Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Plumbing - DRAFT

Comprehensive guidelines and course standards for the Plumbing pathway

Office of College and Career Pathways

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Purpose

The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Plumbing Program of Study. The academic standards in this document are theoretical and performance based. The standards contain content from multiple state departments of education, industry related resources and have been reviewed and vetted by members of the Maryland business and industry community.

In addition to academic standards, the Maryland State Department of Education (MSDE) has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; and Work-Based Learning resources and requirements by course level.

Standards Sources

The following sources collectively support a progression of standards from foundational to advanced Plumbing concepts in a high school context, preparing students for industry-aligned certifications like NCCER Plumbing and OSHA 30 and providing them with the necessary knowledge and skills for career readiness in Plumbing fields.

Here are the key standards sources for Plumbing curriculum:

1. **NCCER (National Center for Construction Education and Research)**
   A. **Description:** Comprehensive competency-based craft training curriculum including Core curriculum and multiple levels of Plumbing training. Includes detailed learning objectives, performance tasks, and assessment materials.
   B. **Use:** Provides the foundational structure for our program, including clear learning progressions and industry-recognized credentials. Aligned with industry needs and updated regularly.
   C. **Source:** Access through NCCER accredited training programs and approved curriculum providers (www.nccer.org)

2. **OSHA Standards (29 CFR 1926 Subpart K)**
   A. Description: Federal safety and health regulations for Plumbing safety in construction.
   B. Use: Ensures program meets required safety training standards and prepares students for workplace requirements.
   C. Source: Freely available at www.osha.gov.

Course Descriptions

Course Level	Course Information	Description
Required Core: Course 1	Core Construction Principles SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	Construction Fundamentals is a foundational course that introduces essential construction industry knowledge and skills while preparing students for careers in multiple construction trades. Students develop competencies in workplace safety, construction math, hand and power tools, construction drawings, and basic rigging. The course emphasizes comprehensive safety training aligned with OSHA 30 Construction certification requirements. Students also build crucial workplace readiness skills through modules on communication, employability, and material handling. Students can earn both NCCER Core and OSHA 30 Construction certifications upon completion.
Required Core: Course 2	Plumbing I SCED: <XX> Grades: 10-12 Prerequisite: Core Construction Principles Credit: 1	In Plumbing Technology I, Students develop proficiency in working with various piping materials including plastic, copper, cast iron, and steel, while learning proper measurement, cutting, and joining techniques. The curriculum covers essential topics such as plumbing safety, tools and equipment usage, basic mathematics, and drawing interpretation. Students gain hands-on experience with drain, waste, and vent (DWV) systems, water distribution systems, and plumbing fixtures. The course emphasizes proper installation techniques, code requirements, and industry best practices. Upon completion, students will be able to identify and properly use plumbing tools, install basic plumbing systems, and understand fundamental plumbing principles and safety protocols.

Course Level	Course Information	Description
Optional Flex: Course 1	Plumbing II SCED: <XX> Grades: 11-12 Prerequisite: Plumbing I Credit: 1	Students master advanced piping calculations, including various types of offsets and rolling measurements. The course covers the interpretation of commercial drawings, installation of sophisticated drainage systems, and comprehensive testing procedures for both DWV and water supply systems. Students learn to work with advanced components such as water heaters, fuel gas systems, and electrical circuits in plumbing applications. Special emphasis is placed on structural considerations, insulation requirements, and firestopping techniques. The curriculum includes extensive hands-on practice with valve installation, system testing, and troubleshooting. Upon completion, students will be prepared to tackle complex plumbing installations, perform advanced calculations, and handle commercial plumbing applications while adhering to relevant codes and safety standards.
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Plumbing I Credit: 1	This flexible, work-based learning course introduces students to real-world applications of classroom knowledge and technical skills through on-the-job experiences and reflective practice. Students engage in career exploration, skill development, and professional networking by participating in youth apprenticeships, registered apprenticeships, pre-apprenticeships, internships, capstone projects, or other approved career-connected opportunities. Variable credit (1–3) accommodates the required on-the-job training hours and related instruction. By integrating industry standards, employability skills, and personalized learning goals, Career Connected Learning I equips students to make informed career decisions, develop a professional portfolio, and build a strong foundation for success in postsecondary education, training, or the workforce.

