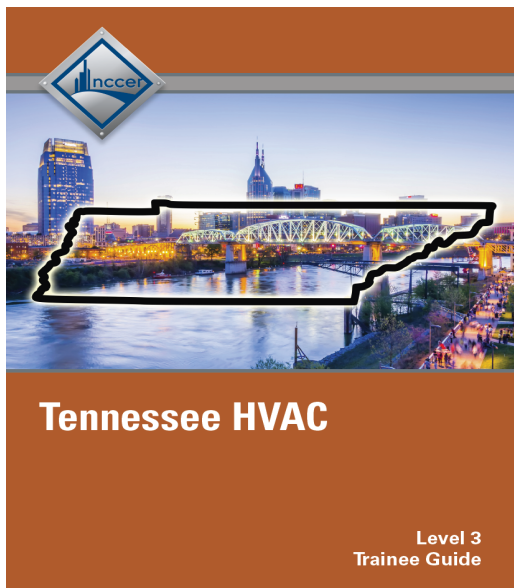


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Tennessee CTE 2016 Adoption: HVAC

Tennessee HVAC (Level 3) Trainee Guide

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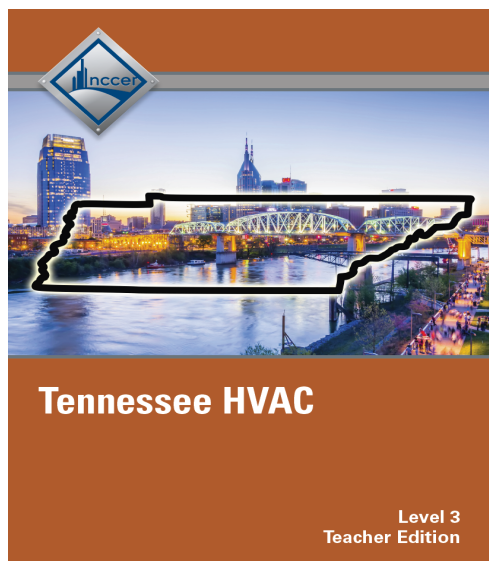
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Tennessee HVAC Level 3 Trainee Guide

Pearson Response to TN Reviewer Comments

List of Changes

- An addendum containing new material was added the Trainee Guide.
- A corresponding addendum containing new material was added to the Instructor Guide.
- Tables of Contents for the Trainee Guide and the Instructor Guide were updated to show the addition of the addenda.

Addenda Details

The **Trainee Guide Addendum (Tennessee Learning Addendum)** contains college and career readiness content and three additional NCCER modules:

00101-15 Basic Safety

44105-08 Construction Documents

44101-08 Introduction to Project Management

The **Instructor Guide Addendum (Tennessee Teaching Addendum)** contains college and career readiness content and the instructor support for the same three additional NCCER modules:

