Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Welding - DRAFT

Comprehensive guidelines and course standards for the Welding pathway

Office of College and Career Pathways

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MARYLAND STATE DEPARTMENT OF EDUCATION

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DOCUMENT HISTORY

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Purpose

The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Welding 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 Welding concepts in a high school context, preparing students for industry-aligned certifications like NCCER Welding and OSHA 30 and providing them with the necessary knowledge and skills for career readiness in Welding fields.

Here are the key standards sources for WELDING 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 Welding 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 WELDING 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.

3. **American Welding Society**
   A. **Description**: The American Welding Society (AWS) is the preeminent organization that provides comprehensive standards, specifications, and educational materials for the welding industry. These materials establish industry benchmarks for welding processes, procedures, qualifications, and inspections. As the recognized authority in welding standards, AWS develops and maintains technical documents that include detailed specifications, visual guides, and instructional resources that are considered the gold standard across all sectors of the welding industry, from construction to manufacturing.
   B. **Use**: AWS materials serve as essential teaching resources for welding instruction through their detailed specifications for weld quality assessment, visual inspection criteria, and joint design standards. Teachers can incorporate these standards into their lessons to teach proper welding techniques, quality control methods, and documentation practices. The visual acceptance criteria are particularly valuable for demonstrating professional standards to students, while the certification frameworks help guide curriculum development to meet industry expectations.
   C. **Source**: AWS standards and educational materials are primarily accessed through their website (www.aws.org) via subscription services or individual purchase. Educational institutions can obtain these resources through AWS educational membership programs, which often provide discounted access. Schools should consult their state's CTE office about existing AWS access agreements, as many institutions can access these materials through state-level partnerships.

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	Welding I SCED: <XX> Grades: 10-12 Prerequisite: Core Construction Fundamentals Credit: 1	This foundational welding course introduces students to essential welding processes and safety protocols. Students develop proficiency in oxyfuel cutting, SMAW (Shielded Metal Arc Welding), and basic GMAW/FCAW (Gas Metal/Flux Cored Arc Welding) operations. The curriculum emphasizes proper equipment setup, base metal preparation, electrode selection, and fundamental joint creation in various positions. Students learn to assess weld quality through visual inspection and industry-standard measurements while maintaining strict adherence to AWS specifications.

Course Level	Course Information	Description
Optional Flex: Course 1	Welding II SCED: <XX> Grades: 11-12 Prerequisite: Welding I Credit: 1	This advanced welding course builds upon foundational skills to develop expertise in complex welding applications. Students master GMAW/FCAW in all positions, learn GTAW (Gas Tungsten Arc Welding) techniques, and perform advanced SMAW operations including open-root welds and pipe-to-plate connections. The curriculum covers metallurgy, pre/post-heat treatments, and comprehensive weld inspection methods including destructive and non-destructive testing. Students interpret advanced welding symbols, create detailed welding plans, and perform welds that meet rigorous AWS standards for various industrial applications.
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Welding 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 WELDING I:** Welding Level 1 Certificate **By the end of WELDING II:** Welding Level 2 Certificate **Optional Credentials (via the Flex Course options):** Apprenticeship

Work-Based Learning Examples and Resources		
Core Construction Principles: **Career Awareness**	**WELDING I:** **Career Preparation**	**WELDING 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:** 51-4121: Welders, Cutters, Solderers, Brazers **Hourly Wage/Annual Salary:** 25th Percentile: $22.77/$47,360 50th Percentile: $26.50/$55,120 75th Percentile: $35.76/$74,390
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:** Welding is a skill necessary in several craft trades, including ironworking, pipefitting and HVAC work. Each of these trades has professional licenses in the state of Maryland that can be obtained from a recognized training facility. Post-secondary training is typically recommended but not required to start working in this field.
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 Welding Program of Study is a comprehensive three-course welding program prepares students for entry-level careers in the welding industry through progressive skill development and industry-recognized certifications. Students advance from basic construction and safety fundamentals through advanced welding techniques, learning essential skills such as producing multi-position welds, interpreting blueprints, operating various welding equipment, performing quality inspections, and executing complex pipe-to-plate connections. Upon completion, graduates are prepared to earn four valuable industry credentials: OSHA 30 Construction certification, NCCER Core, NCCER Welding Level 1, and NCCER Welding Level 2, qualifying them for immediate employment in construction, manufacturing, and fabrication industries.
   D. Core Construction Principles introduces students to the essential fundamentals of the construction industry with a focus on Welding 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 Welding field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles that require welding related skills.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Welding field.

C. The student identifies the issues associated with Welding related 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 Welding related 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 WELDING 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. Utilize arithmetic operations, fractions, and decimals for precise measurements, unit conversions between standard and metric systems, and geometric principles for joint layouts. Students calculate material usage rates, gas flow rates, and amperage settings. Trade-specific applications include measuring angles for weld bevels, calculating material thickness ratios, determining proper wire feed speeds, and computing heat input calculations for different welding processes.
3. Apply principles of basic physics and chemistry essential to welding processes. They study electrical theory including voltage, amperage, and polarity in welding circuits, metallurgy concepts including metal properties and behavior at different temperatures, and thermodynamics in heat transfer and cooling rates. Students learn gas behavior and flow dynamics, principles of magnetism in arc behavior, oxidation processes, and the chemistry of shielding gases. Safety-related science includes understanding radiation physics in arc welding, chemical reactions in fire prevention, and ventilation principles for fume control.

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 industries related to Welding.
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 industries where welding is a necessary skill.

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 Welding related hazards and implement appropriate safety measures.
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: Welding 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 Welding Program of Study is a comprehensive three-course welding program prepares students for entry-level careers in the welding industry through progressive skill development and industry-recognized certifications. Students advance from basic construction and safety fundamentals through advanced welding techniques, learning essential skills such as producing multi-position welds, interpreting blueprints, operating various welding equipment, performing quality inspections, and executing complex pipe-to-plate connections. Upon completion, graduates are prepared to earn four valuable industry credentials: OSHA 30 Construction certification, NCCER Core, NCCER Welding Level 1, and NCCER Welding Level 2, qualifying them for immediate employment in construction, manufacturing, and fabrication industries.
   D. This foundational welding course introduces students to essential welding processes and safety protocols. Students develop proficiency in oxyfuel cutting, SMAW (Shielded Metal Arc Welding), and basic GMAW/FCAW (Gas Metal/Flux Cored Arc Welding) operations. The curriculum emphasizes proper equipment setup, base metal preparation, electrode selection, and fundamental joint creation in various positions. Students learn to assess weld quality through visual inspection and industry-standard measurements while maintaining strict adherence to AWS specifications.
   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 Welding field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles where welding skills are required.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Welding field.

C. The student identifies the issues associated with Welding related 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 Welding related 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 Welding 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. Use basic arithmetic, measurement, and geometry for welding layouts and joint preparation. They calculate dimensions, angles for bevels, and material quantities. Mathematical applications include determining proper amperage settings based on electrode size and material thickness, measuring weld sizes, calculating material usage rates and measuring in decimals and fractions.
3. Use scientific principles intermediate physics and metallurgy concepts specific to welding processes. They learn principles of electricity and magnetism in SMAW operations, thermal dynamics in metal heating and cooling cycles, and physical properties of base metals and electrodes. The curriculum covers gas laws for oxyfuel operations, chemical reactions in flux and slag formation, and molecular behavior of shielding gases. Students also study basic metallurgy including metal crystalline structures, phase transformations, and weld zone composition.

E. The student demonstrates comprehensive knowledge of welding safety practices and procedures. The student is expected to:

1. Analyze potential hazards in welding operations and implement appropriate safety measures.
2. Evaluate and select proper Personal Protective Equipment (PPE) for specific welding tasks.
3. Demonstrate proper ventilation setup and maintenance procedures.
4. Execute emergency response procedures for welding-related incidents.

F. The student demonstrates mastery of oxyfuel cutting processes. The student is expected to:

1. Set up and inspect oxyfuel cutting equipment according to manufacturer specifications.
2. Demonstrate safe oxyfuel working practices.
3. Perform straight, bevel, and piercing cuts meeting industry standards.
4. Troubleshoot common cutting problems and implement solutions.
5. Execute proper shutdown and maintenance procedures.

G. The student applies knowledge of metal preparation techniques. The student is expected to:

1. Analyze metal properties to determine appropriate preparation methods.
2. Execute cleaning and beveling techniques to prepare metals for welding.
3. Measure and verify joint fit-up according to specifications.
4. Demonstrate proficiency in fit-up and layout of parts.
5. Select appropriate preparation tools based on metal type and thickness.

H. The student demonstrates proficiency in SMAW equipment operation. The student is expected to:

1. Configure SMAW equipment for various welding operations.
2. Determine appropriate amperage settings for different electrodes and positions.
3. Diagnose and resolve common SMAW equipment malfunctions.
4. Perform routine maintenance procedures on SMAW equipment.
5. Demonstrate proper shut-down procedures.

I. The student demonstrates understanding of electrode selection and bead formation. The student is expected to:

1. Classify electrodes based on their specifications and applications.
2. Evaluate weld bead appearance to determine quality and needed adjustments.
3. Execute proper electrode manipulation techniques for various welding positions.
4. Maintain proper work and travel angles during bead formation.

J. The student demonstrates competency in creating SMAW joints in various positions. The student is expected to:

1. Create fillet welds in all positions meeting AWS standards, safely.
2. Produce groove welds in all positions meeting AWS standards, safely.
3. Apply proper techniques for tack welding and joint alignment.
4. Analyze and correct weld joint defects.

K. The student demonstrates fundamental knowledge of wire-fed welding processes. The student is expected to:

1. Set up GMAW and FCAW equipment according to manufacturer specifications.
2. Select appropriate wire types and sizes for specific applications.
3. Perform basic GMAW and FCAW operations in flat and horizontal positions.
4. Troubleshoot common wire-feed welding problems.
5. Demonstrate proper shut-down procedures.

