Department of Education | College, Career and Technical Education

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Plumbing Systems

Primary Career Cluster:	Architecture & Construction
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C17H18
Prerequisite(s):	*Mechanical, Electrical, & Plumbing Systems* (C17H23)
Credit:	1
Grade Level:	11-12
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Architecture & Construction courses.
POS Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is one of the third-level course options in the *Mechanical, Electrical, & Plumbing (MEP) Systems* program of study.
Aligned Student Organization(s):	SkillsUSA: https://www.skillsusatn.org/
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/content/tn/education/career-and-technical-education/work-based-learning.html.
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	527, 567, 580, 592, 703
Required Teacher Certifications/Training:	None
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-architecture-construction.html Best for All Central: https://bestforall.tnedu.gov/

Approved April 10, 2015; Amended April 15, 2016, Nov. 2021

Course-At-A-Glance

CTE courses provide students with an opportunity to develop specific academic, technical, and 21st century skills necessary to be successful in career and in life. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards which feed into intentionally designed programs of study.

Students engage in industry relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry standard content and technology, solve industry-based problems, meaningfully interact with industry professionals and use/produce industry specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course, note this is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstration. These include Career Pathways Showcase, Job Interview, Carpentry, Electrical Wiring, Plumbing, and Welding.

Using a Work-based Learning (WB) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.3** | Include a safety briefing in a visit to an industry partner/job site.
- **Standards 3.1-3.2 |** Ask an industry rep to discuss construction industry principles impact on the job.
- **Standards 4.1-4.4** | Ask an industry rep to discuss how drawings and specifications are used on the job.
- **Standard 5.1** | Ask an industry rep to discuss the importance of math on the job.
- **Standards 6.1-11.3** | Do a project that is used by a local industry or evaluated by local industry managers.
- **Standard 12.1** | Guest speaker.
- **Standards 13.1-13.2** | Ask an industry rep to discuss the importance of troubleshooting.
- **Standards 15.1-15.5 |** Ask an industry rep to discuss project management.

Course Description

Plumbing Systems prepares students for careers in plumbing across a variety of residential and commercial settings. Upon completion of this course, proficient students will be able to implement safety procedures and tools to perform operations with plumbing systems. Students will be able to explain how drain, waste, and vent (DWV) systems, water distribution systems, and plumbing fixtures work and apply proper tools and procedures to perform operations with plumbing piping, including measuring, cutting, joining, supporting, and hanging various types of pipe. Students will read and interpret drawings, specifications, and diagrams to determine materials needed to complete a plumbing project. Standards in this course also introduce basic maintenance and troubleshooting procedures and expand on principles of the construction industry, delving deeper into business and project management. Students will continue compiling artifacts for inclusion in their portfolios, which they will carry with them throughout the full sequence of courses in this program of study.

Course Standards

1. Safety

1.1 Safety Hazards and Rules: 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.

1.2 Safety Practices: 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.

1.3 Materials Safety: 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 plumbing work**, including working in confined spaces.

2. Tools & Equipment

2.1 Tools: 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 plumbing industry. Explain how the use of the technology could benefit a company, citing evidence from resources. For example, describe how a new power tool could improve efficiency for a plumber.

3. Construction Industry Principles

3.1 Plumbing in the Construction Industry: Locate and assess **requirements for performing plumbing work** including local, state, and national requirements. Interpret **plumbing 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.

3.2 Project Delivery Methods: 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.

4. Construction Drawings & Specifications

4.1 Construction Drawings: Building on knowledge of construction drawings and specifications from *Mechanical, Electrical, & Plumbing Systems*, examine **plumbing drawings** and identify **common plumbing symbols used** for the **components of pipe assemblies**. **Read and interpret construction drawings**, including detail drawings and equipment schedules, to create a list of materials needed for a given plumbing project. For example, analyze **plumbing plans and isometric drawings** to determine the **materials needed to install a drain, waste, and vent system.**

4.2 Drawings and Specifications: Explain the **relationship between construction drawings and specifications**. **Describe how both the construction drawings and specifications provide information about the plumbing system for a building.** For example, examine construction drawings and specifications to determine the requirements of hangers and supports for a given plumbing piping system.

4.3 Request for Information: 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.

4.4 Scale Drawings: Demonstrate the ability to use an **architect's scale** to measure a **component of a scale drawing**. Create drawings commonly used in the plumbing trade, including orthographic and isometric sketches.

5. Plumbing Math

5.1 Math: Apply **mathematics concepts to solve plumbing problems**, distinguishing which principles apply to a given problem. Concepts should include, but are not limited to:
   a. Using the basic rules of right triangles, such as the 3-4-5 ratio, to lay out and check square corners.
   b. Calculating values associated with angles and triangles to determine the run, travel, and rise of an offset.

6. Plastic Pipe & Fittings

6.1 Plastic Pipe and Fittings: Building on the knowledge of plastic piping from *Mechanical, Electrical, and Plumbing Systems*, distinguish among **different types of plastic plumbing pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of plastic pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of plastic plumbing pipe, including ABS, PVC, CPVC, PE, PEX, and PB. Create a list of the appropriate piping materials, tools, and equipment needed for a given plastic piping application including supports and spacing.

6.2 Install Plastic Pipe: Read and interpret manufacturer's instructions, construction drawings and specifications, and applicable codes to **properly install plastic pipe**, including measuring, cutting, joining, and supporting plastic pipe. Utilize the **appropriate tools, equipment, PPE, and procedures** to safely complete installations. Once installed, pressure test plastic pipe according to local plumbing code to verify installation was properly completed.

7. Copper Tube & Fittings

7.1 Copper Tube and Fittings: Distinguish among **different types of copper tube, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the material properties of copper tube and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for cutting and joining various types of copper tube. Create a **list of the appropriate piping materials, tools, and equipment** needed for a given copper tubing application including supports and spacing.

7.2 Install Copper Tube and Fittings: Read and interpret **manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install copper tubing**, including measuring, cutting, bending, joining, grooving, and supporting plastic pipe. Utilize the **appropriate tools, equipment, PPE, and procedures** to safely complete installations. Once installed, **pressure test copper tube** according to local plumbing code to verify installation was properly completed.

8. Cast-Iron Pipe & Fittings

8.1 Cast-Iron Pipe and Fittings: Distinguish among **different types of cast-iron pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of cast-iron pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and procedures for **cutting and joining hub-and-spigot cast-iron pipe and no-hub cast-iron pipe**. Create a list of the appropriate piping materials, tools, equipment, and PPE needed for a given cast-iron piping application including selecting the correct supports and spacing.

8.2 Install Cast-Iron Pipe and Fittings: Demonstrate **proper procedures to correctly measure, cut, and join cast-iron pipe** utilizing the appropriate tools, equipment, and PPE. Describe testing procedures used to check cast-iron piping for leaking joints, as designated in local plumbing code.

9. Carbon Steel Pipe & Fittings

9.1 Carbon Steel Pipe and Fittings: Distinguish among **different types of steel pipe, fittings, valves, hanging, and support.** Draw on textual evidence and observations to describe the **material properties of steel pipe** and create **guidelines for proper storage and handling requirements**. Compare and contrast the tools, hazards, and **procedures for cutting and joining steel pipe**. Create a list of the appropriate piping materials, tools, and equipment needed for a given steel piping application including supports and spacing.

9.2 Install Carbon Steel Pipe and Fittings: Read and interpret **manufacturer's instructions, construction drawings and specifications, and applicable codes to properly install steel pipe,** including measuring, cutting, joining, and supporting steel pipe. Utilize the appropriate tools, equipment, PPE, and procedures to safely complete installations.

10. Plumbing Fixtures

10.1 Plumbing Fixtures: Describe the **features and operating principles of various types of plumbing fixtures**, including sinks, lavatories, faucets, bathtubs, showers, and water closets. Analyze the **operational procedures of two different water closets**, such as a siphon-action water closet and a blow-out water closet. Compare and contrast the functions and benefits of each, citing resources to make a recommendation for a client based on the specific needs of a project.

11. Drain, Waste, & Vent (DWV) Systems

11.1 Sewer System: Study a **schematic plan of a typical community sewer system**. Citing evidence from a technical description or actual observation of a system, explain **how waste and air moves through a drain, waste system, and vent system from the fixture to the environment**. For example, create a basic diagram of how the waste generated by a clean-up sink in the classroom travels to the local sewage treatment plant.

11.2 Drain, Waste, and Vent System: Demonstrate understanding of the **specific roles of various plumbing components in a drain, waste system, and vent system**. Identify the components, and describe the **function of each**. Be able to describe the physical principles involved such as gravity and pressure.

11.3 Correct a Defective Trap: Analyze the **function of a trap by examining a drain, waste system, and vent system whose trap has lost its seal.** Diagnose and explain **the cause of the problem with the trap** and determine the **appropriate solution**, citing evidence from textbooks or technical manuals in order to justify why the chosen solution is preferable or more effective than another.

12. Water Distribution Systems

12.1 Water Distribution System: Study a schematic **plan of a typical municipal water distribution system**. Explain **how water travels from a water treatment plant to a fixture in a residence**. Create a graphic illustration to represent the **movement of water from one component to the others in the system**. For example, sketch an isometric drawing of a simple water distribution system and label its components.

13. Basic Maintenance & Repair Process

13.1 Troubleshooting: Identify and demonstrate **basic troubleshooting strategies appropriate for evaluating plumbing systems and devices**. For example, in a drain system, develop and implement a troubleshooting strategy to test and remedy a clogged drain.

13.2 Plumbing Maintenance: Identify **routine maintenance procedures that should be performed on plumbing 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 and clean in order to keep a water heater running efficiently.

14. Green Practices in Plumbing

14.1 Plumbing Efficiency: Define the term ***efficiency*** **in the context of the plumbing profession and plumbing systems**. Research and identify **strategies used in the design of plumbing systems and plumbing work practices to increase the efficiency of plumbing systems.** Drawing on resources such as those from the U.S. Green Building Council and EPA Energy Star, create a recommendation for a client outlining green plumbing strategies for a given building.

15. Business & Project Management

15.1 Contract: 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 **plumbing service agreement** for work done for a residential client.

15.2 Project Management: 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.

15.3 Determine Materials for a Project: Interpret **construction drawings and applicable local plumbing codes** to determine the **correct materials, tools, and equipment needed to complete a plumbing 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, project schedule, and inspection checklist for a project, applying the components of the documents to the given project.

15.4 Communication: Produce **clear and coherent writing for communication** in the plumbing industry. Create a **service order** for a given plumbing project. Explain the service order to a peer, as would a service technician to a client.

15.5 Reports: Utilize technology to write and share **periodical reports** (weekly, monthly, etc.) to provide others with **information about progress during plumbing 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.

16. Portfolio

16.1 Portfolio: Update materials from coursework to add to the portfolio started in *Fundamentals of Construction* and *Mechanical, Electrical, & Plumbing Systems*. 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.

Standards Alignment Notes

*References to other standards include:

- NCCER Curriculum: National Center for Construction Education and Research
    - Note: NCCER accreditation is required to offer NCCER credentials to students. Instructors trained through the NCCER Instructor Certification Training Program (ICTP) may use the NCCER curricula to teach the listed standards. By doing so, their students will receive a certificate of completion for NCCER Plumbing Level One and be placed in NCCER's National Registry Database.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.