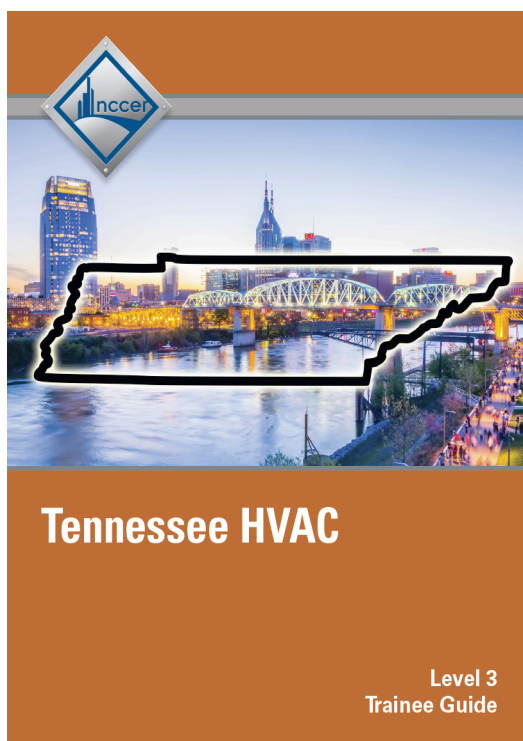
00101-15 Basic Safety

44105-08 Construction Documents

44101-08 Introduction to Project Management

The Tennessee Teaching Addendum also contains additional instructor support for Tennessee Department of Education Standards: Safety (1), Tools and Equipment (4), Construction Industry Principles (5) and (6), Heating Systems (10), Cooling Systems (11), Refrigerant Management (13), Air Distribution Systems (18, 19, 20), and Basic Maintenance & Repair Process (31).

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To the Tennessee Learning Expectations for Tennessee HVAC (Level 3)

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TEXTBOOK NARRATIVE FOR THE STATE OF TENNESSEE

**Tennessee HVAC (Level 3) Trainee Guide, ©2017
ISBN: 978-0-13-454995-8**

SUMMARY:

This custom text contains selected modules from NCCER's HVAC curriculum designed by highly qualified subject matter experts and presents an apprentice approach to the HVAC field, including theoretical and practical skills essential to the success of an HVAC technician.

To provide a comprehensive, user-friendly resource, the text incorporates various features to provide students with the proper tools to get started in the HVAC trade. These features include:

- Learning objectives, Performance Tasks, Trade Terms, and Required Trainee Materials are found at beginning of each module
- Color illustrations and photographs are used throughout the text to highlight important concepts and help clarify complex instructions
- Special Features provide a head start for those entering the HVAC field by presenting technical tips and professional practices from operators in various disciplines
- Safety features are set off from the main text in highlighted boxes and organized into Notes, Cautions, and Warnings based on the potential danger of the issue being addressed
- Going Green looks at ways to preserve the environment, save energy, and make good choices regarding the health of the planet
- Did You Know features offers hints, tips, and other helpful information from the trade
- Step-by-step instructions guide students through technical procedures and tasks
- Each module presents a list of Trade Terms that are discussed within the text and defined at the end of each module
- Review Questions at the end of each module are provided to reinforce the knowledge students have gained

Supplements:

A printed Teacher Edition, ISBN 978-0-13-455000-8, contains an instructor's copy of the student edition as well as lesson plans for each module.

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HVAC	
Course Standards	
Safety	
1) Identify safety hazards on a jobsite and demonstrate practices for safe working. Accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. Recognize and employ universal construction signs and symbols such as colors, flags, stakes, and hand signals that apply to construction workplace situations. Research and evaluate construction company safety plans from local industry. Explain the need for jobsite security to prevent liability. Drawing from examples, create and implement a jobsite safety program in the class to ensure safe practices and procedures including jobsite security procedures. (TN Reading 3, 4, 6; TN Writing 2, 4)	HVAC Level One: 03106-13 Basic Electricity SE/TE: 1.2.0-1.2.1, 3.2-3, 3.5 Module 00101-15 Basic Safety See Addendum
2) Continue to maintain safety records and demonstrate adherence to industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE), as recommended by Occupational, Safety & Health Administration (OSHA) regulations. Incorporate safety procedures when operating tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment. Complete safety test with 100 percent accuracy. (TN Reading 3, 4)	HVAC Level One: 03106-13 Basic Electricity SE/TE: 1.2.0-1.2.1, 3.2-3, 3.5 Module 00101-15 Basic Safety (see Addendum)