Course Level	Course Information	Description
Optional Flex: Course 3	Career Connected Learning II SCED: <XX> Grades: 11-12 Prerequisite: Career Connected Learning I Credit: 1	Building on the foundational experiences of Career Connected Learning I, this advanced work-based learning course provides students with deeper on-the-job practice, leadership opportunities, and refined career exploration. Students continue to enhance their technical and professional skills, expanding their industry networks and aligning personal goals with evolving career interests. Variable credit (1–3) remains aligned with the required training hours and related instruction. Through elevated responsibilities and skill application, Career Connected Learning II prepares students to confidently transition into higher-level postsecondary programs, apprenticeships, or the workforce.

Dual Enrollment and Career Connected Learning Experiences Must be Aligned to the CTE Core.

Industry-Recognized Credentials and Work-Based Learning

Industry-Recognized Credentials – The standards in this document are aligned to the following certifications:
By the end of Core Construction Principles: NCCER Core + OSHA 30 **By the end of Plumbing I:** Plumbing Level 1 Certificate **By the end of Plumbing II:** Plumbing Level 2 Certificate **Optional Credentials (via the Flex Course options):** Apprenticeship

Work-Based Learning Examples and Resources		
Core Construction Principles: **Career Awareness**	**Plumbing I:** **Career Preparation**	**Plumbing II:** **Career Preparation**
• Industry Visits • Guest Speakers • Participation in Career and Technical Student Organizations • Postsecondary Visits – Program Specific Site Tours • Mock Interviews	• All of Career Awareness plus the following: • Job Shadow • Paid and Unpaid Internships	• Paid and Unpaid Internships • Apprenticeships

Labor Market Information: Definitions and Data

Labor market information (LMI) plays a crucial role in shaping Career and Technical Education (CTE) programs by providing insights into industry demands, employment trends, and skills gaps. This data helps education leaders assess the viability of existing programs and identify opportunities for new offerings. By aligning CTE programs with real-time labor market needs, schools can better prepare students for in-demand careers and ensure that resources are effectively utilized to support pathways that lead to high-quality, sustainable employment.

Standard Occupational Code (SOC) and Aligned Industry:

Indicator	Definition	Pathway Labor Market Data
High Wage[1]	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the state of Maryland, and/or leads to a position that pays at least the median hourly or annual wage for the DC-VA-MD-WV Metropolitan Statistical Area (MSA). *Note: A 25th percentile hourly wage of $24.74 or greater is required to meet this definition.*	**Standard Occupational Code:** 47-2152: Plumbers, Pipefitters, and Steamfitters **Hourly Wage/Annual Salary:** 25th Percentile: $22.57/$46,945 50th Percentile: $29.82/$62,025 75th Percentile: $38.50/$80,080
High Skill	Those occupations located within the DC-VA-MD-WV Metropolitan Statistical Area (MSA) with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, bachelor's degree, or higher.	**Typical Entry-Level Education:** To be a practicing plumber in the state of Maryland you need to be licensed through the Maryland Board of Plumbing. This can be accomplished by completing an approved plumbing preparation program, which can included introductory courses in high school.
In-Demand	Annual growth plus replacement, across all Maryland occupations, is 405 openings between 2024-2029.	**Annual Openings**

[1] Living Wage Calculator: https://livingwage.mit.edu/states/24

Labor Market Information Data Source

Lightcast Q4 2024 Data Set. Lightcast occupation employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level Lightcast earnings by industry. Foundational data for the state of Maryland is collected and reported by the Maryland Department of Labor.

