

Metalworking Standards



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Vision

All Nevada students are equipped and feel empowered to attain their vision of success

Mission

To improve student achievement and educator effectiveness by ensuring opportunities, facilitating learning, and promoting excellence



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Standards Development Members

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Business and Industry Validation

All CTE standards developed through the Nevada Department of Education are validated by business and industry through one or more of the following processes: (1) the standards are developed by a team consisting of business and industry representatives, or (2) a separate review panel is coordinated with industry experts to ensure the standards include the proper content, or (3) nationally recognized standards currently endorsed by business and industry.

The Metalworking standards were validated through active participation of business and industry representatives on the development team.

Introduction

The standards in this document are designed to clearly state what the student should know and be able to do upon completion of an advanced high school Metalworking program. These standards are designed for a two-credit course sequence that prepares the student for a technical assessment directly aligned to the standards.

These exit-level standards are designed for the student to complete all standards through their completion of a program of study. These standards are intended to guide curriculum objectives for a program of study.

The standards are organized as follows:

- **Content Standards** are general statements that identify major areas of knowledge, understanding, and the skills students are expected to learn in key subject and career areas by the end of the program.
- **Performance Standards** follow each content standard. Performance standards identify the more specific components of each content standard and define the expected abilities of students within each content standard.
- **Performance Indicators** are very specific criteria statements for determining whether a student meets the performance standard. Performance indicators may also be used as learning outcomes, which teachers can identify as they plan their program learning objectives. The indicators are followed by designations that reflect the course sequence (e.g., L1 for the first-year course of a two-year program and L2 for the second-year course) as referenced in the Core Course Sequence table.

The crosswalks and alignments are located in the Metalworking Supplemental Program Resources document. These will show where the performance indicators support the Nevada Academic Content Standards. For individual course descriptions, please reference the Supplemental Program Resource or the Nevada CTE Catalog.

All students are encouraged to participate in the career and technical student organization (CTSO) that relates to the Metalworking program. CTSOs are co-curricular national organizations that directly reinforce learning in the CTE classroom through curriculum resources, competitive events, and leadership development. CTSOs provide students the ability to apply academic and technical knowledge, develop communication and teamwork skills, and cultivate leadership skills to ensure college and career readiness.

The Employability Skills for Career Readiness identify the skills needed to be successful in all careers and must be taught as an integrated component of all CTE course sequences. These standards are available in a separate document.

The **Standards Reference Code** is only used to identify or align performance indicators listed in the standards to daily lesson plans, curriculum documents, or national standards. The Standards Reference Code is an abbreviated name for the program, and the content standard, performance standard and performance indicator are referenced in the program standards. This abbreviated code for identifying standards uses each of these items. For example, MTL is the Standards Reference Code for Metalworking. For Content Standard 2, Performance Standard 3 and Performance Indicator 4 the Standards Reference Code would be MTL.2.3.4.

Metalworking

Program Information

Program of Study: Metalworking
Standards Reference Code: MTL
Career Cluster: Manufacturing
Career Pathway(s): Production
Program Length: 2-year, completed sequentially
CTSO: SkillsUSA

Program Structure Required Program of Study Courses

The core course sequencing is provided in the following table. Complementary Courses are available and provided later in this document. The following courses provide a completed program of study. The Lab is a complementary course available concurrently with the Metalworking II course.

Core Course Sequence (R) with Lab Course(s) (C)

Required/ Complementary	Course Title	Abbreviated Name
R	Metalworking I	METAL WRKG I
R	Metalworking II	METAL WRKG II
C	Metalworking II Lab	METAL WRKG II L

CONTENT STANDARD 1.0: INTEGRATE CAREER AND TECHNICAL STUDENT ORGANIZATIONS (CTSOs)**Performance Standard 1.1: Explore the History and Organization of CTSOs**