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3) Follow procedures to work safely around materials. Adhere to responsibilities for employees in material safety as outlined by the Hazard Communication Standard (HazCom), such as locating and interpreting material safety data sheets (MSDS). For example, obtain an MSDS for a given material from a supplier in the community. Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. Describe hazards involved with HVAC work, including working around refrigerants, oils, and gases. (TN Reading 3, 4)	HVAC Level One: 03107-13 Introduction to Cooling SE/TE: 2.3.5 HVAC Level One: 03301-13 Refrigerants and Oils SE/TE: 2.4.0-2.4.2, 4.5.0-4.5.4 Appendix
Tools & Equipment	
4) Identify and select the proper tools and accessories, critique the readiness of the tools, use the tools to accomplish the desired tasks, and then return the tools and accessories to their proper storage. Research a new technology recently developed for the HVAC industry. Write persuasively to convince an employer how the use of the technology could benefit the company, citing evidence from resources. For example, describe how a new tool could improve work efficiency for an HVAC technician. (TN Reading 2, 3, 4; TN Writing 1)	HVAC Level One: 03104-13 Soldering and Brazing SE/TE: 1.1.0, 1.1.2, 2.1.0 HVAC Level One: 03105-13 Basic Carbon Steel Piping Practices SE/TE: 2.0.0, 2.2.1-2.2.2, 3.1.1 See TE Addendum
Construction Industry Principles	
5) Locate and assess requirements for performing HVAC work including local, state, and national requirements. Interpret HVAC codes, and determine inspection procedures and other applicable portions of the law. Visit the Tennessee Contractor's Licensing Board's website and analyze its policies and requirements. Explain how such policies impact local construction businesses. (TN Reading 2, 3, 4, 9; TN Writing 7, 8)	See TE Addendum

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6) Consult a variety of sources to describe alternatives to traditional project delivery methods, such as the design-build and construction management-related methods, distinguishing among the roles and relationships of various construction personnel in each scenario. Examine the project delivery method of an actual company. Develop a company profile with supporting graphics the company could share with a client, describing the services provided and explaining the project delivery method used by the company. (TN Reading 2, 3, 4, 5, 7; TN Writing 2, 4; NCCER 44105-08)	Fundamentals of Construction: Introduction to Project Management 44101-08 SE/TE: 7.0.0-7.4.0 See TE Addendum
HVAC and Electricity	
7) Building on knowledge of electricity from <i>Mechanical, Electrical, and Plumbing Systems</i> , describe the functions of electrical components used in HVAC systems. Examine an electrical diagram of an HVAC system and interpret symbols to describe the system, distinguishing between load devices and control devices. For example, annotate a basic HVAC electrical diagram to explain the purpose and function of each component in the overall system to an entry-level HVAC technician. (TN Reading 2, 3, 4, 6, 7; TN Writing 2, 4; NCCER 03106-13)	HVAC Level One: 03106-13 Basic Electricity SE/TE: 1.0.0-1.3.0, 4.0.0-4.3.0
Heating Systems	
8) Building on knowledge of heat transfer from <i>Mechanical, Electrical, & Plumbing Systems</i> , describe the processes by which heat loss calculations are made for a residence. Describe a variety of ways in which heat is lost and why it is important for HVAC professionals to know how to perform heat loss calculations. For a given residence, follow procedures to perform a basic heat loss calculation for a residence with a given u-value and location. (TN Reading 2, 3, 4, 5; TN Math A-SSE, N-Q; TN Physical Science 2; TN Physics 2; NCCER 03108-13)	HVAC Level One: 03107-13 Introduction to Cooling: 1.2.0-1.2.5 HVAC Level One: 03108-13 Introduction to Heating SE/TE: 1.1.6 HVAC Level One: 03215-13 Basic Maintenance: 4.2.3 HVAC Level One 03109-13 Air Distribution Systems: 1.3.0-1.3.4