L. The student evaluates weld quality using industry standards. The student is expected to:

1. Identify common weld defects and their causes.
2. Perform visual inspection of completed welds using AWS criteria.
3. Measure weld size and profile using appropriate gauges.
4. Document weld quality findings according to industry standards.

Course Standards: Welding II

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 Welding Program of Study is a comprehensive three-course welding program prepares students for entry-level careers in the welding industry through progressive skill development and industry-recognized certifications. Students advance from basic construction and safety fundamentals through advanced welding techniques, learning essential skills such as producing multi-position welds, interpreting blueprints, operating various welding equipment, performing quality inspections, and executing complex pipe-to-plate connections. Upon completion, graduates are prepared to earn four valuable industry credentials: OSHA 30 Construction certification, NCCER Core, NCCER Welding Level 1, and NCCER Welding Level 2, qualifying them for immediate employment in construction, manufacturing, and fabrication industries.
   D. The Welding II course builds upon foundational skills to develop expertise in complex welding applications. Students master GMAW/FCAW in all positions, learn GTAW (Gas Tungsten Arc Welding) techniques, and perform advanced SMAW operations including open-root welds and pipe-to-plate connections. The curriculum covers metallurgy, pre/post-heat treatments, and comprehensive weld inspection methods including destructive and non-destructive testing. Students interpret advanced welding symbols, create detailed welding plans, and perform welds that meet rigorous AWS standards for various industrial applications.
   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 Welding field. The student is expected to:

1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles that require welding related skills.
2. Create a professional resume and portfolio that reflects skills, projects, certifications, and recommendations.
3. Demonstrate effective interview skills for roles in the Welding field.

C. The student identifies the issues associated with Welding related 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 Welding related 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 Welding 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 advanced geometry and trigonometry for complex joint configurations and pipe welding. They use algebraic formulas for heat input calculations, statistical analysis for quality control, and advanced measurement techniques for weld testing and inspection. Mathematical skills extend to thermal calculations for pre/post-heat treatments.
3. Study advanced metallurgy including crystalline structures and phase transformations, complex electrical theory for GTAW operations, and advanced thermal dynamics for heat treatment processes. They apply principles of plasma physics, advanced gas dynamics for shielding gas mixtures, and materials science concepts for understanding metal behavior under various conditions.

E. The student demonstrates advanced interpretation of welding symbols and drawings. The student is expected to:

1. Interpret complex welding symbols including supplementary symbols and specifications.
2. Interpret fit-up/layout drawings to determine specifications and measurements.
3. Create detailed welding plans based on blueprint specifications.
4. Calculate material requirements from welding drawings.
5. Verify compliance between completed welds and blueprint requirements.

F. The student analyzes metal properties and their effects on welding. The student is expected to:

1. Identify various metals using physical and mechanical testing methods.
2. Analyze how metal properties affect weldability.
3. Evaluate the effects of heat input on metal properties.
4. Select appropriate welding procedures based on material characteristics.

G. The student demonstrates knowledge of thermal treatment procedures. The student is expected to:

1. Calculate appropriate pre-heat temperatures based on material specifications.
2. Execute proper pre-heating procedures using various heating methods.
3. Monitor and maintain interpass temperatures during welding.
4. Implement appropriate post-weld heat treatment procedures.

H. The student demonstrates mastery of wire-fed welding processes. The student is expected to:

1. Perform GMAW welds in all positions meeting AWS standards, safely.
2. Perform FCAW welds in all positions meeting AWS standards, safely.
3. Select optimal parameters for different material types and thicknesses.
4. Demonstrate proper techniques for welding various joint configurations.

I. The student demonstrates mastery of SMAW applications. The student is expected to:

1. Perform multi-pass welds in all positions meeting AWS standards, safely.
2. Perform open-root V-groove welds in all positions with backing bar, safely.
3. Implement proper techniques for welding pipe to plate, safely.
4. Apply hardfacing and buildup procedures to specification, safely.

J. The student demonstrates proficiency with gas tungsten arc welding fundamentals. The student is expected to:

1. Configure GTAW equipment for various welding applications.
2. Explain the appropriate use scenarios for foot pedal vs. thumb operated GTAW machines and benefits of each.
3. Select appropriate tungsten electrodes based on material and current type.
4. Determine proper shielding gas mixtures for different materials.
5. Perform equipment maintenance and troubleshooting procedures.

K. The student demonstrates proficiency in GTAW plate welding techniques. The student is expected to:

1. Perform GTAW welds on plate in all positions meeting AWS standards, safely.
2. Demonstrate proper torch manipulation techniques for various joint designs, safely.
3. Control heat input to prevent material distortion.
4. Evaluate and correct GTAW weld defects.

L. The student performs comprehensive weld quality evaluation. The student is expected to:

1. Conduct destructive testing procedures according to industry standards.
2. Perform non-destructive testing techniques to evaluate weld quality.
3. Interpret testing results to determine weld acceptability.
4. Document inspection findings according to industry requirements.

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: