

Mandan Public School District

Career & Technical Education

Mandan Public Schools

Welding Technology Curriculum



2010

Table of Contents

Table of Contents2

Preface.....4

Writing Committee Members5

Vision, Mission, Slogan and Philosophy5

 Philosophy of the Welding Technology Curriculum.....5

Welding Technology Curriculum Codes5

Welding Technology Program Standards6

 Standard 1: Welding Safety6

 Standard 2: Welding Symbols7

 Standard 3: Reading Welding Detail Drawings.....8

 Standard 4: Base Metal Preparation.....8

 Standard 5 Joint Fit-up and Alignment.....9

 Standard 6: Weld Quality.....9

 Standard 7: Oxyfuel Processes.....10

 Standard 8: Plasma Arc Cutting (PAC)13

 Standard 9: Air Carbon Arc Cutting and Gouging14

 Standard 10: Shielded Metal Arc Welding (SMAW) – Equipment and Setup.....14

 Standard 11: Shielded Metal Arc Welding (SMAW) – Electrodes and Selection15

 Standard 12: Shielded Metal Arc Welding (SMAW) – Electrodes and Selection16

 Standard 13: Shielded Metal Arc Welding (SMAW) – Beads and Fillet Welds.....18

 Standard 14: Shielded Metal Arc Welding (SMAW) – Groove Welds with Backing18

 Standard 15: Shielded Metal Arc Welding (SMAW) – Equipment and Filler Metals18

Mandan Public Schools
Welding Technology Curriculum

Standard 16: Shielded Metal Arc Welding (SMAW) – Plate	19
Standard 17: Flux Core and/or Metal Core Wire (FCAW) – Equipment and Filler Metals.....	19
Standard 18: Flux Core and/or Metal Core Wire (FCAW) Plate.....	19
Standard 19: Gas Tungstun Arc Welding (GTAW) – Equipment and Filler Materials	20
Standard 20: Gas Tungstun Arc Welding (GTAW) – Plate	20
Standard 21: Gas Tungstun Arc Welding (GTAW) – Aluminum Plate	20
Standard 22: Shielded Metal Arc Welding (SMAW) – Open-Root Pipe Welds.....	21
Standard 23: Shielded Metal Arc Welding (SMAW) – Stainless Steel Groove and Pipe Welds.....	21
Standard 24: Fabrication	21
Standard 25: Metallurgy	22
Course Descriptions and Course Outlines	23
Introduction to Welding.....	23
Welding Technology I	29
Welding Technology II.....	36
Appendix A.....	43
21 st Century Skills.....	43

Preface

The Mandan Public Schools Welding Curriculum Committee revised and updated the Welding Curriculum. The Welding Curriculum Committee included the 2006 North Dakota Welding Content Standards in the curriculum. This updated curriculum will provide Mandan Public School students with the best possible curriculum to assist our students in their career planning and career decision-making.

The Welding Curriculum is articulated in two ways. First, the curriculum is presented based on the 2006 Welding Content Standards. The committee identified each benchmark specific student skill and determined the degree to which each benchmark should be addressed in each course. The following IDM coding system was used to convey this:

- I – Introduce
- D – Develop
- M – Master.

The Welding Curriculum is also articulated according to the 21st Century Skills. The committee identified which Welding Curriculum benchmarks address specific 21st Century Skills. These 21st Century Skills can be seen in Appendix A.

The Welding Curriculum IDM matrix lists each welding course that is available to students at Mandan High School. Welding courses are available to sophomores, juniors and seniors at Mandan High School. Please read the course descriptions to learn more about the course content.

Thanks to the Welding Curriculum Committee for their time, effort, and professionalism in working together on this curriculum committee. I also thank the students and parents who serve on the Welding Advisory Committee at Mandan High School. Mandan Public Schools is fortunate to have such dedicated hardworking professionals who teach our students how to weld.

Dr. Gaylynn Becker
District Curriculum/Data Coordinator

Mandan Public Schools 2010 9-12 Welding Curriculum Writing Committee Members

<u>Name</u>	<u>Building</u>	<u>Area</u>
Mr. David Axt	Mandan High School	Introduction to Welding
Mr. Norge Labrato - Chair	Mandan High School	Introduction to Welding Welding Technology I Welding Technology II
Mrs. Heidi Reiter	Mandan High School	Introduction to Welding
Dr. Gaylynn Becker	Central Administration	District Curriculum/Data Coordinator

Vision, Mission, Slogan and Philosophy

Mandan Public School District's vision is **“Empowering excellence.”** Its mission is **“Empowering every student to lead a productive life and positively contribute to society.”** Its slogan is **“Mandan Schools: Where the Best Begin.”**

The principal objective of the Board shall be to provide maximum educational opportunities for their students to develop in accordance with their individual needs, abilities, and level of maturity. Teachers shall make efforts to aid students to achieve their maximum development mentally, physically, socially, spiritually, and emotionally so that they may properly adjust to our complex democratic society.

The district shall back up its educational program with supporting services necessary for students' health, safety, and personal well being.

Philosophy of the Welding Technology Curriculum is:

The philosophy of the welding program is to provide students the opportunity to learn about welding as an occupation and as a possible career choice. This will be accomplished through various types of metal welding, brazing, flame cutting, blueprint reading, electrical principles, welding symbols, mechanical drawing while emphasizing applied academics, leadership, organizational skills and professional development while adhering to the American Welding Society Standards in welding processes.

Welding Technology Curriculum Codes

- I – Introduce
- D – Develop
- M – Master

Anything beyond the mastery level we assume that reinforcement will occur.

**Welding Technology
Welding Technology Program Standards**

	Intro to Welding	Welding I	Welding II
Standard 1: Welding Safety			
Identify general safety considerations that apply to welding			
1.1 Identify some common hazards in welding			
1.1.1 Identify personal factors that cause accidents on a job-site	I	D	D
1.1.2 Identify physical factors that cause accidents on a job-site	I	D	D
1.1.3 Demonstrate correct use of fire extinguishers	I	D	D
1.1.4 Identify classes of fire extinguishers (A, B, C, & D)			
1.1.5 Identify and demonstrate use of fire blankets	I	D	D
1.1.6 Adhere to safety label directions			
1.1.7 Apply specific information found in manuals, charts, and books	I	D	D
1.1.8 Apply appropriate math to solve welding problems; whole numbers, fractions, decimals, and geometry	I	D	D
1.1.9 Express length, area, volume in the metric system			
1.2 Explain and identify proper personal protection used in welding			
1.2.1 Describe welding conditions that require body, foot, hand, ear, eye, face, and head protection	I	D	D
1.2.2 Identify and use appropriate body protection	I	D	D
1.2.3 Identify and use appropriate foot protection	I	D	D
1.2.4 Identify and use appropriate hand protection	I	D	D
1.2.5 Identify and use appropriate ear protection	I	D	D
1.2.6 Identify and use appropriate eye, face, and head protection	I	D	D
1.3 Analyze ways to avoid welding fumes	I	D	D
1.4 Identify causes of accidents and preventative methods			
1.4.1 Define confined spaces			
1.4.2 Emphasize the importance of proper ventilation when welding in a confined space	I	D	D
1.4.3 Emphasize that simple cleaning and housekeeping contribute greatly to area safety	I	D	D