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9) Analyze various types of gas furnaces and explain how they operate. Describe the equipment and controls involved, the concept of combustion, the various gas fuels, and their combustion characteristics. Explain the proper procedures for installing and maintaining gas furnaces. Perform basic maintenance tasks on a gas furnace, including replacing air filters and measuring temperature. (TN Reading 2, 3, 4; TN Chemistry I 2; NCCER 03108-13)	HVAC Level One: 03108-13 Introduction to Heating SE/TE: 1.2.0-1.2.5, 2.0.0-2.3.3
10) Compare and contrast gas furnaces, hydronic heating systems, and electric heating systems by analyzing the operating procedures and pros and cons of each system. Write a recommendation for a heating system for a client with a given location and building type. Cite evidence from retail catalogues, manufacturers' specifications, and energy ratings to justify the recommendation, defending why the selected system is a better choice than an alternative solution. (TN Reading 1, 2, 3, 4, 5, 9; TN Writing 1, 9; NCCER 03108-13)	HVAC Level One: 03108-13 Introduction to Heating SE/TE: 2.0.0-2.3.3, 3.0.0-3.1.3 See TE Addendum
Cooling Systems	
11) Describe the relationship between temperature and pressure and relate it to use of refrigerant in cooling systems. Distinguish between absolute pressure and gauge pressure. Summarize the processes involved in the basic mechanical refrigeration cycle, including the changes of state that occur and the basic patterns of the refrigerant flow. Analyze the major components of cooling systems and how they function, including compressors, condensers, evaporators, and controls. Draw evidence from textbooks, professional journals, and instructional websites to produce an explanation of the refrigerant cycle and the functioning processes of cooling systems in a written narrative with supporting graphics. (TN Reading 1, 2; TN Writing 2, 4, 6, 8, 9; TN Physical Science 1; TN Physics 2; NCCER 03107-13)	HVAC Level One: 03107-13 Introduction to Cooling SE/TE: 1.1.1, 1.3.1, 2.0.0-2.2.0, 3.0.0-3.2.4 See TE Addendum

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12) Utilize common measurement instruments including thermometers and gauge manifolds to measure temperature and pressure in an operating cooling system. Demonstrate the ability to calibrate a set of refrigerant gauges and thermometers, connect a refrigerant gauge manifold, and properly calculate subcooling and superheat on an operating system using the gauge manifold and a temperature probe. (TN Reading 3, 4; TN Math N-Q; TN Physical Science 1; TN Physics 2; NCCER 03107-13)	HVAC Level One: 03107-13 Introduction to Cooling SE/TE: 1.5.0-1.5.2 HVAC Level Two: 03301-13 Refrigerants and Oils SE/TE: 3.1.1-3.1.2
Refrigerant Management	
13) Building on knowledge from <i>Mechanical, Electrical, & Plumbing Systems</i> , describe the impact of refrigerants on the environment and the laws and regulations that are in place to protect the environment, such as the Montreal Protocol, the Clean Air Act, and EPA technician certification requirements. Distinguish among the various types of refrigerant, identifying the properties and cylinder color codes of each type. Read and interpret safety precautions and regulations impacting the recovery, containment, handling, and disposal of refrigerants, including EPA regulations, manufacturer's technical bulletins and MSDSs, and transportation requirements established by the U.S. Department of Transportation (DOT), analyzing how requirements are structured in the text. For example, evaluate the condition of a refrigerant container and determine if it meets DOT requirements, including proper labeling. Interpret unresolved or inadequately documented information. (TN Reading 1, 2, 3, 4, 5, 6, 7, 8, 9; NCCER 03301-13)	HVAC Level Two: 03301-13 Refrigerants and Oils SE/TE: 1.0.0-1.2.0, 2.0.0-2.4.2 HVAC Level Two: 03205-13 Leak Detection, Evacuation, Recovery, and Charging SE/TE: 2.0.0-2.2.6 See TE Addendum
14) Describe the strategies and equipment used to leak test refrigerant circuits. Apply the appropriate tools, equipment, and procedures to safely pressurize a refrigerant system in preparation for leak testing and leak test the pressurized system. (TN Reading 2, 3; NCCER 03205-13)	HVAC Level Two: 03205-13 Leak Detection, Evacuation, Recovery, and Charging SE/TE: 1.0.0-1.2.3

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15) Explain the various procedures used to recover, recycle, and reclaim refrigerant from equipment. Read and interpret technical documents to determine the required recovery level of a given HVAC system. Apply the appropriate tools, equipment, and procedures to safely perform refrigerant-recovery techniques while adhering to applicable regulations, including applying proper labeling and maintaining accurate records. Interpret and implement regulations surrounding the recycling, reclaiming, and disposing of refrigerant. (TN Reading 2, 3, 4; NCCER 03205-13)	HVAC Level Two: 03205-13 Leak Detection, Evacuation, Recovery, and Charging SE/TE: 2.2.0-2.2.6
16) Evaluate the purpose and procedures of system evacuation of an air conditioning system. Describe steps for selecting the appropriate tools to perform an evacuation for a given system. Compare and contrast common methods of evacuation such as deep vacuum and triple evacuation. Apply the appropriate tools, equipment, and procedures to safely perform a system evacuation. (TN Reading 3, 7, 9; NCCER 03205-13)	HVAC Level Two: 03205-13 Leak Detection, Evacuation, Recovery, and Charging SE/TE: 3.0.0-3.2.5
17) Explain and demonstrate how to properly charge various types of refrigerant circuits using different methods including by weight, by superheat, and by subcooling, safely employing the appropriate, tools, equipment and procedures. (TN Reading 3, 7; NCCER 03205-13)	HVAC Level Two: 03205-13 Leak Detection, Evacuation, Recovery, and Charging SE/TE: 4.0.0-4.2.4
Air Distribution Systems	

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18) Describe the physical principles involved in air distribution systems, including pressure, velocity, and volume. Recognize the various types and properties of mechanical equipment that make up an air distribution system, including various blowers, fans, duct materials, grilles, registers, and dampers. Analyze the design of a simple air distribution system (i.e., as found in a typical residence) and explain how the system functions, noting where physical principles can be observed. Create a visual display with supporting text to explain the functions of the system. (TN Reading 2, 3, 4, 5, 7; TN Writing 2, 9; TN Physical Science 1; NCCER 03109-13)	HVAC Level One: 03109-13 Air Distribution Systems SE/TE: 1.0.0-1.1.1, 2.0.0-2.5.2, 3.1.0-3.2.2 See TE Addendum
19) Research the purpose and importance of ventilation in modern HVAC systems. Use technology to create a brochure an HVAC technician could share with a client to illustrate the impact of proper ventilation on indoor air quality including services provided by the technician and steps the client can take to insure high indoor air quality. (TN Reading 1, 2, 4; TN Writing 2, 4, 6, 9; NCCER 03109-13)	HVAC Level One: 03109-13 Air Distribution Systems SE/TE: 3.3.0-3.3.2 See TE Addendum
20) Illustrate how the design and proper installation of an air distribution system impacts the energy efficiency of the system. Drawing on observations, supporting technical manuals, and resources such as those from the U.S. Green Building Council and EPA Energy Star, create an oral or written recommendation for a client outlining strategies to increase energy efficiency for the HVAC system in a given building, such as properly sealing the ducts, dampers, and vent locations. (TN Reading 2, 3, 4, 5; TN Writing 4; TN Physical Science 1; NCCER 03109-13)	HVAC Level One: 03109-13 Air Distribution Systems SE/TE: 3.3.0-3.3.2 See TE Addendum

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21) Utilize test equipment including tachometers, manometers, and velometers to analyze the performance of an air distribution system. For example, collect measurements with a velometer, apply the information to calculate the airflow volume in a duct, and report the findings using appropriate units. Read and interpret equivalent length charts and required air volume and duct size charts. (TN Reading 2, 3, 4; TN Math N-Q; TN Physical Science 1; NCCER 03109-13)	HVAC Level One: 03109-13 Air Distribution Systems SE/TE: 1.3.0-1.3.4
Basic Copper & Plastic Piping	
22) Distinguish among different types of plastic pipe, fittings, and valves for use in HVAC, and select the correct support and spacing for HVAC plastic piping. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of plastic pipe. Employ tools and procedures to safely measure, cut, and join plastic piping and fittings for HVAC. (TN Reading 2, 3, 4; TN Math N-Q; NCCER 03103-13)	HVAC Level One: 03103-13 Basic Copper and Plastic Piping Practices SE/TE: 3.0.0-3.2.3
23) Describe the properties of various types of copper tubing used for HVAC. Describe common fittings, hangers, and supports used in copper tubing. Demonstrate how to measure, cut, and bend copper tubing for HVAC systems while preparing the tubing to be joined. Demonstrate techniques for mechanically joining copper tubing, including flared connections compression connections. Prepare tubing for soldering and brazing by swaging, deburring, and cleaning a tube. Inspect completed joints by safely performing leak testing procedures. (TN Reading 2, 3, 4; TN Math N-Q; NCCER 03103-13)	HVAC Level One: 03103-13 Basic Copper and Plastic Piping Practices SE/TE: 1.0.0-1.2.5, 2.0.0-2.2.4
Soldering & Brazing	

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24) Explain the purpose and process of soldering and brazing for an HVAC professional, outlining how the techniques work. Compare and contrast soldering and brazing, noting the uses, procedures, and equipment for each. Distinguish among the purposes, types, and uses of a variety of filler alloys and fluxes used in soldering and brazing, drawing on evidence from textbooks, manuals, and technical specifications to support claims. (TN Reading 2, 4, 9; NCCER 03104-13)	HVAC Level One: 03104-13 Soldering and Brazing SE/TE: 1.0.0-1.1.1, 2.0.0-2.1.1
25) Describe the tools, equipment, and PPE used for soldering and brazing. Explain the safe operation of soldering and brazing equipment including assembling, testing, lighting, and shutting down acetylene and oxyacetylene equipment. Safely set up and shut down an acetylene single tank and oxyacetylene equipment. Describe and demonstrate procedures to safely prepare, solder, and braze copper tubing using various fittings. (TN Reading 2, 3, 4, 9; NCCER 03104-13)	HVAC Level One: 03104-13 Soldering and Brazing SE/TE: 1.1.2-1.1.3, 2.1.2-2.1.3
26) Implement safe procedures to complete copper, brass, and steel tubing assemblies for a given layout. Steps include measuring, cutting, and fitting assemblies; choosing the proper filler alloys and fluxes for the assigned job; demonstrating proper use of acetylene and oxyacetylene equipment; and pressure testing assemblies to determine the proper completion of assemblies. (TN Reading 3; NCCER 03104-13)	HVAC Level One: 03104-13 Soldering and Brazing SE/TE: 1.2.0-1.3.0, 2.2.0-2.4.0
Carbon Steel Piping	
27) Describe the characteristics and uses of steel pipe, making note of the similarities and differences in steel piping, plastic piping, and copper tubing. Draw on evidence from textbooks and physical observations to support claims. (TN Reading 2, 9; NCCER 03105-13)	HVAC Level One: 03105-13 Basic Carbon Steel Piping Practices SE/TE: 1.0.0-1.1.1
28) Analyze the classification and measurement of pipe threads. Describe the uses of different types of fittings used on steel pipe. Employ tools and procedures to safely measure, cut, thread, and ream steel pipe. (TN Reading 2, 3; NCCER 03105-13)	HVAC Level One: 03105-13 Basic Carbon Steel Piping Practices SE/TE: 1.2.0-1.4.0, 2.0.0-2.2.2