Methodology for High Wage Calculations

To combine labor market data across multiple Standard Occupational Classifications (SOCs), a weighted average approach was used to ensure accurate representation of the marketplace. Median wages for each SOC were weighted based on their respective employment levels, reflecting the relative demand for each occupation. This method ensures that occupations with higher employment contribute proportionately to the overall wage calculation. Additionally, job openings from all relevant SOCs were summed to determine the total projected demand. For example, if Mechanical Engineers account for 67% of total employment and Electrical Engineers for 33%, their respective wages are weighted accordingly, and job openings are aggregated to provide a comprehensive view of labor market opportunities. This approach delivers a balanced and accurate representation of both wages and employment demand for the program.

Methodology for In-Demand Calculations

The baseline for annual job openings, taking into account new positions and replacement positions, was determined by taking the average of all annual job openings between 2024 and 2029 across all 797 career sectors at the 5-digit SOC code level. For the 2024-2029 period, average job openings (growth + replacement) is 405.

Course Standards: Core Construction Principles

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 9-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Construction Career Cluster prepares students for careers in designing, planning, and building sustainable infrastructure. This field includes architects, engineers, construction managers, and skilled trades professionals.
   C. The Plumbing program prepares students for careers in residential, commercial, and industrial Plumbing systems. Through a comprehensive curriculum aligned with industry standards, students develop foundational construction skills and specialized Plumbing knowledge while earning industry-recognized certifications. The program emphasizes hands-on learning, safety protocols, and real-world applications, preparing graduates for immediate entry into the Plumbing trade or advanced technical education.
   D. Core Construction Principles introduces students to the essential fundamentals of the construction industry with a focus on Plumbing systems career preparation. This foundational course aligns with NCCER Core certification and OSHA safety standards, emphasizing construction safety, basic math operations, hand and power tool operations, blueprint reading, and material handling. Students develop critical workplace skills through modules covering communication, employability skills, and construction drawings.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. KNOWLEDGE AND SKILLS

A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:

1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the construction field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Plumbing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as an Electrician or in the Plumbing field.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Plumbing field.

C. The student identifies the issues associated with Plumbing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a construction environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Plumbing hazards and how to avoid or minimize them in the workplace.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection.

D. The student integrates core academic skills into Plumbing construction practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply mathematical concepts such as operations with whole numbers, fractions, and decimals; working with geometric shapes and calculating their areas/volumes; measurement using both metric and imperial units; converting between measurement systems; working with scale drawings (architectural, engineering, and metric scales); calculating load values and equivalent resistance in Plumbing circuits; and determining proper sizing for Plumbing components based on mathematical formulas.
3. Use scientific principles including Plumbing theory (atomic structure, conductors/insulators, circuit behavior, Ohm's Law), materials science (properties of Plumbing materials, material strength), physical science (mechanical advantage, force and motion), and human factors engineering (ergonomics, physiological effects of electricity, respiratory protection), which are all essential for understanding and safely performing Plumbing and construction work.

E. The student demonstrates understanding of construction industry fundamentals and career opportunities. The student is expected to:

1. Analyze the current state and key career fields within Plumbing related careers.
2. Evaluate the benefits and opportunities available in a construction career.
3. Outline the typical career progression path for craft professionals.
4. Develop a plan to pursue a career in the Plumbing field.

F. The student implements construction safety protocols and procedures. The student is expected to:

1. Analyze workplace incidents, associated costs, and methods to reduce hazards;.
2. Demonstrate proper fall protection techniques and hazard prevention methods.
3. Identify and mitigate struck-by and caught-in-between hazards.
4. Evaluate Plumbing work site hazards and implement appropriate safety measures that include practices that minimize damage to service provider and surrounding work space.
5. Select and utilize appropriate personal protective equipment (PPE) for specific hazards.
6. Apply safety practices for common job-site hazards.

G. The student applies mathematical principles in construction contexts. The student is expected to:

1. Solve basic arithmetic problems using whole numbers.
2. Calculate measurements and dimensions using fractions.
3. Solve construction-related problems using decimal numbers.
4. Measure lengths accurately using common measuring tools.
5. Convert between units of measurement in both imperial and metric systems.
6. Calculate areas and volumes of common geometric shapes.

H. The student demonstrates proper use and maintenance of hand tools. The student is expected to:

1. Identify and safely operate common hand tools.
2. Select and utilize appropriate measurement and layout tools.
3. Maintain and properly store hand tools common to construction sites.