- 1.1.1 Discuss the requirements of CTSO participation/involvement as described in Carl D. Perkins Law (Level 1 (L1), Level 2 (L2))
- 1.1.2 Research nationally recognized CTSOs (L1, L2)
- 1.1.3 Investigate the impact of federal and state government regarding the progression and operation of CTSOs (e.g., Federal Statutes and Regulations, Nevada Administrative Code [NAC], Nevada Revised Statutes [NRS]) (L1, L2)

Performance Standard 1.2: Develop Leadership Skills

- 1.2.1 Discuss the purpose of parliamentary procedure (L1, L2)
- 1.2.2 Demonstrate the proper use of parliamentary procedure (L1, L2)
- 1.2.3 Differentiate between an office and a committee (L1, L2)
- 1.2.4 Discuss the importance of participation in local, regional, state, and national conferences, events, and competitions (L1, L2)
- 1.2.5 Participate in local, regional, state, or national conferences, events, or competitions (L1, L2)
- 1.2.6 Describe the importance of a constitution and bylaws to the operation of a CTSO chapter (L1, L2)

Performance Standard 1.3: Participate in Community Service

- 1.3.1 Explore opportunities in community service-related work-based learning (WBL) (L1, L2)
- 1.3.2 Participate in a service learning (program related) and/or community service project or activity (L1, L2)
- 1.3.3 Engage with business and industry partners for community service (L1, L2)

Performance Standard 1.4: Develop Professional and Career Skills

- 1.4.1 Demonstrate college and career readiness (e.g., applications, resumes, interview skills, presentation skills) (L1, L2)
- 1.4.2 Describe the appropriate professional/workplace attire and its importance (L1, L2)
- 1.4.3 Investigate industry-standard credentials/certifications available within this Career Cluster™ (L1, L2)
- 1.4.4 Participate in authentic contextualized instructional activities (L1, L2)
- 1.4.5 Demonstrate technical skills in various student organization activities/events (L1, L2)

Performance Standard 1.5: Understand the Relevance of Career and Technical Education (CTE)

- 1.5.1 Make a connection between program standards to career pathway(s) (L1, L2)
- 1.5.2 Explain the importance of participation and completion of a program of study (L1, L2)
- 1.5.3 Promote community awareness of local student organizations associated with CTE programs (L1, L2)

CONTENT STANDARD 2.0: IDENTIFY LAB ORGANIZATION AND SAFETY PROCEDURES**Performance Standard 2.1: Demonstrate General Lab Safety Rules and Procedures**

- 2.1.1 Describe general shop safety rules and procedures (i.e., safety test) (L1)
- 2.1.2 Describe the roles of OSHA in workplace safety (L1)
- 2.1.3 Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities (i.e., personal protective equipment – PPE) (L1)
- 2.1.4 Utilize safe procedures for handling of tools and equipment (L1)
- 2.1.5 Operate lab equipment according to safety guidelines (L1)
- 2.1.6 Identify and use proper lifting procedures and proper use of support equipment (L1)
- 2.1.7 Utilize proper ventilation procedures for working within the lab/shop area (L1)
- 2.1.8 Identify marked safety areas (L1)
- 2.1.9 Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment (L1)
- 2.1.10 Identify the location and use of eye wash stations (L1)
- 2.1.11 Identify the location of the posted evacuation routes (L1)
- 2.1.12 Identify and wear appropriate clothing for lab/shop activities (L1)
- 2.1.13 Secure hair and jewelry for lab/shop activities (L1)
- 2.1.14 Demonstrate knowledge of the safety aspects of high voltage circuits (L1)
- 2.1.15 Locate and interpret safety data sheets (SDS) (L1)
- 2.1.16 Prepare time or job cards, reports or records (L1)
- 2.1.17 Perform housekeeping duties (L1)
- 2.1.18 Follow verbal instructions to complete work assignments (L1)
- 2.1.19 Follow written instructions to complete work assignments (L1)

Performance Standard 2.2: Identify and Utilize Hand Tools

- 2.2.1 Identify hand tools and their appropriate usage (L1)
- 2.2.2 Identify standard and metric designation (L1)
- 2.2.3 Demonstrate the proper techniques when using hand tools (L1)
- 2.2.4 Demonstrate safe handling and use of appropriate tools (L1)
- 2.2.5 Demonstrate proper cleaning, storage, and maintenance of tools (L1)