Mandan Public Schools
Welding Technology Curriculum

1.4.4 Define hot work permits and fire watches			
1.4.5 Identify factors requiring a hot work permit and fire watches			
1.4.6 Review the basic safety procedures specific to oxyfuel gas welding	I	D	D
1.4.7 Identify hazards of cutting containers			
1.5 Demonstrate safety techniques for storing and handling cylinders			
1.5.1 Identify the requirements for safe storage and handling of cylinders	I	D	M
1.5.2 Identify the requirements for locating, securing, and identifying cylinder storage	I	D	M
1.5.3 Discuss precautions and procedures specific to valve protection caps	I	M	M
1.5.4 Review the general precautions for working with cylinders	I	M	M
1.5.5 Review the basic safety procedures specific to power tools	I	D	D
1.5.6 Discuss the procedures and precautions for working with electricity and arc-welding equipment	I	D	D
1.6 Identify and explain uses for material safety data sheets	I	D	D
1.6.1 Discuss the purpose of and information available on a material safety data sheet (MSDA).			
1.7 Explain how to avoid electrical shock when welding	I	D	D
1.7.1 Review guidelines for avoiding electric shock			
1.8 Demonstrate proper material handling methods	I	D	D
1.8.1 Explain procedures and precautions for lifting heavy objects	I	D	D
1.8.2 Identify and discuss the elements of an emergency action plan	I	D	M
Standard 2: Welding Symbols			
Recognize welding symbols and interpret meaning	Intro to Welding	Welding I	Welding II
2.1 Identify and explain the various parts of a welding symbol	I	D	D
2.2 Identify and explain fillet and groove weld symbols	I	D	D
2.3 Analyze welding symbols on drawings, specifications, and welding procedure specifications (SPSs)	I	D	D
2.4 Interpret welding symbols from print	I	D	D

Standard 3: Reading Welding Detail Drawings			
Identify, interpret, and practice reading welding detail drawings			
3.1 Identify and explain a welding detail drawing			
3.2 Identify and explain lines, materials fills, and sections			
3.3 Identify and explain object views			
3.4 Identify and explain dimensioning			
3.5 Develop basic welding drawings			
3.6 Identify and explain notes and bill of materials			
Standard 4: Base Metal Preparation	Intro to Welding	Welding I	Welding II
Analyze general information, procedures, and techniques that apply to base metal preparation			
4.1 Clean base metal for welding or cutting	I	D	M
4.1.1 Explain why base metals must be cleaned before welding	I	D	D
4.1.2 Identify types of surface corrosion	I	D	D
4.1.3 Identify defects caused by surface contamination	I	D	D
4.1.4 Discuss proper power tool procedures	I	D	D
4.1.5 Discuss tools and methods used for mechanical cleaning	I	D	D
4.2 Identify and explain joint design			
4.3 Introduce joint preparation and explain how to identify joint specifications			
	0	W	W

Standard 5: Joint Fit-up and Alignment			
Examine codes, procedures, and uses for joint fit-up and alignment			
5.1 Identify and explain job code specifications			
5.2 Explain the uses of fit-up gauges and measuring devices to check joint fit-up			
5.3 Identify and explain how to fit up joints using plate and pipe fit-up tools			
5.4 Identify and explain distortion and how it is controlled	I	D	D
5.5 Identify the steps to check for joint misalignment and poor fit-up before and after welding			
Standard 6: Weld Quality			
Examine codes and practices that apply to weld quality and analyses	Intro to Welding	Welding I	Welding II
6.1 Identify and explain codes governing welding			
6.2 Identify and explain weld imperfections and their causes			
6.2.1 Define discontinuities and list the most common ones			
6.2.2 Discuss the procedures that minimize porosity	I	D	D
6.2.3 Define inclusions and discuss their causes	I	D	D
6.2.4 Define cracks and identify the three basic types that occur in weld metal			
6.2.5 Define base metal cracking and identify basic types			
6.2.6 Define undercut and discuss its causes	I	D	D
6.2.7 Discuss the undesirable effects of arc strikes	I	D	D
6.2.8 Describe the causes of spatter	I	D	D
6.3 Identify and explain nondestructive examination practices			
6.3.1 List basic NDE practices			
6.3.2 Explain the procedures used in visual inspection	I	D	D

6.4 Identify common destructive testing methods	I	D	D
6.5 Identify and explain welder qualification tests			
6.6 Explain the importance of quality workmanship	I	D	D
6.6.1 Emphasize the importance of quality work	I	D	D
6.6.2 Emphasize the need to understand the site organization			
6.6.3 Explain why the welder should follow the chain of command			
Standard 7: Oxyfuel Processes			
Identify and explain equipment, equipment set up, and techniques that apply to oxyfuel processes	Intro to Welding	Welding I	Welding II
7.1 Identify and explain the use of oxyfuel cutting equipment	I	D	D
7.1.1 Explain the purpose and applications of oxyfuel cutting	I	D	D
7.1.2 Review safety guidelines for working with oxyfuel equipment	I	D	D
7.1.3 Discuss procedures for preventing fire and explosions	I	D	D
7.1.4 Emphasize the need for proper ventilation	I	D	D
7.1.5 Discuss the power contained in various explosive mixtures	I	D	D
7.1.6 Summarize the equipment used for oxyfuel cutting	I	D	D
7.1.7 Discuss the properties of oxygen and the use of oxygen cylinders	I	D	D
7.1.8 Emphasize the danger of removing protective caps from cylinders that are not secured	I	D	D
7.1.9 Discuss the properties of acetylene and the use of acetylene cylinders	I	D	D
7.1.10 Discuss the flame temperatures of oxygen with various fuel gasses			
7.1.11 Discuss the uses of and precautions associated with liquefied fuel gas cylinders	I	D	D
7.1.12 Emphasize the danger of applying heat directly to a cylinder or regulator	I	D	D
7.1.13 Explain the purpose and use of regulators	I	D	D
7.1.14 Compare and contrast the two types of regulators			
7.1.15 Identify the guidelines for preventing injury to personnel and damage to regulators	I	D	D
7.1.16 Discuss the purpose and uses of check valves and flashback arrestors	I	D	D
7.1.17 Emphasize the proper use of torch wrenches	I	D	D
7.1.18 Discuss the purpose and use of hoses	I	D	D

Mandan Public Schools
Welding Technology Curriculum

7.1.19 Explain the applications for one-piece & combination cutting torches	I	D	D
7.1.20 Explain the purpose of tip cleaners and tip drills	I	D	D
7.1.21 Emphasize that matches and gas-filled lighters must never be used to light torches	I	D	D
7.1.22 Describe cylinder carts and explain their purposes	I	D	D
7.1.23 Explain how to use a cup-type striker	I	D	D
7.1.24 Demonstrate how to use a soapstone and how to sharpen it	I	D	D
7.2 Identify the steps for set up of oxyfuel equipment	I	D	D
7.2.1 Emphasize the need to handle cylinders carefully	I	D	D
7.2.2 Discuss the ANSI requirements for separating fuel and oxygen cylinders	I	D	D
7.2.3 Point out that an acetylene cylinder found on its side should be up-righted so that acetone can settle	I	D	D
7.2.4 Identify appropriate methods to open valves	I	D	D
7.2.5 Point out that cloths used to wipe valve seats must be free of oil and grease	I	D	D
7.2.6 List the steps that must be followed to attach regulators	I	D	D
7.2.7 List the steps that must be followed to install flashback arrestors and check valves			
7.2.8 Discuss the dangers of flashback	I	D	D
7.2.9 Explain that new hoses contain material that can clog torch needle valves	I	D	D
7.2.10 Emphasize the danger of blowing out hoses with compressed air, fuel, gas, or oxygen	I	D	D
7.2.11 List the steps that must be followed to connect hoses to regulators and torches	I	D	D
7.2.12 List the steps that must be followed to install attachments and cutting tips on torches	I	D	D
7.2.13 Discuss the dangers associated with excessive acetylene flow rates	I	D	D
7.2.14 List the steps that must be followed to close torch valves	I	D	D
7.2.15 Discuss the importance of loosening regulator adjusting screws	I	D	D
7.2.16 List the steps that must be followed to open cylinder valves	I	D	D
7.2.17 List the steps that must be followed to purge torches and set working pressures	I	D	D
7.2.18 Point out that static pressure must not rise to 15 psi if acetylene is used as a fuel gas	I	D	D
7.2.19 Point out that T-wrenches should always be left in place	I	D	D
7.2.20 Emphasize the importance of leak testing	I	D	D

Mandan Public Schools
Welding Technology Curriculum

7.2.21 Identify procedures that help prevent flashback	I	D	D
7.2.22 Emphasize that detergent must not contain oil	I	D	D
7.2.23 Discuss the harmful effects of over tightening connections	I	D	D
7.2.24 Warn the students that explosive concentrations of gases may accumulate if equipment is not purged and leak-testing in a well-ventilated area	I	D	D
7.3 Identify the steps to light and adjust an oxyfuel torch			
7.3.1 Compare and contrast the three types of oxyfuel flames	I	D	D
7.3.2 Define backfire and discuss possible causes	I	D	D
7.3.3 List the steps that must be followed to ignite torches	I	D	D
7.3.4 Identify manufacturer's charts for selecting tips and igniting torches			
7.3.5 Explain how to set maximum fuel flow for the tip size in use	I	D	D
7.3.6 Emphasize proper handling and transportation of cylinders	I	D	M
7.3.7 Point out that fuel gas and oxygen cylinders must never be stored together	I	D	D
7.4 Identify the steps to shut down and disassemble oxyfuel cutting equipment			
7.4.1 Demonstrate how to shut down oxyfuel cutting equipment	I	D	M
7.4.2 Demonstrate how to disassemble oxyfuel cutting equipment	I	D	M
7.4.3 Point out that permanent markers should not be used on cylinders			
7.4.4 Demonstrate how to change empty cylinders			
7.4.5 Emphasize proper handling and transportation of cylinders	I	D	M
7.5 Perform oxyfuel cutting, heating, and welding			
7.5.1 Summarize the cutting procedures	I	D	D
7.5.2 Describe the features of good and bad cuts	I	D	D
7.5.3 Discuss the causes of bad cuts	I	D	D
7.5.4 Emphasize the importance of properly laying out and marking cuts	I	D	M
7.5.5 Summarize the procedures for cutting thin and thick steel	I	D	D
7.5.6 Emphasize the dangers of holding the tip upright when cutting thin steel			
7.5.7 Summarize the procedures for piercing a plate	I	D	D
7.5.8 Summarize the procedures for cutting bevels	I	D	D
7.5.9 Summarize the procedures for performing washing	I	D	D
7.5.10 Summarize the procedures for performing gouging	I	D	M
7.5.11 Explain why the torch angle and travel speed are critical for performing gouging	I	D	M

Mandan Public Schools
Welding Technology Curriculum

7.5.12 Preheat metal for specific application	I	D	M
7.5.13 Post heat metal for a specific application/stress relief	I	D	M
7.5.14 Pierce holes and cut slots	I	D	M
7.5.15 Cut 90 degree and beveled edges on mild steel plate	I	D	M
7.5.16 Cut circles free hand and with guide	I	D	D
7.5.17 Layout, cut, and fit plate, and structural shapes	I	D	M
7.5.18 Select welding/brazing rod for specific application	I	D	M
7.5.19 Run ripple bead without filler metal in flat position	I	D	M
7.5.20 Run stringer bead without filler metal in flat position	I	D	M
7.5.21 Run stringer bead and joints with filler metal in flat position	I	D	M
7.5.22 Run stringer bead and joints with filler metal in horizontal position	I	D	D
7.5.23 Run stringer bead and joints with filler metal in vertical position	I	D	D
7.5.24 Run stringer bead and joints with filler metal in overhead position	I	D	D
7.5.25 Braze carbon steel	I	D	D
7.5.26 Braze cast iron	I	D	D
7.5.27 Layout, cut, and fit pipe	I	D	D
7.6 Operate a motorized, portable oxyfuel gas cutting machine			
7.6.1 Summarize the procedures for performing straight line cutting and bevel cutting with an oxyfuel cutting machine	I	D	M
Standard 8: Plasma Arc Cutting (PAC)			
Understand the set up, processes, and maintenance of plasma arc cutting (PAC) equipment and procedures	Intro to Welding	Welding I	Welding II
8.1 Identify and understand PAC processes	I	D	D
8.2 Identify PAC equipment	I	D	D
8.3 Identify steps to prepare and set up PAC equipment	I	D	D
8.4 Use PAC equipment to make various types of cuts	I	D	D
8.5 Identify the process to properly store equipment and clean the work area after use	I	D	D

<p>Standard 9: Air Carbon Arc Cutting and Gouging</p> <p>Identify the steps for installation, preparation, and operation of air carbon arc cutting and gouging equipment</p>	Intro to Welding	Welding I	Welding II
9.1 Identify and explain the air carbon arc cutting (CAC-A) process and equipment			
9.2 Identify steps to select and install CAC-A electrodes			
9.3 Identify steps to prepare the work area and CAC-A equipment for safe operation			
9.4 Use CAC-A equipment for washing and gouging activities			
<p>Standard 10: Shielded Metal Arc Welding (SMAW) – Equipment and Setup</p> <p>Identify and explain equipment, equipment set up, and electrical current that apply to shielded metal arc welding</p>	Intro to Welding	Welding I	Welding II
10.1 Identify factors that affect electrode selection			
10.1.1 Explain how SMAW is performed	I	D	D
10.1.2 Discuss the welding current and arc	I	D	D
10.1.3 Discuss the significance of work lead location during welding	I	D	D
10.1.4 Explain the types of welding for which AC and DC current are used	I	D	D
10.1.5 Compare and contrast the two general methods for striking an arc	I	D	D
10.1.6 Compare and contrast AC and DC power	I	D	D
10.1.7 Define polarity and point out that it only applies to DC current	I	D	D
10.1.8 Discuss the welding heating effect caused by polarity	I	D	D
10.2 Identify and explain welding electrical current			
10.2.1 Explain how the voltage in welding machines is stepped down			
10.2.2 Define and discuss voltage	I	D	D
10.2.3 Define and discuss amperage	I	D	D

Mandan Public Schools
Welding Technology Curriculum

10.3 Identify and explain arc welding machines			
10.3.1 Explain how SMAW machine ratings are determined	I	D	D
10.3.2 Describe the operation of circuit breakers in welding machines			
10.3.3 Describe the construction of welding cables			
10.3.4 Explain the problems that occur if welding cables are equipped			
10.4 Explain setting up engine driven arc welding equipment			
10.5 Identify and explain tools for weld cleaning			
10.5.1 List typical preventative maintenance tasks	I	D	D
10.5.2 Provide examples of hand tools used in cleaning welds	I	D	D
Standard 11: Shielded Metal Arc Welding (SMAW) – Electrodes and Selection Identify and explain classifications and electrode selection for shielded metal arc welding	Intro to Welding	Welding I	Welding II
11.1 Identify factors that affect electrode selection			
11.1.1 Discuss the function of electrodes in SMAW	I	D	D
11.2 Explain the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME) filler metal classification system			
11.2.1 Explain that the AWS A5.XX series of specification is used in all major welding codes and industries, except where other approvals are specified			
11.2.2 Discuss the purpose of the specifications	I	D	D
11.2.3 Explain the electrode classification system	I	D	D
11.2.4 Discuss mild steel electrode characteristics	I	D	D
11.2.5 Point out that SMAW electrodes are sized by wire core diameter	I	D	D
11.2.6 Explain how to interpret electrode markings	I	D	M
11.3 Identify and select the proper electrode for an identified welding task.			

11.3.1 List the four groups of electrodes	I	D	D
11.4 Identify different types of filler metals			
11.4.1 Explain that the filler metal should be compatible with the base metal	I	D	D
11.4.2 Discuss the ways in which base metal thickness, base metal surface conditions, welding position, joint design, and welding current affect electrode selection	I	D	D
11.5 Explain the storage and control of filler metals	I	D	D
11.5.1 Explain the code requirements for handling and storage of electrodes			
11.5.2 Explain how to inspect filler metals as it is received			
11.5.3 Describe the requirements for storing filler metal	I	D	
11.5.4 Explain the purpose of electrode storage ovens	I	D	
11.5.5 Discuss the electrode exposure times			
11.5.6 Describe guidelines for drying electrodes			
11.6 Explain filler metal traceability requirements and how to use applicable code requirements			
<p>Standard 12: Shielded Metal Arc Welding (SMAW) – Electrodes and Selection</p> <p>Identify and explain methods, complications, preventative measures, and techniques that apply to bead and fillet welds</p>	Intro to Welding	Welding I	Welding II
12.1 Identify steps to set up SMAW equipment	I	D	D
12.1.1 List the steps that must be followed to set up arc welding equipment	I	D	D
12.1.2 List the steps that must be followed to prepare a machine for welding	I	D	M
12.1.3 Discuss the amperages used for electrode types and sizes	I	D	M
12.2 Describe the method of striking and extinguishing an arc	I	D	D
12.2.1 Explain the scratching method for striking an arc	I	D	M
12.2.2 Explain the tapping method of striking an arc	I	D	M
12.2.3 Demonstrate setting up welding equipment	I	D	M
12.2.4 Explain that striking arcs with low hydrogen electrodes is more difficult than with most other electrodes	I	D	D
12.2.5 Demonstrate how to accurately tap strike an electrode	I	D	D
12.3 Describe cause of arc blow and wander			

Mandan Public Schools
Welding Technology Curriculum

12.3.1 Explain the causes and effects of arc blow	I	D	D
12.4 Perform stringer, weave, and overlapping beads			
12.4.1 Define stringer and weave beads	I	D	D
12.4.2 Point out that the WPS must be followed when making stringer and weave beads	I	D	D
12.4.3 Discuss solutions to arc shifting or arc wander			
12.4.4 Demonstrate the whipping or stepping motion used to control the weld puddle when depositing stringer beads	I	D	M
12.4.5 Point out that face shields must be worn to prevent injury from hot Slag	I	D	M
12.4.6 Define the mnemonic LASH (length & angle, speed, heat) or CALS (current setting, angle of electrode, length of arc, speed of travel)	I	D	D
12.4.7 Identify the steps that must be followed to make a restart	I	D	D
12.4.8 point out that a termination leaves a crater and explain how to fill it	I	D	D
12.4.9 Describe how to tack-weld tabs to a workpiece to eliminate welding starting and stopping points			
12.4.10 Demonstrate how to make weave beads using an E6010 or E6011, E7014, E0718, E7024 electrode per position	I	D	D
12.4.11 Discuss proper weave bead width	I	D	D
12.5.12 Describe how overlapping beads are made	I	D	D
12.5.13 Demonstrate how to make overlapping beads using an E6010 or E6011, E7018, E7024 per position	I	D	D
12.5.14 Demonstrate how to make stringer beads using an E6010 or E6011, E7018, E7024 per position	I	D	D
12.5 Perform fillet welds in the 2F, 3F, and 4F positions	I	D	D
12.5.1 Discuss the two types of fillet welds	I	D	D
12.5.2 Demonstrate the difference between equal and unequal leg fillet welds	I	D	D
12.5.3 Emphasize that the site WPS must be followed for fillet welds	I	D	D
12.5.4 Discuss weld stresses and fillet weld contours			
12.5.5 Demonstrate how to make fillet welds in the 2F (horizontal) position with an E6010 or E6011, E7014, E7018, E7024 electrode	I	D	D
12.5.6 Demonstrate how workpieces are tacked together properly	I	D	D
12.5.7 Discuss heat loss in T-joints			
12.5.8 Point out that the most common defect for T-joints is undercut on the vertical plate	I	D	M

Standard 13: Shielded Metal Arc Welding (SMAW) – Beads and Fillet Welds Explain and practice methods and positions for groove welds with backing	Intro to Welding	Welding I	Welding II
13.1 Identify and explain groove welds	I	D	D
13.2 Identify the steps to set up shielded metal arc welding (SMAW) equipment for making V-groove welds	I	D	D
13.3 Perform SMAW for V-groove welds with backing in the 1G, 2G, 3G, and 4G positions	I	D	M
Standard 14: Shielded Metal Arc Welding (SMAW) – Groove Welds with Backing Identify procedures to prepare and perform open V-groove welds	Intro to Welding	Welding I	Welding II
14.1 Identify the steps to prepare SMAW equipment for open v-groove welds	I	D	D
14.2 Identify the steps and perform open-root V-groove welds in G1, G2, G3, and 4G positions	I	D	M
Standard 15: Gas Metal Arc Welding (GMAW) – Equipment and Filler Metals Explain the equipment and filler metals that apply to gas metal arc welding	Intro to Welding	Welding I	Welding II
15.1 Explain GMAW safety	I	D	D
15.2 Explain the characteristics of welding current and power sources	I	D	D
15.3 Identify and explain the use of GMAW equipment	I	D	M
15.4 Identify and explain the use of GMAW shielding gases and filler metals	I	D	M
15.5 Identify the steps to set up GMAW equipment and identify tools for weld cleaning	I	D	D

Standard 16: Gas Metal Arc Welding (GMAW) - Plate Identify and explain the equipment and weld types that apply to gas metal arc welding	Intro to Welding	Welding I	Welding II
16.1 Identify and explain GMAW equipment set up	I	D	D
16.2 Identify and demonstrate bead types	I	D	M
16.3 Identify and explain fillet welds	I	D	M
16.4 Identify and explain open-root V-groove welds	I	D	D
Standard 17: Flux Core and/or Metal Core Wire (FCAW) – Equipment and Filler Metals Explain the equipment and filler metals that apply to flux cored arc welding	Intro to Welding	Welding I	Welding II
17.1 Explain FCAW safety			
17.2 Explain the characteristics of welding current and power sources			
17.3 Identify and explain the use of FCAW equipment			
17.4 Identify and explain the use of FCAW shielding gases and filler metals			
17.5 Identify the steps to set up FCAW equipment and identify tools for weld cleaning			
Standard 18: Flux Core and/or Metal Core Wire (FCAW) - Plate Identify and explain the equipment and weld types that apply to flux cored arc welding	Intro to Welding	Welding I	Welding II
18.1 Identify and explain FCAW equipment set up			
18.2 Identify and demonstrate bead types			
18.3 Identify and explain fillet welds			
18.4 Identify and explain open-root V-groove welds			

<p>Standard 19: Gas Tungsten Arc Welding (GTAW) – Equipment and Filler Materials</p> <p>Explain the equipment and filler materials that apply to gas tungsten arc welding</p>	Intro to Welding	Welding I	Welding II
19.1 Explain GTAW safety			I/D
19.2 Identify and explain the use of GTAW equipment			I/D
19.3 Identify and explain the use of GTAW filler metals			I/D
19.4 Identify steps to set up GTAW equipment			I/D
<p>Standard 20: Gas Tungsten Arc Welding (GTAW) – Plate</p> <p>Identify and explain the equipment and weld types that apply to gas tungsten arc welding</p>	Intro to Welding	Welding I	Welding II
20.1 Identify and explain the use of GTAW techniques			
20.2 Identify and explain bead types			
20.3 Identify and explain groove and open V-groove welds			
<p>Standard 21: Gas Tungsten Arc Welding (GTAW) – Aluminum Plate</p> <p>Identify and explain the equipment, characteristics, and weld types that apply to gas tungsten arc welding when using aluminum</p>	Intro to Welding	Welding I	Welding II
21.1 Identify and explain aluminum metallurgy			
21.2 Explain and identify characteristics of aluminum			
21.3 Explain GTAW and set up equipment to weld aluminum plate			
21.4 Explain and practice GTAW techniques for plate, including padding in the flat position with stringer beads, using aluminum filler metal			
21.5 Make fillet welds on aluminum plate in 1F, 2F, 3F, and 4F positions			
21.6 Make multi-pass open V-groove welds with backing on aluminum plate in the 1G, 2G, 3G, and 4G positions			

Standard 22: Shielded Metal Arc Welding (SMAW) – Open-Root Pipe Welds Identify procedures and techniques that apply to open-root pipe welds	Intro to Welding	Welding I	Welding II
22.1 Identify and explain how to prepare arc welding equipment for open-root pipe welds			
22.2 Identify and explain open-root V-groove pipe welds			
Standard 23: Shielded Metal Arc Welding (SMAW) – Stainless Steel Groove and Pipe Welds Explain the preparation, processes, and positions of stainless steel groove pipe welds	Intro to Welding	Welding I	Welding II
23.1 Identify and explain stainless steel metallurgy			
23.2 Identify and explain the selection of electrodes for welding stainless steel			
23.3 Identify and explain welding variation for stainless steel			
23.4 Identify the steps to prepare arc welding equipment for stainless steel welds			
23.5 Explain stainless steel open-root V-groove welds			
23.6 Demonstrate SMAW on stainless steel open-root V-groove joints in 1G, 2G, 3G, and 4G positions			
23.7 Explain stainless steel open-root V-groove pipe welds			
23.8 Demonstrate SMAW on stainless steel open-root V-groove pipe welds in 1G-Rotated, 2G, 5G, and 6G positions			
Standard 24: Fabrication Identify and practice basic fabrication skills	Intro to Welding	Welding I	Welding II
24.1 Identify basic concepts of fabrication	I	D	D

Mandan Public Schools
Welding Technology Curriculum

Standard 25: Metallurgy Recognize and use principles of metallurgy	Intro to Welding	Welding I	Welding II
25.1 Identify basic concepts of metallurgy	I	D	D

Course Description and Course Outline

Introduction to Welding

Course Description

Grade:	10 thru 12
Term:	2 semesters / 1 class period per day
Credits:	1
Prerequisite:	None

Course Description: This course provides the exploration, study and hands on exploration of metal working and joining. Students will study the occupations through use of a textbook and visiting related sites on field trips. Textbook studies are reinforced with hands on activities of sheet metal work, threading, sand casting, use of hand tools, shop machines, (OAW) Oxy-Acetylene welding, (SMAW) Shielded Metal Arc Welding, (GMAW) Gas Metal Arc Welding, (OAC) Oxy-Acetylene Cutting, and (PAC) Plasma Arc Cutting. Activities are conducted in a teamwork environment.

I- Introduce

D- Develop

M- Master

Course Outline

The student will learn:

Orientation

- I Metals technology occupations
- I Metal shop task chart
- I Shop and classroom rules
- I Materials Safety Data Sheets
- I Work ethics
- I Metallurgy
- I Metals we use
- I Understanding drawings
- I Measurement

- I Layout work
- I Hand tools
- I Hand tools that cut
- I Hand threading
- I Fasteners
- I Welding
- I Heat treatment of metal
- I Metal finishes
- I Grinding
- I Drills and drilling machines
- I Power sawing
- I Quality control

Safety

I D M	Weld shop safety
I D M	Power tool safety
I D M	Shielded metal arc welding safety
I D M	Gas metal arc welding safety
I D M	Oxy-Acetylene cutting and welding safety
I D M	Material handling safety
I D M	Drill press safety
I D M	Ironworker safety
I D M	Grinder safety
I D M	Band saw safety

Purpose of course

- I D M Shop and tool safety
- I D M Work ethics are acquired through punctuality and time management
- I D Metal working career exploration through use of the textbook and field trips
- I D M Measuring using rulers, micrometers and calipers in hands on activities
- I D M Identification and proper use of hand tools
- I D M Identification and proper use of hand tools that cut
- I D Metal threading including internal and external threads and identifying national coarse and national fine fractional threads and metric threads, with hands on activities to reinforce learning.
- I D Exploring sheet metal occupation and joining of sheet metal with the use of seams, with hands on activities to reinforce learning using bar folders to hem, forming roll to roll sheet metal, break to from bends, and squaring shears to cut sheet metal.
- I D Exploring sand casting and foundry work careers through field trips, hands on preparation of the mold, operating the furnace, pouring the mold and finishing the casting.
- I D Knowledge for equipment setup and trouble shoot problems in oxy-acetylene welding.
- I D Oxy-acetylene welding building a weld pad in the 1F and 2F positions using ER70S filler metal.
- I D Knowledge for equipment setup and trouble shoot problems in shielded metal arc welding using E6011 electrodes.
- I D Shielded metal arc welding building a weld pad in the 1F and 2F positions using E6011 electrodes.
- I D Knowledge for equipment setup and trouble shoot problems in shielded metal arc welding using E6013 electrodes.
- I D Shielded metal arc welding building a weld pad in the 1F and 2F positions using E6013 electrodes.
- I D Knowledge for equipment setup and trouble shoot problems in gas metal arc welding using ER70S filler wire.
- I D Gas metal arc welding, building a weld pad in the 1F and 2F positions using ER70S filler metal.
- I D Knowledge for setup of a power saw and safe use in hands on activities using the power saw.

Mandan Public Schools
Welding Technology Curriculum

- I D Knowledge for setup and safe use of hand drills and a drill press while conducting hands on activities.
- I D Knowledge for setup and safe use of hand grinders and bench grinders while conducting hands on activities.
- I D Layout work is experienced through a final project in which the student is required to design and build a final project using the skills acquired throughout the course.

Resources Required

- Modern Metalworking textbook by John R. Walker
- Instructional videos
 - Shielded Metal Arc Welding
 - Oxy-Acetylene Welding
 - Oxy-Acetylene Cutting
 - Gas Metal Arc Welding
 - Flux Core Arc Welding
 - Plasma Arc Cutting

- E6011 electrodes
- E6013 electrodes
- 3/32" ER70S wire
- 1/8" ER70S wire
- ER70S .035 diameter wire
- Plasma arc cutting supplies
- Oxy-Acetylene cutting tips
- Oxy-Acetylene welding tips
- 1/4" mild steel sheet steel
- 16 gauge mild steel sheet steel
- 22 gauge galvanized sheet metal
- Transportation for field trips to related sites

Welding Technology I Curriculum

Course Description

Grade:	11 & 12
Term:	2 Semesters / 2 class periods per day
Credits:	2
Prerequisite:	None

Course Description: This course provides the study and hands on skills in joining metal. Related areas covered are tool and equipment safety, theory of the welding processes, equipment set-up, corrective actions on identified welding problems, operation of metal shop equipment, basic welding skills and print reading. Hands on activities include Plasma Arc Cutting (PAC), Oxy-Acetylene Cutting (OAC), and building weld pads and weld joints in Oxy-Acetylene Welding (OAW), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW). Activities are conducted in a teamwork environment. Leadership skills are introduced through Skills USA a student vocational organization. This course is the prerequisite for Welding Technology II.

Course Outline

I- Introduce D- Develop M- Master

The student should:

Orientation

- I The welding occupation
- I Employers who employ welders
- I Job seeking skills
- I Weld shop task chart
- I Welding competency ratings
- I Skills USA
- I Weld shop and classroom rules
- I Materials Safety Data Sheets
- I Competency profile folder

- I Work ethics
- I Print reading
- I Preparation for fabrication
- I Metallurgy

Safety

I D M	Weld shop safety
I D M	Power tool safety
I D M	Shielded metal arc welding safety
I D M	Gas metal arc welding safety
I D M	Oxy-Acetylene cutting and welding safety
I D M	Material handling safety
I D M	Drill press safety
I D M	Ironworker safety
I D M	Grinder safety
I D M	Band saw safety

Purpose of course

I D M	Shop and tool safety
I D M	Work ethics
I D M	Measuring using rulers, micrometers and calipers in hands on activities
I D M	Identification and proper use of hand tools
I D M	Identification and proper use of hand tools that cut
I D M	Job seeking skills assembling a resume and completing job applications
I D M	Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E6010 electrodes
I D M	Shielded metal arc welding building a pad with E6010 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Shielded metal arc welding on edge, tee, butt, corner and lap joints with E6010 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7014 electrodes
I D M	Shielded metal arc welding building a pad with E7014 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7014 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7018 electrodes
I D M	Shielded metal arc welding building a pad with E7018 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7018 electrodes in the 1F, 2F, 3F, and 4F positions
I D M	Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7024 electrodes
I D M	Shielded metal arc welding building a pad with E7024 electrodes in the 1F and 2F positions