I. The student demonstrates safe and proper use of power tools. The student is expected to:

1. Identify the tool most appropriate for the job to be performed.
2. Operate industry related tools safely and effectively.
3. Perform maintenance on related industry tools.
4. Demonstrate appropriate storage and safety techniques when tools are not in use.

J. The student interprets construction drawings and specifications. The student is expected to:

1. Identify basic components and features of construction drawings, schematics, and diagrams.
2. Differentiate between various types of construction drawings.

K. The student develops effective workplace communication skills. The student is expected to:

1. Demonstrate effective verbal and non-verbal communication in construction settings.
2. Apply reading and writing skills to construction-related tasks.

L. The student develops professional workplace behaviors and skills. The student is expected to:

1. Understand the importance of consistent attendance, punctuality, and professional communication.
2. Evaluate construction business opportunities and workforce entry strategies.
3. Apply critical thinking skills to solve workplace problems.
4. Demonstrate appropriate social skills in professional settings to include customer service interactions that communicate the problem, potential solutions, and create positive customer experiences.

M. The student implements proper material handling techniques. The student is expected to:

1. Identify and explain specific uses for different industry related materials.
2. Apply safety precautions in material handling operations.
3. Select and operate appropriate material handling equipment.

Course Standards: Plumbing I

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Construction Career Cluster prepares students for careers in designing, planning, and building sustainable infrastructure. This field includes architects, engineers, construction managers, and skilled trades professionals.
   C. The Plumbing Program of Study prepares students for a career in the plumbing trade through a comprehensive three-course sequence. Students learn essential skills such as measuring and cutting different types of pipe, installing fixtures and appliances, assembling water supply and drainage systems, and interpreting building plans. The program emphasizes hands-on experience with industry-standard tools and materials while teaching students to calculate measurements, perform system testing, and ensure all work meets building codes and safety requirements. Through progressive skill development, students gain experience with both residential and commercial plumbing applications, including installation, maintenance, and troubleshooting of various plumbing systems. Upon successful completion of the program, graduates earn three industry-recognized certifications: NCCER Core, OSHA 30 Construction, and NCCER Plumbing Levels 1 and 2, preparing them to enter the workforce with verified skills and knowledge.
   D. Plumbing I builds upon core construction knowledge to introduce students to fundamental Plumbing theory and hands-on applications in the Plumbing trade. Students work with various piping materials including plastic, copper, cast iron, and steel, while learning proper measurement, cutting, and joining techniques. The curriculum covers essential topics such as plumbing safety, tools and equipment usage, basic mathematics, and drawing interpretation. Students gain hands-on experience with drain, waste, and vent (DWV) systems, water distribution systems, and plumbing fixtures. The course emphasizes proper installation techniques, code requirements, and industry best practices. Upon completion, students will be able to identify and properly use plumbing tools, install basic plumbing systems, and understand fundamental plumbing principles and safety protocols.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**

A. The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:

1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
3. Employ effective reading, writing, and technical documentation skills.
4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
5. Demonstrate leadership skills and collaborate effectively as a team member.
6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the construction field, following applicable laws and best practices for safety.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. The student identifies various career pathways in the Plumbing field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as an Carpenter or in the Plumbing field.
2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Plumbing field.

C. The student identifies the issues associated with Plumbing hazards found on a jobsite. The student is expected to:

1. Demonstrate safe working procedures in a construction environment.
2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
3. Identify Plumbing hazards and how to avoid or minimize them in the workplace.
4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection.

D. The student integrates core academic skills into Plumbing construction practices. The student is expected to:

1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
2. Apply mathematical concepts including basic geometric principles, measuring techniques, and conversion between different measurement systems. Students learn to calculate pipe lengths, fitting allowances, and end-to-end dimensions for basic pipe installations. Mathematical concepts are applied to determine proper sizing for water supply lines, pipe grade calculations for drainage systems, and basic material takeoff calculations from construction drawings.
3. Use scientific principles including physical properties of different piping materials (plastic, copper, cast iron, and steel) and their applications. The curriculum covers fundamental concepts of water pressure, flow, and gravity in relation to drain, waste, and vent (DWV) systems. Basic principles of hydraulics are introduced through the study of water distribution systems. Students learn about the effects of temperature on different materials and basic principles of water treatment and distribution.

