles, and troubleshooting of these systems are vital to the future success of trainees in the HVAC/R trade.

### Objectives

#### Learning Objective 1
- Identify and describe various alternative heating and cooling systems.
  - a. Identify and describe solid-fuel heating equipment.
  - b. Identify and describe waste-oil heating equipment.
  - c. Identify and describe passive and active solar heating systems.
  - d. Identify and describe evaporative coolers.

#### Learning Objective 2
- Identify and describe various unique heating and cooling systems and equipment.
  - a. Identify and describe direct-fired make-up air units.
  - b. Identify and describe computer room cooling systems and equipment.
  - c. Identify and describe enclosure- and spot-cooling equipment.
  - d. Identify and describe valance and chilled-beam cooling approaches.
  - e. Identify and describe air turnover systems.

### Performance Tasks

This is a knowledge-based module; there are no performance tasks.

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**Teaching Time: 7.5 hours**

(Three 2.5-Hour Classroom Sessions)

Session time may be adjusted to accommodate your class size, schedule, and teaching style.

**Prerequisites**

Core Curriculum; HVAC Level One; HVAC Level Two; HVAC Level Three.

**Before You Begin**

As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from [www.nccerirc.com](http://www.nccerirc.com). The passing score for submission into NCCER's Registry is 70% or above for the written examination; performance testing is graded pass or fail.
### Classroom Equipment and Materials

- Whiteboard/chalkboard
- Markers/chalk
- Pencils and paper
- HVAC Level Four PowerPoint® Presentations
- DVD player
- LCD projector and screen
- Computer
- Calculators
- Internet access during class (optional)
- Copies of the Module Examination and Performance Profile Sheets

### Safety Considerations

This is a knowledge-based module. As such, trainees are not required to work with or in the vicinity of functioning HVAC equipment. However, electrical and mechanical safety must be emphasized at all times. Trainees should be reminded to always wear the proper PPE, follow safe practices, and give due respect to the hazards of energized and operating HVAC systems.

### Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.


There are a number of online resources available for trainees who would like more information on alternative and specialized heating and cooling systems. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos that may be identified in the lesson plan before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the subject matter and add them to the PowerPoint® presentations throughout the program.
The Lesson Plan for this module is divided into three 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces trainees to various alternative heating and cooling systems.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to engage trainees in conversation regarding their futures in the trade.
3. Describe solid-fuel heating equipment.
4. Discuss waste-oil heating equipment and their operating features.
5. Describe and compare passive and active solar heating systems.
6. Discuss the application of evaporative cooling.

**SESSION TWO**

Session Two introduces various unique heating and cooling systems and their applications.

1. Show the Session Two PowerPoint® presentation.
2. Describe direct-fired make-up air units and their options.
3. Describe computer room cooling systems, system layouts, and relevant equipment.
4. Discuss enclosure-and spot-cooling equipment.
5. Describe valance and chilled-beam cooling equipment and applications.
6. Introduce air turnover systems and describe their primary applications.

**SESSION THREE**

Session Three is a review and testing session. Have trainees complete the module Review Questions. Alternatively, these may have been assigned as homework at the end of Session Two. Go over the module Review Questions in class prior to the exam and answer any questions that the trainees may have.

1. Have trainees complete the written examination.
2. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.
Lesson Plans for Module 46101-11

**FUNDAMENTALS OF CREW LEadership**

Module 11 (46101-11) teaches the skills needed to become an effective crew leader. It will help a crew leader who wants to become more effective, as well as a crew member who aspires to become a crew leader. The module covers basic leadership skills, safety, and project control.

### Objectives

**Section One**

1. Describe the opportunities in the construction and power industries.
2. Describe how workers’ values change over time.
3. Explain the importance of training and safety for the leaders in the construction and power industries.
4. Describe how new technologies are beneficial to the construction and power industries.
5. Identify the gender and minority issues associated with a changing workforce.
6. Describe what employers can do to prevent workplace discrimination.
7. Differentiate between formal and informal organizations.
8. Describe the difference between authority, responsibility, and accountability.
9. Explain the purpose of job descriptions and what they should include.
10. Distinguish between company policies and procedures.

**Section Two**

1. Describe the role of a crew leader.
2. List the characteristics of effective leaders.
3. Be able to discuss the importance of ethics in a supervisor’s role.
4. Identify the three styles of leadership.
5. Describe the forms of communication.
6. Describe the four parts of verbal communication.
7. Describe the importance of active listening.
8. Explain how to overcome the barriers to communication.
9. List ways that leaders can motivate their employees.
10. Explain the importance of delegating and implementing policies and procedures.
11. Distinguish between problem solving and decision making.

**Section Three**

1. Explain the importance of safety.
2. Give examples of direct and indirect costs of workplace accidents.
3. Identify safety hazards of the construction industry.
4. Explain the purpose of OSHA.
5. Discuss OSHA inspection procedures.
6. Identify the key points of a safety program.
7. List steps to train employees on how to perform new tasks safely.
8. Identify a crew leader’s safety responsibilities.
9. Explain the importance of having employees trained in first aid and cardiopulmonary resuscitation (CPR).
10. Describe the indications of substance abuse.
11. List the essential parts of an accident investigation.
12. Describe ways to maintain employee interest in safety. Distinguish between company policies and procedures.

**Section Four**

1. Describe the three phases of a construction project.
2. Define the three types of project delivery systems.
3. Define planning and describe what it involves.
4. Explain why it is important to plan.
5. Describe the two major stages of planning.
6. Explain the importance of documenting job site work.
7. Describe the estimating process.
8. Explain how schedules are developed and used.
9. Identify the two most common schedules.
10. Explain how the critical path method (CPM) of scheduling is used.
11. Describe the different costs associated with building a job.
12. Explain the crew leader’s role in controlling costs.
13. Illustrate how to control the main resources of a job: materials, tools, equipment, and labor.
14. Explain the differences between production and productivity and the importance of each.

### Performance Tasks

**Performance Task 1 (Section Four)**

- Develop and present a look-ahead schedule.

**Performance Task 2 (Section Four)**

- Develop an estimate for a given work activity.
Teaching Time: 20 hours
(Eight 2.5-Hour Classroom Sessions)
Session time may be adjusted to accommodate your class size, schedule, and teaching style.

Prerequisites
The prerequisites for this module are dependent upon the structure of the specific craft training program in which trainees are specifically enrolled.

Before You Begin
As you prepare for each session, allow sufficient time to review the course objectives, content, visual aids (including the PowerPoint® presentation), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

Using your access code, download the written examinations and performance profile sheets from www.nccerirc.com. The passing score for submission into NCCER’s Registry is 70% or above for the written examination; performance testing is graded pass or fail.

Safety Considerations
This module should be conducted in a classroom or conference room environment. Therefore, no special safety precautions are required.

Classroom Equipment and Materials
Whiteboard/chalkboard
Markers/chalk
Pencils and paper
HVAC Level Four PowerPoint® Presentations
DVD player
LCD projector and screen
Computer
Internet access during class (optional)
A drawing marked to show as-built changes.
Copies of the Module Examination and Performance Profile Sheets
Additional Resources
This module presents thorough resources for task training. The following resources are suggested for further study.

* National Institute of Occupational Safety and Health (NIOSH), www.cdc.gov/niosh.

NCCER Publications:
  * Your Role in the Green Environment
  * Sustainable Construction Supervisor

* Occupational Safety and Health Administration (OSHA), www.osha.gov.
* Society for Human Resources Management (SHRM), www.shrm.org.

There are a number of online resources, including video, available for trainees who would like more information on crew leadership. A search for additional information may be assigned as homework to interested trainees.

Instructors should view any videos before using them to ensure their suitability. The videos can provide teachable moments in both proper and improper work processes and behaviors. Be prepared to stop the videos at appropriate times to point out and discuss both proper and improper conduct and techniques.

Instructors are also encouraged to locate additional audiovisual aids available on the internet, make personal videos, and take photos related to the relevant trade and add them to the PowerPoint® presentations throughout the program.
Session Outline for 46101-11

FUNDAMENTALS OF CREW LEADERSHIP

The Lesson Plan for this module is divided into eight 2.5-hour sessions. This time includes 10 minutes for administrative tasks and a 10-minute break per session.

**SESSION ONE**

Session One introduces the trainees to the basic elements of leadership. It covers an overview of industry and the need for a trained workforce; gender and cultural issues; and the structure and dynamics of business organizations.

1. Show the Session One PowerPoint® presentation.
2. Use the Kickoff Activity to get trainees engaged and give them an idea of what they will learn in this module.
3. Describe how to understand and motivate crew members.
4. Discuss the importance of gender and cultural issues in the workplace.
5. Describe the various types of organizational structures found in businesses.
6. Discuss the relationships of authority, responsibility, and accountability.

**SESSION TWO**

Session Two covers leadership skills. It focuses on the role of the crew leader and the transition from crew member. It discusses the characteristics of good leaders, leadership styles, and ethics. Key elements of this session are effective communication; motivating others; team building; delegating; and problem solving. A number of exercises will allow the trainees to test their leadership skills.

1. Show the Session Two PowerPoint® presentation.
2. Describe the qualities of an effective leader.
3. Discuss methods of communication and the importance of listening.
4. Describe how to motivate others.
5. Discuss the elements of team building and delegating.
6. Describe how to deal with problems on the job.
7. Discuss how to resolve special problems that often confront a crew leader.

**SESSION THREE**

Session Three focuses on safety. It presents the role of the crew leader in maintaining crew safety. Trainees will learn the relationship between safety and cost and will learn to view safety from a leadership perspective. Included in this lesson are discussions of company and crew leader responsibility for safety and accident investigation, as well as methods of promoting safety among the workforce.

1. Show the Session Three PowerPoint® presentation.
2. Describe how safety issues can directly and indirectly affect a company’s cost of doing business.
3. Discuss OSHA inspections and penalties for safety violations.
4. Describe how an employer safety program is structured and the role of the crew leader in the program.
5. Explain how a crew leader is involved in day-to-day safety issues such as conducting safety training sessions and assisting in accident investigations.
6. Describe how crew leaders can promote safe work practices within their crews.
Session Four
Session Four introduces the subject of project control. It deals with the fundamentals, including project phases, project scheduling, cost estimating, and planning. It introduces the trainee to the contractual aspects of a project and the steps in completing a project, from its initial concept through the final delivery. Trainees will learn how to estimate labor and materials.

1. Show the Session Four PowerPoint® presentation.
2. Describe the different types of contracts and the three phases of a project.
3. Explain how to estimate the manpower and materials required for a project.
4. Discuss the function of planning and the planning process.
5. Describe how to plan the various resources such as manpower, tools, equipment and materials required for a project.

Session Five
Session Five continues to focus on project control. It introduces trainees to various types of schedules and how they are used. Included in this session are discussions of project control methods related to cost and the crew leader’s role in controlling project cost. Also covered in this session are methods used in controlling labor, material, tools, and equipment on the job site.

1. Show the Session Five PowerPoint® presentation.
2. Discuss the different project scheduling methods.
3. Explain how to prepare project schedules.
4. Describe the tools and methods used to control project cost.
5. Describe the tools and methods used to control resources during a job.
6. Explain the difference between production and productivity and explain why these concepts are an important part of project planning and control.

Sessions Six and Seven
Sessions Six and Seven are laboratory sessions in which the trainees will practice the development of a project schedule and a cost estimate.

1. Note that there is no PowerPoint® presentation associated with this session.
2. Using an instructor-prepared scenario appropriate for the trade, trainees complete the tasks associated with Performance Tasks 1 and 2.

Session Eight
Session Eight is a review and testing session.

1. Review any material that has not been fully presented and answer any questions that the trainees may have.
2. Have the trainees complete the written examination. Any outstanding performance testing must be completed during this session as well.
3. Record the testing results on Training Report Form 200, and submit the report to your Training Program Sponsor.