Mandan Public Schools
Welding Technology Curriculum

- I D M Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7024 electrodes in the 1F and 2F positions
- I D M Knowledge for equipment setup and trouble shoot problems in oxy-acetylene welding with ER70-S filler metal
- I D M Oxy-Acetylene welding building a pad with ER70-s filler metal in the 1F, 2F, 3F, and 4F positions
- I D M Oxy-Acetylene welding on edge, tee, butt, corner and lap joints with ER70-s filler metal in the 1F, 2F, 3F, and 4F positions
- I D M Knowledge for equipment setup and trouble shoot problems in shielded metal arc with ER70-S .035 wire using 25% argon and 75% carbon dioxide shielding gas
- I D M Gas metal arc welding building a pad with ER70-S .035 wire in the 1F, 2F, 3F, and 4F positions
- I D M Gas metal arc welding on edge, tee, butt, corner and lap joints with ER70-S .035 wire in the 1F, 2F, 3F, and 4F positions
- I D M Knowledge for equipment setup and trouble shoot problems in flux core arc welding with E7100-T wire using 25% argon and 75% carbon dioxide shielding gas
- I D M Flux core arc welding building a pad with E7100-T dual shield wire in the 1F, 2F, 3F, and 4F positions
- I D M Flux core arc welding on edge, tee, butt, corner and lap joints with E7100-T dual shield wire in the 1F, 2F, 3F, and 4F positions
- I D M Knowledge for equipment setup and trouble shoot problems in gas tungsten arc welding with ER70-S filler wire using 100% argon shielding gas
- I D M Gas tungsten arc welding building a pad with ER70-S filler wire using 100% argon shielding gas in the 1F, 2F, 3F, and 4F positions
- I D M Gas tungsten arc welding on edge, tee, butt, corner and lap joints with ER70-S filler wire using 100% argon shielding gas in the 1F, 2F, 3F, and 4F positions
- I D M Knowledge for equipment setup and trouble shoot problems in oxy-acetylene brazing
- I D M Oxy-Acetylene brazing building a pad with flux coated brass filler metal in the 1F, 2F, 3F, and 4F positions
- I D M Oxy-Acetylene brazing on edge, tee, butt, corner and lap joints with flux coated brass filler metal in the 1F, 2F, 3F, and 4F positions

Mandan Public Schools
Welding Technology Curriculum

- I D M Knowledge for equipment setup and trouble shoot problems in oxy-acetylene cutting
- I D M Oxy-Acetylene cutting circles, shapes, bevels, and gouging
- I D M Knowledge for equipment setup and trouble shoot problems in plasma arc cutting
- I D M Plasma arc cutting circles, shapes, and bevels
- I D M Knowledge for equipment setup and trouble shoot problems in carbon arc cutting with air
- I D M Carbon arc cutting circles, shapes, bevels and gouging
- I D M Print reading knowledge
- I D M Metal preparation for fabrication
- I D M Knowledge of metallurgy

Resources Required

- American Welding Society Certified Welding Inspector Instructor Certification
- National Center for Construction Education and Research
 - Industrial Welding Level 1 Instructors Guide
 - Industrial Welding Level 1 Trainees Guide
- Welding curriculum guide for each student
- Instructional videos
 - Shielded Metal Arc Welding
 - Oxy-Acetylene Welding
 - Oxy-Acetylene Cutting
 - Gas Metal Arc Welding
 - Flux Core Arc Welding
 - Plasma Arc Cutting

- E6010 electrodes
- E7014 electrodes
- E7018 electrodes
- E7024 electrodes
- 3/32" ER70S wire
- 1/8" ER70S wire
- 1/8" flux coated brazing wire
- 1/8" bare brass wire
- ER70S .035 diameter wire
- E7100T .045 flux core dual shield wire
- 1/8" 2% thoriated tungsten
- 3/32" ER308 wire
- 1/8" ER308 wire
- 1/4" carbon arc rods
- Plasma arc cutting supplies
- Oxy-Acetylene cutting tips
- Oxy-Acetylene welding tips
- 1/4" mild steel sheet steel
- 3/8" mild steel sheet steel
- Transportation for field trips to related sites

Welding Technology II Curriculum

Course Description

Grade:	11 & 12
Term:	2 Semesters / 2 class periods per day
Credits:	2
Prerequisite:	Welding Technology I

Course Description: This course provides the study and hands on skills in joining metal. Related areas covered are tool and equipment safety, theory of the welding processes, equipment set-up, corrective actions on identified welding problems, operation of metal shop equipment, welder certification which conforms to American Welding D1.1 welding code and print reading. Hands on activities include Plasma Arc Cutting (PAC), Oxy-Acetylene Cutting (OAC), and performing certification tests and weld joints in Oxy-Acetylene Welding (OAW), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW). Activities are conducted in a teamwork environment. Leadership skills are introduced through Skills USA, a student vocational organization. The prerequisite for this course is Welding Technology I.

Course Outline

I- Introduce D- Develop M- Master

The student should:

Orientation

- I The welding occupation
- I Employers who employ welders
- I Job and shop safety
- I Job seeking skills
- I Weld shop task chart
- I Welding competency ratings
- I Skills USA

- I Weld shop and classroom rules
- I Materials Safety Data Sheets
- I Competency profile folder
- I Work ethics
- I Print reading
- I Preparation for fabrication
- I Metallurgy

Safety

I D M	Weld shop safety
I D M	Power tool safety
I D M	Shielded metal arc-welding safety
I D M	Gas metal arc-welding safety
I D M	Oxy-Acetylene cutting and welding safety
I D M	Material handling safety
I D M	Drill press safety
I D M	Ironworker safety
I D M	Grinder safety
I D M	Band saw safety

Purpose of course

- D M Shop and tool safety
- D M Work ethics
- D M Job seeking skills assembling a resume and completing job applications
- D M Measuring using rulers, micrometers and calipers in hands on activities
- D M Identification and proper use of hand tools
- D M Identification and proper use of hand tools that cut
- D M Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E6010 electrodes
- D M Shielded metal arc welding on edge, tee, butt, corner and lap joints with E6010 electrodes in the 1F, 2F, 3F, and 4F positions
- D M Shielded metal arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with E6010 electrodes in the 1G, 2G, 3G, and 4G positions
- D M Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7014 electrodes
- D M Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7014 electrodes in the 1F, 2F, 3F, and 4F positions
- D M Shielded metal arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with E7014 electrodes in the 1G, 2G, 3G, and 4G positions
- D M Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7018 electrodes
- D M Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7018 electrodes in the 1F, 2F, 3F, and 4F positions
- D M Shielded metal arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with E7018 electrodes in the 1G, 2G, 3G, and 4G positions

Mandan Public Schools
Welding Technology Curriculum

- D M Knowledge for equipment setup and trouble shoot problems in shielded metal arc with E7024 electrodes
- D M Shielded metal arc welding on edge, tee, butt, corner and lap joints with E7024 electrodes in the 1F and 2F positions
- D M Shielded metal arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with E7024 electrodes in the 1G and 2G positions
- D M Knowledge for equipment setup and trouble shoot problems in oxy-acetylene welding with ER70-S filler metal
- D M Oxy-Acetylene welding on edge, tee, butt, corner and lap joints with ER70-s filler metal in the 1F, 2F, 3F, and 4F positions
- D M Oxy-Acetylene welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with ER70-S filler metal in the 1G, 2G, 3G, and 4G positions
- D M Knowledge for equipment setup and trouble shoot problems in gas metal arc welding with ER70-S .035 wire using 25% argon and 75% carbon dioxide shielding gas
- D M Gas metal arc welding on edge, tee, butt, corner and lap joints with ER70-S .035 wire in the 1F, 2F, 3F, and 4F positions
- D M Gas metal arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with ER70-S wire in the 1G, 2G, 3G, and 4G positions
- D M Knowledge for equipment setup and trouble shoot problems in flux core arc welding with E7100-T wire using 25% argon and 75% carbon dioxide shielding gas
- D M Flux core arc welding on edge, tee, butt, corner and lap joints with E7100-T dual shield wire in the 1F, 2F, 3F, and 4F positions
- D M Flux core arc welding performing a weld certification bend test that conforms to American Welding Society code D1.1 with E7190-T wire in the 1G, 2G, 3G, and 4G positions
- D M Knowledge for equipment setup and trouble shoot problems in gas tungsten arc welding with ER70-S filler wire using 100% argon shielding gas
- D M Gas tungsten arc welding on edge, tee, butt, corner and lap joints with ER70-S filler wire using 100% argon shielding gas in the 1F, 2F, 3F, and 4F positions
- D M Gas tungsten arc welding performing a weld certification bend test that conform to American Welding Society code D1.1 with ER70-S wire using 100% argon shielding gas in the 1G, 2G, 3G, and 4G positions

Mandan Public Schools
Welding Technology Curriculum

- D M Knowledge for equipment setup and trouble shoot problems in oxy-acetylene cutting
- D M Oxy-Acetylene cutting circles, shapes, bevels, and gouging
- D M Knowledge for equipment setup and trouble shoot problems in plasma arc cutting
- D M Plasma arc cutting circles, shapes, and bevels
- D M Knowledge for equipment setup and trouble shoot problems in carbon arc cutting with air
- D M Carbon arc cutting circles, shapes, bevels and gouging
- D M Print reading knowledge while fabricating projects using drawing
- D M Metal preparation for fabrication
- D M Knowledge of metallurgy used in annealing, normalizing and tempering

Resources Required

- American Welding Society Certified Welding Inspector Instructor Certification
- National Center for Construction Education and Research
 - Industrial Welding Level 1 Instructors Guide
 - Industrial Welding Level 1 Trainees Guide
- Welding curriculum guide for each student
- Instructional videos
 - Shielded Metal Arc Welding
 - Oxy-Acetylene Welding
 - Oxy-Acetylene Cutting
 - Gas Metal Arc Welding
 - Flux Core Arc Welding
 - Plasma Arc Cutting

- E6010 electrodes
- E7014 electrodes
- E7018 electrodes
- E7024 electrodes
- 3/32" ER70S wire
- 1/8" ER70S wire
- 1/8" flux coated brazing wire
- 1/8" bare brass wire
- ER70S .035 diameter wire
- E7100T .045 flux core dual shield wire
- 1/8" 2% thoriated tungsten
- 3/32" ER308 wire
- 1/8" ER308 wire
- 1/4" carbon arc rods
- Plasma arc cutting supplies
- Oxy-Acetylene cutting tips
- Oxy-Acetylene welding tips
- 1/4" mild steel sheet steel
- 3/8" mild steel sheet steel
- Transportation for field trips to related sites

Appendix A

21st Century Skills – 12th Grade

The Partnership for 21st Century Skills organization in cooperation with the National Council of Teachers of English developed a 21st Century Skills Map. The 21st Century Skills Map has so far been developed at grades 4, 8, and 12.

We did an alignment between the 21st Century Skills Map and Mandan Public Schools' Welding Curriculum. Not all of the 21st Century Skills are addressed by Mandan Public Schools' Welding Curriculum. However, some of the skills may also be addressed by other curriculums in Mandan Public Schools. This match is a guide to assist us in the identification of which 21st Century Skills align to specific benchmarks in each grade. If someone else did the match, we would expect slightly different results.

We numbered the 12 broad 21st Century Skills 1-12. In front of each 21st Century Skill is a digit which indicates the grade level at which the 21st Century Skill was developed. Each of these 12 skills has 1 or more sub-skills. We numbered the sub-skills with a decimal point followed by another digit in numerical sequence.

The numbers in parenthesis below the 21st Century sub-skills refer to Mandan Public Schools' Welding Curriculum. The first digit in parenthesis refers to the grade level. The second digit in the parenthesis refers to the standard. The third digit in parenthesis refers to the benchmark.

It is important that these 21st Century Skills be addressed by the various components of the school curriculum. As new state standards and benchmarks are developed, we hope that they will address the 21st Century Skills.

12.1 Creativity and Innovation

12.1.1 Develop and communicate new ideas to others
(3.1; 3.2; 3.3; 3.4; 3.5; 3.6)

12.1.2 Demonstrate originality and inventiveness in work
(3.5)

12.1.3 Act on creative ideas to make a tangible and useful contribution to the domain in which the innovation occurs

12.2 Critical Thinking & Problem Solving

12.2.1 Frame, analyze and synthesize information in order to solve problems and answer questions
(1.3; 2.3)

12.2.2 Identify and ask significant questions that clarify various points of view

12.2.3 Exercise sound reasoning in understanding
(4.1.1; 5.1; 5.2; 5.3; 5.4; 5.5; 6.1; 6.2; 6.3; 7.1; 10.1.1; 10.1.4; 10.1.5; 10.1.6; 13.1; 15.3; 15.4; 16.3; 16.4; 17.3; 17.4; 18.1; 18.3; 18.4; 19.2; 19.3; 20.1; 20.2; 20.3; 21.1; 21.3; 21.4; 22.1; 22.2; 23.1; 23.2)

12.3 Communication

12.3.1 Articulate thoughts clearly and effectively through writing, speaking, and multimedia

12.3.2 Articulate thoughts clearly and effectively through writing

12.4 Collaboration

12.4.1 Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal

12.4.2 Assume shared responsibility for collaborative work

12.4.3 Demonstrate the ability to work effectively with diverse teams

12.5 Information Literacy

12.5.1 Possess and share a fundamental understanding of the ethical/legal issues surrounding the access and use of information

12.5.2 Use information accurately and creatively for the issue or problem at hand

12.6 Media Literacy

12.6.1 Understand how media messages are constructed, for what purposes and using which tools, characteristics and conventions

12.7 ICT Literacy

12.7.1 Use technology as a tool to research, organize, evaluate and communicate information, and possess a fundamental understanding of the ethical/legal issues surrounding the access and use of information

12.7.2 Use technology as a tool to communicate information

12.7.3 Use digital technology, communication tools and/or networks appropriately to integrate, evaluate, and create information

12.8 Flexibility & Adaptability

12.8.1 Work effectively in a climate of ambiguity and changing priorities

12.9 Initiative & Self-Direction

12.9.1 Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise

12.9.1 Demonstrate commitment to learning as a lifelong process

12.10 Social & Cross-Cultural Skills

12.10.1 Bridge cultural differences and use differing perspectives to increase innovation and the quality of work (6.6.1)

12.10.2 Leverage the collective intelligence of groups when appropriate

12.11 Productivity & Accountability

12.11.1 Demonstrate diligence and a positive work ethic (e.g., being punctual and reliable).
(6.6.1)

12.12 Leadership & Responsibility

12.12.1 Act responsibly with the interests of the larger community in mind
(6.6.2; 6.6.3)