E. The student demonstrates understanding of the plumbing profession and workplace safety. The student is expected to:

1. Describe the history and current state of the plumbing profession.
2. Identify career opportunities and professional characteristics in plumbing.
3. Explain the causes and costs of workplace accidents and how they may be prevented in practice.
4. Demonstrate proper use of personal protective equipment (PPE).
5. Apply hazard communication and work zone safety procedures.
6. Implement proper safety precautions for hand and power tools.
7. Identify specific safety hazards encountered in existing building repairs; i.e. asbestos, lead, mold, etc.
8. Demonstrate emergency response procedures for repair situations that include water damage control, gas leaks, and other common residential and commercial applications.
9. Identify safety protocols specific to occupied building repairs and renovations.
10. Demonstrate understanding of trenching, confined space, and underground work safety.
11. Execute proper lockout/tagout procedures.

F. The student identifies and properly uses plumbing tools and equipment. The student is expected to:

1. Identify and demonstrate proper use of basic diagnostic and hand tools in plumbing to include pipe cameras, leak detectors, moisture meters, etc.
2. Demonstrate basic drain clearing techniques and use of related tools/equipment.
3. Select and use appropriate measuring and layout tools.
4. Demonstrate proper use of leveling tools and techniques.
5. Apply proper techniques for cutting tools and pipe assembly tools.
6. Operate power tools safely according to manufacturer specifications.
7. Perform proper maintenance and storage of hand and power tools.

G. The student applies mathematical concepts in plumbing applications. The student is expected to:

1. Perform calculations using whole numbers, fractions, and decimals.
2. Demonstrate mathematical conversions and use of the metric system.
3. Demonstrate the use of common measuring tools and techniques.
4. Calculate squares and square roots in plumbing applications.
5. Identify parts of fittings and related dimensions.
6. Calculate pipe lengths using various measurement methods.
7. Determine end-to-end dimensions using fitting allowances.
8. Perform cost analysis comparing repair vs. replace where applicable.

H. The student interprets plumbing drawings and documentation. The student is expected to:

1. Identify elements and components of construction drawings.
2. Interpret drawing scales, dimensions, and symbols.
3. Explain the role of construction documents in plumbing.
4. Create mechanical, site, isometric and/or orthographic drawings applicable to the industry.
5. Read and interpret plumbing-specific drawings including submittals and fixture drawings.
6. Create modification plans that integrate new components with existing systems.

I. The student demonstrates proficiency with piping materials and installation techniques. The student is expected to:

1. Identify and explain applications for different piping materials to include modern and historical industry related materials; i.e. plastic, copper, cast iron, steel, lead, terra cotta, orangeberg piping, etc.
2. Interpret pipe sizing and labeling conventions for various materials.
3. Select appropriate fittings and valves for different applications.
4. Apply proper measuring, cutting, and joining techniques for each pipe material.
5. Install and support horizontal and vertical pipe runs.
6. Perform pressure testing on installed piping systems.

J. The student understands plumbing fixtures and their applications. The student is expected to:

1. Identify materials used in manufacturing plumbing fixtures.
2. Describe common bathroom and kitchen fixtures.
3. Explain operating principles of water closets and other fixtures.
4. Compare different types of faucets including compression and non-compression.
5. Demonstrate knowledge of fixture installation requirements.

K. The student comprehends drain, waste, and vent (DWV) systems. The student is expected to:

1. Explain the benefits and components of DWV systems.
2. Identify types and parts of traps and their installation requirements.
3. Select and apply appropriate DWV fittings for various applications.
4. Describe sewer connections and waste disposal systems.
5. Apply plumbing codes related to DWV system construction.
6. Create isometric drawings of DWV systems.