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29) Explain and demonstrate the methods of installing, connecting, and mechanically joining steel pipe, including joining threaded pipe using fittings, pipe grooving methods, and assembling flanged steel pipe. (TN Reading 3; NCCER 03105-13)	HVAC Level One: 03105-13 Basic Carbon Steel Piping Practices SE/TE: 3.0.0-3.4.1
Basic Maintenance & Repair Process	
30) Identify and demonstrate basic troubleshooting strategies appropriate for evaluating HVAC systems, appliances, and devices. For example, develop and implement a troubleshooting strategy to test and remedy an undercharged system. (TN Reading 3)	N/A
31) Identify routine maintenance procedures that should be performed on HVAC systems for a given building. Create a timeline of recommended maintenance procedures for a client, justifying why each procedure is necessary by highlighting its preventive or cost-efficient characteristics. For example, create a schedule of items to inspect, clean, and replace in order to keep an HVAC system running efficiently. (TN Reading 2, 3, 4, 7; TN Writing 4; NCCER 03215-13)	HVAC Level Two: 03215-13 Basic Maintenance SE/TE: 4.0.0-4.4.5
Construction Drawings & Specifications	
32) Explain the relationship between construction drawings and specifications. Describe how both the construction drawings and specifications provide information about the HVAC system for a building. For example, examine construction drawings and specifications to determine the requirements for hangers and supports in a given HVAC piping system. (TN Reading 1, 2, 4, 5, 6, 7; NCCER 44105-08)	See SE & TE Addenda Project Management 44105-08 Construction Documents SE/TE: 4.4.0-4.3.0
33) Describe processes by which construction professionals obtain clarification from architects regarding construction documents, such as by the use of requests for information (RFI's). Write a request for information (RFI), as would a construction professional to an architect to request clarification for a detail of the construction documents, such as the selection of a product. (TN Writing 4; NCCER 44105-08)	See SE & TE Addenda 44101-08 Introduction to Project Management

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Business & Project Management	
34) Describe the components and purpose of a basic contract document for a residential project, determining the meaning of key terms and other industry-specific words. Recognize the relationship and responsibilities of various parties to a contract. Write a basic contract for a job, such as a HVAC service agreement for work done for a residential client. (TN Reading 2, 3, 4, 5; NCCER 44105-08)	See SE & TE Addenda Project Management 44105-08 Construction Documents SE/TE: 5.0.0
35) Establish and implement specific goals to manage project assignments in a timely manner, including organizing teams to effectively manage assignments, monitoring and reporting on project progress, and evaluating a completed project according to client requirements. For example, inspect and critique a team member's work, providing constructive feedback for improvement. Similarly, respond to constructive feedback from a team member to improve project outcomes and meet project goals. (TN Reading 2, 6; TN Writing 2)	See SE & TE Addenda 44101-08 Introduction to Project Management SE/TE: 2.0.0, 5.0.0-6.4.0
36) Interpret construction drawings and diagrams to determine the correct materials, tools, and equipment needed to complete an HVAC project. Plan and implement the steps needed to complete the project, adhering to inspection procedures and employing safe practices throughout. Draw from print and electronic examples to create a material list, cost estimation, schedule, and inspection checklist for a project, applying the components of the documents to the given project. (TN Reading 2, 3; TN Writing 4)	See SE & TE Addenda 44105-08 Construction Documents SE/TE: 4.0.0
37) Produce clear and coherent writing for communication in the HVAC industry. Create a service order for a given HVAC project. Explain the service order to a peer, as would a service technician to a client. (TN Reading 4; NCCER 03215-13)	HVAC Level Two: 03215-13 Basic Maintenance SE/TE: 4.5.0-4.5.5

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38) Utilize technology to write and share periodical reports (weekly, monthly, etc.) to provide others with information about progress during HVAC projects as would a project manager to a supervisor. Summarize activities in a narrative form including overall progress in relationship to a previously planned schedule. (TN Reading 3; TN Writing 2, 4, 6, 10)	See SE & TE Addenda 44101-08 Introduction to Project Management SE/TE: 3.5.0-3.6.0
Portfolio	
39) Update materials from coursework to add to the portfolio started in <i>Fundamentals of Construction and Mechanical, Electrical, & Plumbing Systems</i> . Continually reflect on coursework experiences and revise and refine the career plan generated in prior courses. Include photographs or illustrations and written descriptions of sequential progress in construction projects. (TN Writing 2, 4, 5, 6)	N/A