Performance Standard 2.3: Identify and Utilize Power Tools and Equipment

- 2.3.1 Identify power tools and their appropriate usage (L1)
- 2.3.2 Identify equipment and their appropriate usage (L1)
- 2.3.3 Demonstrate the proper techniques when using power tools and equipment (L1)
- 2.3.4 Demonstrate safe handling and use of appropriate power tools and equipment (L1)
- 2.3.5 Demonstrate proper cleaning, storage, and maintenance of power tools and equipment (L1)
- 2.3.6 Demonstrate the safe use of a grinder (L1)

CONTENT STANDARD 3.0: APPLY FUNDAMENTAL PRINT READING, MEASUREMENT, AND LAYOUT/FIT-UP TECHNIQUES**Performance Standard 3.1: Demonstrate Print Reading and Sketching Practices**

- 3.1.1 Interpret basic elements of a technical drawing (i.e., title block information, dimensions, line types) (L1)
- 3.1.2 Identify industry standard welding, machining, tolerance, and call out symbols. (L2)
- 3.1.3 Prepare a materials list from a technical drawing (L2)
- 3.1.4 Describe various types of drawings (i.e., part, assembly, pictorial, orthographic, isometric, schematic) (L2)
- 3.1.5 Understand dimensioning, sectional drawings, fasteners, tables, charts, and assembly drawings (L2)
- 3.1.6 Sketch a basic shop drawing (L2)

Performance Standard 3.2: Demonstrate Measuring and Scaling Techniques

- 3.2.1 Identify industry standard units of measure (L1)
- 3.2.2 Determine and apply the equivalence between fractions and decimals (L1)
- 3.2.3 Convert between customary (i.e., SAE, Imperial) and metric systems (L2)
- 3.2.4 Determine appropriate engineering and metric scales (L2)
- 3.2.5 Measure and calculate size, area, and volume (L2)
- 3.2.6 Demonstrate proper use of precision measuring tools (i.e., wire gauge, micrometer, dial-indicator, dial-caliper) (L2)

Performance Standard 3.3: Utilize Layout Principles and Practices

- 3.3.1 Interpret drawing, sketch, or specification information (L2)
- 3.3.2 Prepare work area for layout (L2)
- 3.3.3 Select appropriate materials to complete work assignment (L2)
- 3.3.4 Use layout and marking tools as required (L2)
- 3.3.5 Lay out parts using measurement practices (staggered dimensions, running dimensions, geometric principles) (L2)

Performance Standard 3.4: Demonstrate Preparation and Fit-Up Practices

- 3.4.1 Identify and explain distortion and how it is controlled (L2)
- 3.4.2 Check for proper joint configurations (i.e., bevel angle, root opening, landings) (L2)
- 3.4.3 Check for joint misalignment and poor fit-up before and after welding (L2)

CONTENT STANDARD 4.0: IDENTIFY PROPERTIES OF METALS

Performance Standard 4.1: Identify Material Properties and Science

- 4.1.1 Research field identification methods for base metals (i.e., mill certificate) (L1)
- 4.1.2 Identify the physical characteristics and mechanical properties of metals (L2)
- 4.1.3 Identify and explain forms and shapes of structural metals (L1, L2)

Performance Standard 4.2: Identify Filler Metal

- 4.2.1 Explain filler metal classifications systems (i.e., American Welding Society, American Society of Mechanical Engineers) (L1)
- 4.2.2 Identify different types of filler metals (L1)
- 4.2.3 Explain the storage and control of filler metals (L2)

CONTENT STANDARD 5.0: APPLY WELDING TECHNIQUES**Performance Standard 5.1: Apply Safety Procedures**

- 5.1.1 Perform safety inspections of OFW and SMAW equipment and accessories (L1)
- 5.1.2 Make minor external repairs to OFW and SMAW equipment and accessories (L1)
- 5.1.3 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of OFW (L1)
- 5.1.4 Identify and explain the use of GMAW equipment (i.e., spray transfer, globular, short circuit, pulse) (L2)
- 5.1.5 Perform safety inspections of GMAW equipment and accessories (L2)
- 5.1.6 Make minor external repairs to GMAW equipment and accessories (L2)
- 5.1.7 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of GMAW and FCAW equipment (L2)

Performance Standard 5.2: Produce Welds Using Oxy-Fuel Welding (OFW)

- 5.2.1 Set up for OFW operations (L1)
- 5.2.2 Operate OFW equipment (L1)
- 5.2.3 Perform welds in the 1F and 2F position (L1)

Performance Standard 5.3: Produce Welds Using Shielded Metal Arc Welding (SMAW) on Carbon Steel

- 5.3.1 Set up for SMAW operations (L1)
- 5.3.2 Operate SMAW equipment (L1)
- 5.3.3 Perform welds in the 1F position (L1)
- 5.3.4 Perform welds in the 2F position (L1)
- 5.3.5 Perform welds in the 1G position (L2)
- 5.3.6 Perform welds in the 2G position (L2)

Performance Standard 5.4: Produce Welds Using Gas Metal Arc Welding Short Circuiting Transfer (GMAW-S) on Carbon Steel

- 5.4.1 Set up for GMAW-S operations (L1)
- 5.4.2 Operate GMAW-S equipment (L1)
- 5.4.3 Perform welds in the 1F position (L1)
- 5.4.4 Perform welds in the 2F position (L2)
- 5.4.5 Perform welds in the 1G position (L2)
- 5.4.6 Perform welds in the 2G position (L2)

CONTENT STANDARD 6.0: APPLY THERMAL CUTTING PROCESSES**Performance Standard 6.1: Demonstrate Oxy-Fuel Gas Cutting (OFC)**

- 6.1.1 Perform safety inspections of OFC equipment and accessories (L1)
- 6.1.2 Make minor external repairs to OFC equipment and accessories (L1)
- 6.1.3 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of OFC equipment (L1)
- 6.1.4 Set up for OFC operations (L1)
- 6.1.5 Operate OFC equipment (L1)
- 6.1.6 Perform straight, square edge cutting operations in the flat position (L1)
- 6.1.7 Perform shape, square edge cutting operations in the flat position (L1)
- 6.1.8 Perform straight, bevel edge cutting operations in the flat position (L1)

Performance Standard 6.2: Demonstrate Plasma Arc Cutting (PAC) on Carbon Steel

- 6.2.1 Perform safety inspections of PAC equipment and accessories (L2)
- 6.2.2 Make minor external repairs to PAC equipment and accessories (L2)
- 6.2.3 Set up for PAC operations (L2)
- 6.2.4 Operate PAC equipment (L2)
- 6.2.5 Perform straight, square edge cutting operations in the flat position (L2)
- 6.2.6 Perform shape, square edge cutting operations in the flat position (L2)

CONTENT STANDARD 7.0: IDENTIFY WELDING CODES, INSPECTIONS, AND TESTING PRINCIPLES**Performance Standard 7.1: Identify Welding Codes, Qualifications, and Certifications**

- 7.1.1 Identify and explain weld imperfections and their causes (L1)
- 7.1.2 Explain the importance of quality workmanship (L1)
- 7.1.3 Identify and explain nondestructive examination practices (L2)

CONTENT STANDARD 8.0: APPLY FABRICATION FUNDAMENTALS

Performance Standard 8.1: Utilize Base Metal Preparation Fundamentals

- 8.1.1 Clean base metal for welding or cutting (L1)
- 8.1.2 Identify joint design (L1)
- 8.1.3 Mechanically bevel the edge of a mild steel plate (L2)
- 8.1.4 Thermally bevel the end of a mild steel plate (L2)
- 8.1.5 Select the proper joint design based on a welding procedure specification (WPS) (L2)

Performance Standard 8.2: Demonstrate Part Preparation with Cutting and Forming Techniques

- 8.2.1 Perform bending or forming operations (L1)
- 8.2.2 Perform drilling or boring operations (L1)
- 8.2.3 Perform shearing operations (L1)

Performance Standard 8.3: Demonstrate Fabrication Techniques

- 8.3.1 Demonstrate proper setup of fabrication area, equipment, and materials (L2)
- 8.3.2 Construct projects in the proper sequence (L2)
- 8.3.3 Produce tack or spot welds to specifications (L2)
- 8.3.4 Properly lay out projects from prints (L2)
- 8.3.5 Check work for accuracy (L2)

Performance Standard 8.4: Identify Threads and Fasteners

- 8.4.1 Identify SAE and metric threads (i.e., screw, tapered, self-tapping) (L1)
- 8.4.2 Identify various fastening methods (i.e., rivets, adhesive, screws, seams) (L1)
- 8.4.3 Cut internal and external threads manually and mechanically (i.e., tap and die, lathe) (L2)
- 8.4.4 Categorize fastening methods by appropriate applications (L2)
- 8.4.5 Demonstrate fastening methods on various materials (L2)

Performance Standard 8.5: Utilize Metal Forming Processes

- 8.5.1 Identify and explain various forming processes (L1)
- 8.5.2 Identify different types of forming equipment (L1)
- 8.5.3 Demonstrate metal drawing and tapering processes (L2)
- 8.5.4 Demonstrate heat treating processes (L2)
- 8.5.5 Demonstrate braking and bending applications, both manually and mechanically (L2)

CONTENT STANDARD 9.0: APPLY SHEET METAL TECHNIQUES**Performance Standard 9.1: Utilize Sheet Metal Layout Principles and Practices**

- 9.1.1 Construct paper patterns for a simple sheet metal project (L1)
- 9.1.2 Lay out directly on metal using dyes, scribes, dividers, trammel points, and edge gauges (L1)
- 9.1.3 Identify edges and seams used in typical sheet metal layout (L2)
- 9.1.4 Demonstrate the use of radial and parallel line development (L2)

Performance Standard 9.2: Demonstrate Fastening Techniques

- 9.2.1 Identify and list the various sheet metal fastening techniques (L1)
- 9.2.2 Demonstrate the ability to join sheet metal together with rivets, resistance welding, and seaming techniques (L2)

Performance Standard 9.3: Utilize Forming and Cutting Techniques

- 9.3.1 Perform basic preventative non-electrical maintenance on machines and tools to comply with safety requirements for optimal performance levels (L2)
- 9.3.2 Form sheet metal using a box and pan break, slip roll, and a rotary machine (L2)
- 9.3.3 Cut sheet metal using foot shears/power shears, hand shears, Beverly shears, and Whitney punches (L2)
- 9.3.4 Use appropriate cutting and folding techniques (L2)

CONTENT STANDARD 10.0: APPLY MACHINING TECHNIQUES

Performance Standard 10.1: Demonstrate Fundamentals of Machining

- 10.1.1 Use charts and tables to determine cutting, drilling, and knurling speeds (L2)
- 10.1.2 Select the proper cutting tool based on job requirements (L2)
- 10.1.3 Safely sharpen cutting tools (L2)

Performance Standard 10.2: Utilize Metalworking Machines

- 10.2.1 Identify and explain the purpose and use of metalworking lathes and milling machines (L2)
- 10.2.2 Perform facing, straight turning, shoulder turning, center drilling, knurling, and parting operations on a lathe (L2)
- 10.2.3 Turn a taper using one of the three taper cutting techniques on a lathe (i.e., tailstock offset, and compound rest) (L2)

Performance Standard 10.3: Utilize Drilling Machines

- 10.3.1 Identify components of the drill press (L1)
- 10.3.2 Set up and securely clamp a work piece to the drill press table (L1)
- 10.3.3 Select appropriate drill size based on job requirements (L1)
- 10.3.4 Perform drilling operations (L1)
- 10.3.5 Use charts and tables to determine cutting speeds and feeds for drilling a specific medium (L2)