L. The student analyzes water distribution systems. The student is expected to:

1. Describe municipal, residential, and private water distribution systems.
2. Explain water sources and treatment processes.
3. Identify and explain functions of system components.
4. Apply backflow prevention principles and methods.
5. Select appropriate valves for water distribution systems.
6. Calculate proper sizing for main supply lines.
7. Create isometric drawings of water distribution systems.

Course Standards: Plumbing II

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 11-12.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Construction Career Cluster prepares students for careers in designing, planning, and building sustainable infrastructure. This field includes architects, engineers, construction managers, and skilled trades professionals.
   C. The Plumbing Program of Study prepares students for a career in the plumbing trade through a comprehensive three-course sequence. Students learn essential skills such as measuring and cutting different types of pipe, installing fixtures and appliances, assembling water supply and drainage systems, and interpreting building plans. The program emphasizes hands-on experience with industry-standard tools and materials while teaching students to calculate measurements, perform system testing, and ensure all work meets building codes and safety requirements. Through progressive skill development, students gain experience with both residential and commercial plumbing applications, including installation, maintenance, and troubleshooting of various plumbing systems. Upon successful completion of the program, graduates earn three industry-recognized certifications: NCCER Core, OSHA 30 Construction, and NCCER Plumbing Levels 1 and 2, preparing them to enter the workforce with verified skills and knowledge.
   D. Plumbing II builds upon core construction knowledge to introduce students to fundamental Plumbing theory and hands-on applications in the Plumbing trade. Students master advanced piping calculations, including various types of offsets and rolling measurements. The course covers the interpretation of commercial drawings, installation of sophisticated drainage systems, and comprehensive testing procedures for both DWV and water supply systems. Students learn to work with advanced components such as water heaters, fuel gas systems, and electrical circuits in plumbing applications. Special emphasis is placed on structural considerations, insulation requirements, and firestopping techniques. The curriculum includes extensive hands-on practice with valve installation, system testing, and troubleshooting. Upon completion, students will be prepared to tackle complex plumbing installations, perform advanced calculations, and handle commercial plumbing applications while adhering to relevant codes and safety standards.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. **The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:**
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper handling of hardware and following OSHA guidelines.
      7. Exhibit an understanding of legal and ethical responsibilities in the construction field, following applicable laws and best practices for safety.
      8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

   B. **The student identifies various career pathways in the Plumbing field. The student is expected to:**
      1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles as an Electrician or in the Plumbing field.
      2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
      3. Demonstrate effective interview skills for roles in the Plumbing field.

   C. **The student identifies the issues associated with Plumbing hazards found on a jobsite. The student is expected to:**
      1. Demonstrate safe working procedures in a construction environment.
      2. Explain the purpose of the Occupational Safety and Health Administration (OSHA) and how it promotes safety on the job.
      3. Identify Plumbing hazards and how to avoid or minimize them in the workplace.
      4. Explain safety issues concerning lockout and tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection.

D. **The student integrates core academic skills into Plumbing construction practices. The student is expected to:**
   1. Demonstrate the use of clear communication techniques, both written and verbal, that are consistent with industry standards.
   2. Apply mathematical concepts such as the 3-4-5 ratio method for squaring corners and calculate various types of pipe offsets, including parallel and rolling offsets at different angles (11¼, 22½, 45, 60, and 72 degrees). Students will practice advanced geometric calculations, trigonometric principles for determining offset constants, and more complex grade and elevation calculations. Students perform detailed material takeoffs and apply mathematical principles to commercial plumbing applications.
   3. Use scientific principles including electrical theory including voltage, current, resistance, and power calculations as applied to water heaters and electronic plumbing controls. The students will review thermodynamics in relation to water heater operation and heat transfer through piping systems. Students learn about the chemical properties and behavior of different fuel gases and oils, principles of combustion, and the science behind backflow prevention. The course includes advanced concepts in hydraulics and pneumatics for pressure testing and system design, as well as the scientific principles behind firestopping and insulation.

E. The student demonstrates advanced mathematical applications in plumbing. The student is expected to:
   1. Apply the 3-4-5 method to create and verify square corners.
   2. Calculate standard and rolling offsets of varying angles.
   3. Measure and calculate parallel offsets for 11¼, 22½, 45, 60, and 72-degree angles.
   4. Calculate rolling offsets using constants and framing squares.
   5. Solve complex mathematical problems related to plumbing installations.

F. The student interprets and applies commercial plumbing drawings. The student is expected to:
   1. Use commercial drawings to locate utilities and install piping systems.
   2. Document and communicate needed changes on construction drawings.
   3. Determine pipe entry points, routes, and fixture locations from plans.
   4. Create and interpret material takeoffs and isometric drawings.
   5. Apply coordination, BIM, and as-built drawing principles.

G. The student demonstrates knowledge of structural penetrations, insulation, and firestopping. The student is expected to:
   1. Execute proper cutting, boring, and sleeving of structural members according to code.
   2. Select and install appropriate pipe insulation materials.
   3. Identify and install firestopping materials in required locations.
   4. Apply reinforcement techniques for structural modifications.
   5. Demonstrate proper protection and support of pipe installations.

H. The student installs and tests complete DWV systems. The student is expected to:

1. Plan and execute DWV system installations using appropriate materials.
2. Calculate proper grade using various leveling tools.
3. Install and connect building sewers and drains according to code.
4. Locate and install stacks and fixture connections.
5. Execute proper testing procedures for both underground and aboveground systems.

I. The student installs specialized drainage systems. The student is expected to:

1. Install and set elevations for floor drains, area drains, and floor sinks.
2. Install primary and secondary roof drainage systems.
3. Install trap primers and waterproof membranes for shower pans.
4. Apply proper installation techniques for specialty drainage applications.
5. Test and verify proper operation of drainage systems.

J. The student installs and tests complete water supply systems. The student is expected to:

1. Evaluate and plan domestic water distribution systems using plans.
2. Select appropriate materials and sizes for water service and distribution.
3. Install water service lines including backflow prevention.
4. Perform proper testing procedures on water supply systems.
5. Document and verify system compliance with local codes.

K. The student installs and maintains various types of valves. The student is expected to:

1. Identify and explain the operation of different valve types.
2. Select appropriate valves for specific applications.
3. Install valves according to manufacturer specifications.
4. Service and maintain various types of valves.
5. Troubleshoot common valve problems and failures.

L. The student demonstrates understanding of water heater systems. The student is expected to:

1. Identify and explain the operation of various water heater types.
2. Apply safety procedures when working with water heating systems.
3. Install different types of water heaters according to code.
4. Test and verify proper water heater operation.
5. Perform basic maintenance and troubleshooting.

M. The student applies electrical principles in plumbing applications. The student is expected to:

1. Implement electrical safety practices when working with plumbing systems.
2. Calculate voltage, current, resistance, and power in circuits.
3. Test electrical components using appropriate equipment.
4. Interpret electrical diagrams and symbols for plumbing systems.
5. Troubleshoot electrical issues in plumbing equipment.

N. The student installs and tests fuel gas and oil systems. The student is expected to:

1. Demonstrate safe practices in working with gas/fuel systems to include proper ventilation, safe handling, collection, disposal, etc.
2. Identify components and properties of various fuel systems.
3. Install and connect appliances to fuel gas systems.
4. Size, purge, and test fuel gas systems according to code.
5. Verify proper system pressure using appropriate testing equipment.

Course Standards: Career Connected Learning I and II

Career connected learning is an educational approach that integrates classroom instruction with real-world experiences, enabling high school students to explore potential careers and develop relevant skills before graduation. By participating in work-based learning opportunities—such as apprenticeships, internships, capstone projects, and school-based enterprises—students apply academic concepts in authentic settings, gain practical industry knowledge, and build professional networks. This hands-on engagement helps students connect their studies to future career paths, strengthens their problem-solving and communication skills, and supports a smoother transition into college, vocational programs, or the workforce.

All Career and Technical Education Programs of Study include aspects of work-based learning, and almost all of the programs include two Career Connected Learning (CCL) courses. Below are the course descriptions for CCL I and CCL II. The CCL standards can be found via this link: