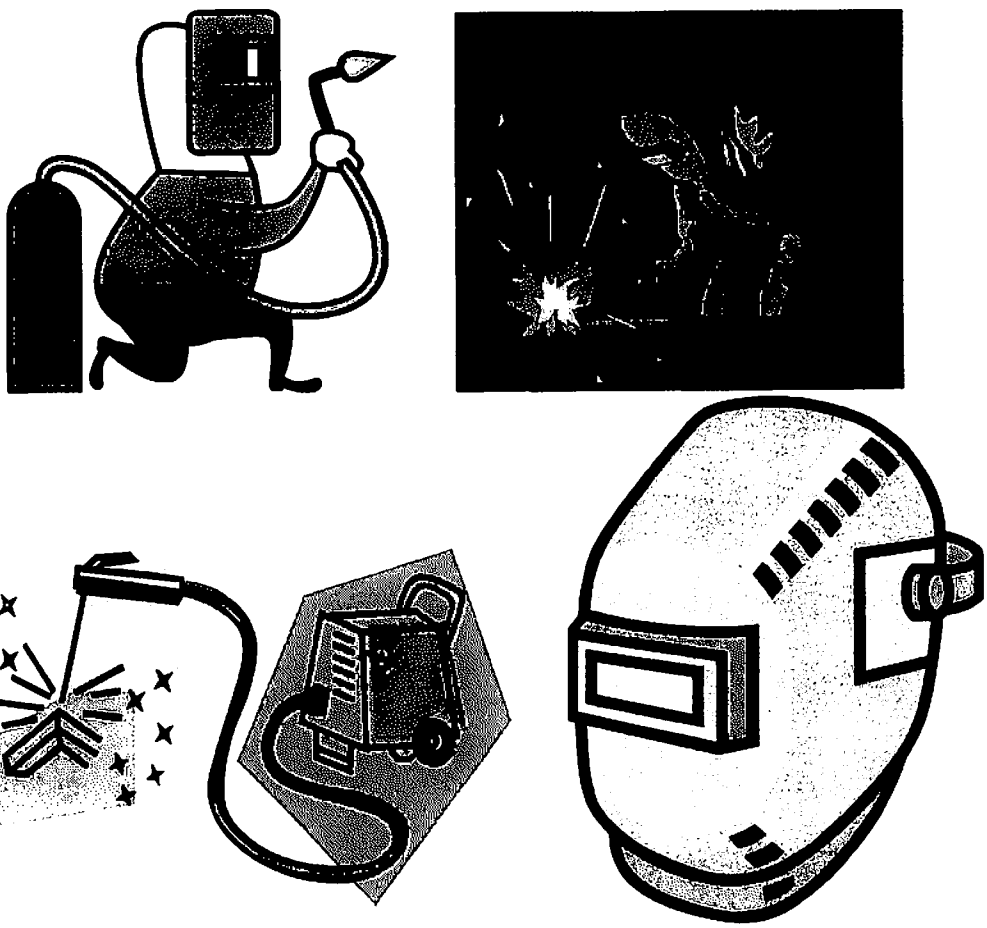
Lewis & Clark Career Center

Curriculum Guide

Welding



Curriculum Guide
For
Welding

Course Rationale, Course Description, Units of Study

Competencies

Crosswalk to Show Me Standards

Articulation Agreements

Employer Survey / Advisory Board Minutes

Instructional Methods

Integrated Lesson Sample

Work Experience Program

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Program Evaluation

Program Brochures/Enrollment Packet

Miscellaneous

COMBINATION WELDING

2 year program; 3 units of credit per year
Prerequisite: Asthma Free

Combination welding is open to students interested in welding and metal working as an occupation. Students are instructed in shop safety and the proper procedures for each welding process. Oxy fuel cutting, arc, mig and tig welding, plasma cutting, and air arc cutting processes are taught in all four weld positions and on the five basic weld joints. Metallurgy, blueprint reading, reading a tape measure, metal fabricating techniques and weld symbols are included in the program.

The lab is set up to simulate the welding industry. Students are evaluated by written tests and by testing their welds as specified by the American Welding Society code.

Students interested in a career in welding should have good eye/hand coordination, mechanical aptitude, manual dexterity, freedom from asthma, allergies and physical disabilities which prevent bending, stooping, lifting and working in awkward positions.

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COMBINATION WELDING
UNITS OF STUDY

- Safety in Welding
- Welding Theory
- Reading a Tape Measure
- Gas Cutting
- Electric Components of Electric Welder
- Flux Cored Arc Welding
- Shielded Metal Arc Welding
- Gas Tungsten Arc Welding
- Gas Metal Arc Welding
- Weldability of Metals
- Identification of Metals
- Testing Welds
- Metal Fabrication Techniques
- Business Operations
- Plasma Cutting
- Inspection & Testing of Welds
- Welder Qualifications & Certification
- Mechanical Work
- Employability Skills
- SkillsUSA
- **Articulated with: Construction Craft Laborer Apprenticeship**
  Linn State Technical College

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WELDING COMPETENCIES

STUDENT: **ID:**

Rating Scale:

3	Mastered
2	Requires Supervision
1	Not Mastered
N	No Exposure

3	2	1	N	A. SAFETY AND BASIC SKILLS
				1. Identify and correct or report safety hazards
				2. Identify and utilize proper storage for flammables
				3. Identify and demonstrate correct use of fire extinguishers
				4. Identify ventilation hazards and take corrective action
				5. Observe and adhere to safety labels
				6. Maintain, use and safely work with machines, tooling and equipment
				7. Use power equipment, grinder, drill press and power saw safely/correctly
				8. Identify confined space and fall protection hazards
				9. Obtain and use reference books and charts
				10. Apply math to solution of welding problems - whole numbers, fractions, decimals, rounding numbers
				11. Apply math to solution of welding problems - geometry and trigonometry
				12. Identify basic hand tools
				13. Select, use and care for hand tools
				14. Identify and store electrodes/filler materials
				15. Read and implement welding procedures
				16. Identify basic power sources
				17. Identify structural shapes, sizes and weights

3	2	1	N	B. PRINT READING
				1. Read and interpret basic prints (AWS B1)
				2. Interpret welding symbols, abbreviations and joint designs (AWS B2)
				3. Construct an exercise (s) using basic print and sketch
				4. Make sketches - pictorial and orthographic (AWS B1)
				5. Convert English measurements to metric and vice-versa

3	2	1	N	C. OXYFUEL CUTTING/BRAZING
				1. Demonstrate safety procedures for oxyfuel cutting/brazing (AWS D1-1, D2-1)
				2. Describe theory of oxyfuel cutting/brazing
				3. Identify types of fuel gases and their applications
				4. Handle, make preliminary safety inspection and store cylinders properly (AWS D1-3)
				5. Identify, select and set up oxyfuel welding and cutting equipment (AWS D1-3, D2-3)
				6. Light and adjust flame for welding and cutting (AWS D1-4, D2-4)
				7. Pierce holes and cut slots (AWS D1-5, D1-6, D2-5)
				8. Make straight 90 degree and beveled cuts on mild steel plate and pipe (AWS D1-5, D1-7, D2-5, D2-6)
				9. Make circle cuts - off hand and with guide (AWS D1-6)
				10. Lay out, cut and fit materials (such as pipe, plate and structural shapes) (AWS D1-6)

				11. Braze weld materials
				12. Prepare coupon for testing and pass visual test
				13. Identify brazing and cutting problems, their causes and take corrective action (AWS D1-2, D2-2)
				14. Identify and select correct brazing rod and flux, if applicable
3	2	1	N	**D. LAYOUT, FIT-UP AND FABRICATION**
				1. Make layout of material for plate, structural and pipe fabrication
				2. Prepare material for weld procedure specification (WPS)
				3. Fabricate parts from a drawing or sketch (AWS B3)

3	2	1	N	**E. SHIELDED METAL ARC - GENERAL**
				1. Demonstrate safety procedures for shielded metal are welding (AWS C1-1)
				2. Describe theory of shielded metal arc welding
				3. Select polarity and current for electrode (AWS C1-3)
				4. Identify and make proper electrode selection for base material and material thickness or follow WPS
				5. Identify joint design and prepare material for WPS (AWS C1-3)
				6. Identify shielded metal arc welding problems, their causes and take corrective action (AWS C1-2, C1-3)
				7. Build pad of beads in horizontal position (qualifies flat position) (AWS C1-4)
				8. Build pad of beads in vertical position upward (AWS C1-4)
				9. Visually inspect shielded metal arc weld

3	2	1	N	**F. SHIELDED METAL ARC - 3/8" PLATE**
				1. Make weld in 2F position with E-6010 or E-6011 (qualified 1F position) (AWS C1-5)
				2. Make weld in 2F position with E-7024 (AWS C1-5)
				3. Make weld in 2F position with E-7018 (qualifies 1F position) (AWS C1-5)
				4. Make weld in 3F position, vertical up, with E-6010 or E-6011 (AWS C1-5)
				5. Make weld in 3F position, vertical up, with E-7018 (AWS C1-5)
				6. Make weld in 4F position with E-6010 or E-6011 (AWS C1-5)
				7. Make weld in 4F position with E-7018 (AWS C1-5)
				8. Make weld in 2G position with E-6010 or E-6011 (qualifies 1G position) (AWS C1-6, C1-7)
				9. Make weld in 2G position with E-7018 (qualifies 1G position) (AWS C1-6, C1-7)
				10. Make weld in 3G position, vertical up, with E-6010 or E-6011 (AWS C1-6, C1-7)
				11. Make weld in 3G position, vertical up, with E-7018 (AWS C1-6, C1-7)
				12. Make weld in 4G position with E-6010 or E-6011 (AWS C1-6)
				13. Make weld in 4G position with E-7018 (AWS C1-6)

3	2	1	N	**G. SHIELDED METAL ARC - PIPE (2"- 6" DIA.)**
				1. Make weld in 1G position with E-6010 or E-6011 (AWS C1-6)
				2. Make weld in 1G position with E-7018 (AWS C1-6)
				3. Make weld in 2G position with E-6010 or E-6011 (AWS C1-6)
				4. Make weld in 2G position with E-7018 (AWS C1-6)
				5. Make weld in 5G position, vertical up, with E-6010 or E-6011 (AWS C1-6)
				6. Make weld in 5G position, vertical up, with E-7018 (AWS C1-6)
				7. Make weld in 5G position, vertical down, with E-6010 or E-6011 (AWS C1-6)
				8. Make weld in 6G position, vertical up, with E-6010 or E-6011 (AWS C1-6)
				9. Make weld in 6G position, vertical up, with E-7018 (AWS C1-6)

3	2	1	N	**H. SHIELDED METAL ARC - 16 GA. STEEL**
				1. Make weld in 1F position with E-6010 or E-6011 (AWS C1-5)
				2. Make weld in 1F position with E-6013 (AWS C1-5)
				3. Make weld in 2F position with E-6010 or E-6011 (AWS C1-5)
				4. Make weld in 2F position with E-6013 (AWS C1-5)
				5. Make weld in 3F position with E-6010 or E-6011 (AWS C1-5)
				6. Make weld in 3F position with E-6013 (AWS C1-5)

				7. Make weld in 4F position with E-6010 or E-6011 (AWS C1-5)
				8. Make weld in 4F position with E-6013 (AWS C1-5)
				9. Make butt weld in horizontal position with E-6010 or E-6011 (qualifies flat position)
				10. Make butt weld in horizontal position with E-6013 (qualifies flat position)
				11. Make butt weld in vertical down position with E-6010 or E-6011
				12. Make butt weld in vertical down position with E-6013
				13. Make butt weld in overhead position with E-6010 or E-6011
				14. Make butt weld in overhead position with E-6013

3	2	1	N	I. GAS METAL ARC WELDING - PLATE AND PIPE
				1. Demonstrate safety procedures for gas metal arc welding (AWS C2-1)
				2. Describe theory of gas metal arc welding
				3. Identify, select and safely handle shielding gases for various metals (AWS C2-3)
				4. Adjust current, voltage, pulse, wire feed rate and gas flow (AWS C2-4, C2-7)
				5. Identify, select and set up equipment (AWS C2-2, C2-3)
				6. Identify and select solid wire electrode for carbon steel, aluminum and stainless steel (AWS C2-3)
				7. Make weld in 2F position with carbon steel and solid wire (qualifies 1F position) (AWS C2-5, C2-7)
				8. Make weld in 2F position with aluminum (qualifies 1F position)
				9. Make weld in 2F position with stainless steel (qualifies 1F position)
				10. Make weld in 3F position, vertical up, with material 3/16" or thicker (AWS C2-5)
				11. Make weld in 3F position, vertical down, with carbon steel thinner than 3/16" and solid wire (AWS C2-5)
				12. Make weld in 4F position with solid wire (AWS C2-5)
				13. Make butt weld in 1G position with aluminum
				14. Make butt weld in 1G position with stainless steel
				15. Make weld in 2G position with solid wire (qualifies 1G position) (AWS C2-6, C2-15)
				16. Make weld in 3G position, vertical up, with carbon steel 3/16" or thicker (AWS C2-6)
				17. Make weld in 3G position, vertical down, with carbon steel less than 3/16" thick (AWS C2-6)
				18. Make weld in 5G position, vertical up, with carbon steel (pipe)
				19. Make weld in 6G position, vertical up, with carbon steel (pipe)
				20. Identify gas metal arc welding problems, their causes and take corrective action (AWS C2-2)
				21. Prepare gas metal arc weld for test

3	2	1	N	J. GAS TUNGSTEN ARC WELDING (CARBON STEEL, STAINLESS STEEL, ALUMINUM)
				1. Demonstrate safety procedures for gas tungsten arc welding (AWS C4-1)
				2. Describe theory of gas tungsten arc welding
				3. Identify, select and set up equipment and explain functions (AWS C4-2, C4-3)
				4. Identify, select and safely handle shielding gases (C4-3)
				5. Identify, select, shape and install tungsten electrode (AWS C4-3)
				6. Adjust polarity, pulse, current, gas flow setting and post flow timer and strike arc (AWS C4-3, C4-4)
				7. Identify joint design and prepare material for weld procedure specification (WPS)
				8. Select filler rod for base material (AWS C4-3)
				9. Make weld in 2F position, stainless steel (qualifies 1F position) (AWS C4-9)
				10. Make weld in 2F position, aluminum (qualifies 1F position) (AWS C4-7)
3	2	1	N	J. GAS TUNGSTEN ARC WELDING (CARBON STEEL, STAINLESS STEEL, ALUMINUM)
				11. Make weld in 2F position, carbon steel (qualifies 1F position) (AWS C4-5)
				12. Make weld in 3F position, stainless steel (AWS C4-9)
				13. Make weld in 3F position, aluminum
				14. Make weld in 3F position, carbon steel (AWS C4-5)
				15. Make weld in 2G position, stainless steel (qualifies 1G position) (AWS C4-10)
				16. Make weld in 2G position, aluminum (qualifies 1G position) (AWS C4-8)

				17. Make weld in 2G position, carbon steel (qualifies 1G position) (AWS C4-6)
				18. Make weld in 3G position, vertical up, on stainless steel
				19. Make weld in 3G position, vertical up, on aluminum
				20. Make weld in 3G position, vertical up, on carbon steel (AWS C4-6)
				21. Make weld in 4G position with carbon steel (AWS C4-6)
				22. Identify gas tungsten arc welding problems, their causes and take corrective action (AWS C4-2)
				23. Prepare gas tungsten arc weld for test

3	2	1	N	K. PLASMA ARC CUTTING
				1. Demonstrate safety procedures for plasma cutting (AWS E2-1)
				2. Describe theory of plasma cutting
				3. Set up and operate plasma cutting equipment (AWS E2-3, E2-4)
				4. Lay out and make straight line cuts
				5. Lay out and make bevel cuts
				6. Lay out and make circular cuts (AWS E2-5)
				7. Lay out and make pattern cuts (AWS E2-5)
				8. Lay out, cut and bevel pipe to a 30-37 1/2 degree angle
				9. Lay out and cut square and round solid stock

3	2	1	N	L. METALLURGY AND HEAT TREATING
				1. Demonstrate safety procedures for metallurgy and heat treating
				2. Identify the classification and physical properties of ferrous and nonferrous metals
				3. Identify and apply principles of preheating and postheating
				4. Describe and apply principles of metallurgy in annealing, hardening and tempering
				5. Describe methods of testing metals
				6. Identify types of ferrous metal by spark test
				7. Describe the relationship between the hardness test of weld, heat affect zone and base metal and interpret

3	2	1	N	M. CARBON ARC GOUGING
				1. Demonstrate safety procedures for carbon arc gouging (AWS E1-1)
				2. Describe theory of carbon arc gouging
				3. Identify and select electrode size, polarity, currect and air pressure
				4. Set up and operate carbon arc gouging equipment (AWS E1-2, E1-3, E1-4)
				5. Remove weld material/backgouge (AWS E1-4, E1-5)

3	2	1	N	N. FLUX CORED ARC WELDING
				1. Demonstrate safety procedures for flux cored arc welding (AWS C3-1)
				2. Describe theory of flux cored arc welding
				3. Identify, select and safely handle shielding gases for various metals (AWS C3-3)
3	2	1	N	N. FLUX CORED ARC WELDING
				4. Adjust current, voltage, pulse, wire feed rate and gas flow (AWS C3-3, C3-4)
				5. Identify, select and set up equipment (AWS C3-2, C3-3)
				6. Identify and select cored wire electrodes for carbon steel and stainless steel (AWS C3-3)
				7. Make weld in 2F position with carbon steel and cored wire (qualifies 1F position) (AWS C3-5)
				8. Make weld in 3F position, vertical up, with carbon steel and cored wire (AWS C3-5)
				9. Make weld in 2G position with carbon steel and cored wire (qualifies 1G positoin) (AWS C3-6)
				10. Make weld in 3G position, vertical up, with carbon steel and cored wire (AWS C3-6)
				11. Identify welding problems, their causes and take corrective action
				12. Prepare flux cored arc weld for test

3	2	1	N	O. VISUAL WELD TESTING
				1. Prepare sample for visual test per appropriate standard (AWS C1-7, F1-1, F1-2)

				2. Inspect for undercut, overlap, porosity, slag, spatter and weld size (AWS C1-7, F1-2)
				3. Identify defects and take corrective action based on visual test (AWS C1-7, F1-2)

3	2	1	N	P. DESTRUCTIVE TESTING
				1. Prepare coupon for bent test per appropriate standard
				2. Perform destructive test on welds
				3. Identify defects and take corrective actions based on destructive test

3	2	1	N	Q. NON-DESTRUCTIVE TESTING
				1. Prepare sample for non-destructive test per appropriate standard (AWS C1-7)
				2. Perform non-destructive test per appropriate standards (AWS C1-7)
				3. Inspect for undercut, overlap, porosity, slag and spatter (AWS C1-7)
				4. Identify defects and take corrective action based on non-destructive test

3	2	1	N	R. LEADERSHIP COMPETENCIES
				1. Demonstrate an understanding of VICA, its structure and activities
				2. Demonstrate an understanding of one's personal values
				3. Perform tasks related to effective personal management skills
				4. Demonstrate interpersonal skills
				5. Demonstrate etiquette and courtesy
				6. Demonstrate effectiveness in oral and written communication
				7. Develop and maintain a code of professional ethics
				8. Maintain a good professional appearance
				9. Perform basic tasks related to securing and terminating employment
				10. Perform basic parliamentary procedures in a group meeting

* Highlighted items indicate essential skills.

Name: _____ **Welding** 70-6300-C

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect employability readiness rather than the grades given in class.

Rating Scale:
3 Mastered - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

NOTES: * = Core competencies (essential for the first day on the job). The numbers in brackets [e.g., A01] reflect the IDs used in computerized tracking software. Numbers in parentheses at the end of each competency apply to national skill standards by AWS (EG2.0-95). **NOTE: These competencies are addressed in the Missouri VICA Curriculum Guide lessons. Rev. 1995

3	2	1	N	**01. Safety**
				1. *Identify and correct or report safety hazards [A01]
				2. *Identify and utilize proper storage for flammables [A02]
				3. *Identify and demonstrate correct use of fire extinguishers [A03]
				4. *Identify ventilation hazards and take corrective action [A04]
				5. *Observe and adhere to safety labels [A05]
				6. *Maintain, use and safely work with machines, tooling and equipment [A06]
				7. *Use power equipment, grinder, drill press and power saw safely/correctly [A11]
				8. *Identify confined space and fall protection hazards [A16]
				Other: _____

3	2	1	N	**02. Basic Skills**
				1. *Obtain and use reference books and charts [A07]
				2. *Apply math to solution of welding problems - whole numbers, fractions, decimals, rounding numbers [A08]
				3. Apply math to solution of welding problems - geometry and trigonometry [A17]
				4. *Identify basic hand tools [A09]
				5. *Select, use and care for hand tools [A10]
				6. *Identify and store electrodes/filler materials [A12]
				7. *Read and implement welding procedures [A13]
				8. *Identify basic power sources [A14]
				9. Identify structural shapes, sizes and weights [A18]
				Other: _____

3	2	1	N	**03. Print Reading**
				1. *Read and interpret basic prints [B01] (B1)
				2. *Interpret welding symbols, abbreviations and joint designs [B02] (B2)
				3. Construct an exercise(s) using basic print and sketch [B03]
				4. Make sketches - pictorial and orthographic [B04] (B1)
				5. Convert English measurements to metric and vice-versa [B06]
				Other: _____

3	2	1	N	**04. Layout, Fit-Up and Fabrication**
				1. Make layout of material for plate, structural and pipe fabrication [D01]
				2. *Prepare material for weld procedure specification (WPS) [D02]
				3. Fabricate parts from a drawing or sketch [D03] (B3)
				Other: _____

3	2	1	N

05. Oxyfuel Cutting/Brazing

1. *Demonstrate safety procedures for oxyfuel cutting/brazing [C01] (D1-1, D2-1)
2. Describe theory of oxyfuel cutting/brazing [C20]
3. *Identify types of fuel gases and their applications [C02]
4. *Handle, make preliminary safety inspection and store cylinders properly [C03] (D1-3)
5. *Identify, select and set up oxyfuel welding and cutting equipment [C04] (D1-3, D2-3)
6. *Light and adjust flame for welding and cutting [C05] (D1-4, D2-4)
7. *Pierce holes and cut slots [C06] (D1-5, D1-6, D2-5)
8. *Make straight 90 degree and beveled cuts on mild steel plate and pipe [C07] (D1-5, D1-6, D2-5)
9. Make circle cuts - off hand and with guide [C08] (D1-6)
10. Lay out, cut and fit materials (such as pipe, plate and structural shapes) [C09] (D1-6)
11. Braze weld materials [C21]
12. *Prepare coupon for testing and pass visual test [C17]
13. Identify brazing and cutting problems, their causes and take corrective action [C18] (D1-2, D2-2)
14. Identify and select correct brazing rod and flux, if applicable [C19]

Other: _____

3	2	1	N

06. Shielded Metal Arc - General

1. *Demonstrate safety procedures for shielded metal arc welding [E01] (C1-1)
2. Describe theory of shielded metal arc welding [E02]
3. *Select polarity and current for electrode [E17] (C1-3)
4. *Identify and make proper electrode selection for base material and material thickness or follow WPS (weld procedure specification) [E04] (C1-3)
5. *Identify joint design and prepare material for WPS [E05] (C1-3)
6. Identify shielded metal arc welding problems, their causes and take corrective action [E06] (C1-2, C1-3)
7. *Build pad of beads in horizontal position (qualifies flat position) [E18] (C1-4)
8. Build pad of beads in vertical position upward [E19] (C1-4)
9. *Visually inspect shielded metal arc weld [E20]

Other: _____

3	2	1	N

07. Shielded Metal Arc - 3/8" Plate

1. *Make weld in 2F position with E-6010 or E-6011 (qualifies 1F position) [F04] (C1-5)
2. *Make weld in 2F position with E-7024 [F05] (C1-5)
3. *Make weld in 2F position with E-7018 (qualifies 1F position) [F06] (C1-5)
4. Make weld in 3F position, vertical up, with E-6010 or E-6011 [F21] (C1-5)
5. Make weld in 3F position, vertical up, with E-7018 [F22] (C1-5)
6. Make weld in 4F position with E-6010 or E-6011 [F09] (C1-5)
7. Make weld in 4F position with E-7018 [F10] (C1-5)
8. Make weld in 2G position with E-6010 or E-6011 (qualifies 1G position) [F14] (C1-6, C1-7)
9. Make weld in 2G position with E-7018 (qualifies 1G position) [F16] (C1-6, C1-7)
10. Make weld in 3G position, vertical up, with E-6010 or E-6011 [F23] (C1-6, C1-7)
11. Make weld in 3G position, vertical up, with E-7018 [F24] (C1-6, C1-7)
12. Make weld in 4G position with E-6010 or E-6011 [F19] (C1-6)
13. Make weld in 4G position with E-7018 [F20] (C1-6)

Other: _____

3	2	1	N

08. Shielded Metal Arc - Pipe (2"-6" Dia.)

1. *Make weld in 1G position with E-6010 or E-6011 [G01] (C1-6)
2. *Make weld in 1G position with E-7018 [G03] (C1-6)
3. Make weld in 2G position with E-6010 or E-6011 [G04] (C1-6)
4. Make weld in 2G position with E-7018 [G06] (C1-6)
5. Make weld in 5G position, vertical up, with E-6010 or E-6011 [G11] (C1-6)
6. Make weld in 5G position, vertical up, with E-7018 [G12] (C1-6)
7. Make weld in 5G position, vertical down, with E-6010 or E-6011 [G13] (C1-6)
8. Make weld in 6G position, vertical up, with E-6010 or E-6011 [G14] (C1-6)
9. Make weld in 6G position, vertical up, with E-7018 [G15] (C1-6)

Other: _____

3	2	1	N

09. Shielded Metal Arc - 16 Ga. Steel

1. *Make weld in 1F position with E-6010 or E-6011 [H01] (C1-5)
2. *Make weld in 1F position with E-6013 [H17] (C1-5)
3. *Make weld in 2F position with E-6010 or E-6011 [H03] (C1-5)
4. *Make weld in 2F position with E-6013 [H18] (C1-5)
5. Make weld in 3F position with E-6010 or E-6011 [H05] (C1-5)
6. Make weld in 3F position with E-6013 [H06] (C1-5)
7. Make weld in 4F position with E-6010 or E-6011 [H07] (C1-5)
8. Make weld in 4F position with E-6013 [H08] (C1-5)
9. *Make butt weld in horizontal position with E-6010 or E-6011 (qualifies flat position) [H11]
10. *Make butt weld in horizontal position with E-6013 (qualifies flat position) [H19]
11. Make butt weld in vertical down position with E-6010 or E-6011 [H13]
12. Make butt weld in vertical down position with E-6013 [H20]
13. Make butt weld in overhead position with E-6010 or E-6011 [H15]
14. Make butt weld in overhead position with E-6013 [H21]

Other: _____

3	2	1	N	**10. Gas Metal Arc Welding - Plate and Pipe**
				1. *Demonstrate safety procedures for gas metal arc welding [I01] (C2-1)
				2. *Describe theory of gas metal arc welding [I34]
				3. *Identify, select and safely handle shielding gases for various metals [I02] (C2-3)
				4. *Adjust current, voltage, pulse, wire feed rate and gas flow [I03] (C2-4, C2-7)
				5. *Identify, select and set up equipment [I04] (C2-2, C2-3)
				6. *Identify and select solid wire electrode for carbon steel, aluminum and stainless steel [I35] (C2-3)
				7. *Make weld in 2F position with carbon steel and solid wire (qualifies 1F position) [I36] (C2-5, C2-7)
				8. Make weld in 2F position with aluminum (qualifies 1F position) [I18]
				9. Make weld in 2F position with stainless steel (qualifies 1F position) [I19] (C3-6)
				10. Make weld in 3F position, vertical up, with material 3/16" or thicker [I37] (C2-5)
				11. Make weld in 3F position, vertical down, with carbon steel thinner than 3/16" and solid wire [I38] (C2-5)
				12. Make weld in 4F position with solid wire [I39] (C2-5)
				13. Make butt weld in 1G position with aluminum [I40]
				14. Make butt weld in 1G position with stainless steel [I41]
				15. *Make weld in 2G position with solid wire (qualifies 1G position) [I42] (C2-6, C2-15)
				16. Make weld in 3G position, vertical up, with carbon steel 3/16" or thicker [I27] (C2-6)
				17. Make weld in 3G position, vertical down, with carbon steel less than 3/16" thick [I28] (C2-6)
				18. Make weld in 5G position, vertical up, with carbon steel (pipe) [I30]
				19. Make weld in 6G position, vertical up, with carbon steel (pipe) [I46]
				20. *Identify gas metal arc welding problems, their causes and take corrective action [I32] (C2-2)
				21. *Prepare gas metal arc weld for test [I33]
				Other: _____

3	2	1	N	**11. Flux Cored Arc Welding**
				1. *Demonstrate safety procedures for flux cored arc welding [O01] (C3-1)
				2. Describe theory of flux cored arc welding [O02]
				3. *Identify, select and safely handle shielding gases for various metals [O03] (C3-3)
				4. *Adjust current, voltage, pulse, wire feed rate and gas flow [O04] (C3-3, C3-4)
				5. *Identify, select and set up equipment [O05] (C3-2, C3-3)
				6. *Identify and select cored wire electrodes for carbon steel and stainless steel [O06] (C3-3)
				7. *Make weld in 2F position with carbon steel and cored wire (qualifies 1F position) [O07] (C3-5)
				8. Make weld in 3F position, vertical up, with carbon steel and cored wire [O08] (C3-5)
				9. *Make weld in 2G position with carbon steel and cored wire (qualifies 1G position) [O09] (C3-6)
				10. Make weld in 3G position, vertical up, with carbon steel and cored wire [O10] (C3-6)
				11. Identify welding problems, their causes and take corrective action [O11]
				12. Prepare flux cored arc weld for test [O12]
				Other: _____

3	2	1	N

12. Gas Tungsten Arc Welding (Carbon Steel, Stainless Steel, Aluminum)

1. *Demonstrate safety procedures for gas tungsten arc welding [J01] (C4-1)
2. Describe theory of gas tungsten arc welding [J35]
3. *Identify, select and set up equipment and explain function [J02] (C4-2, C4-3)
4. *Identify, select and safely handle shielding gases [J03] (C4-3)
5. *Identify, select, shape and install tungsten electrode [J04] (C4-3)
6. *Adjust polarity, pulse, current, gas flow setting and post flow timer and strike arc [J05] (C4-3, 4-4)
7. Identify joint design and prepare material for weld procedure specification (WPS) [J06]
8. Select filler rod for base material [J07] (C4-3)
9. Make weld in 2F position, stainless steel (qualifies 1F position) [J15] (C4-9)
10. Make weld in 2F position, aluminum (qualifies 1F position) [J16] (C4-7)
11. Make weld in 2F position, carbon steel (qualifies 1F position) [J17] (C4-5)
12. Make weld in 3F position, stainless steel [J18] (C4-9)
13. Make weld in 3F position, aluminum [J19]
14. Make weld in 3F position, carbon steel [J20] (C4-5)
15. Make weld in 2G position, stainless steel (qualifies 1G position) [J27] (C4-10)
16. Make weld in 2G position, aluminum (qualifies 1G position) [J28] (C4-8)
17. Make weld in 2G position, carbon steel (qualifies 1G position) [J29] (C4-6)
18. Make weld in 3G position, vertical up, on stainless steel [J30]
19. Make weld in 3G position, vertical up, on aluminum [J31]
20. Make weld in 3G position, vertical up, on carbon steel [J32] (C4-6)
21. Make weld in 4G position with carbon steel [J36] (C4-6)
22. Identify gas tungsten arc welding problems, their causes and take corrective action [J33] (C4-2)
23. Prepare gas tungsten arc weld for test [J34]

Other: _____

3	2	1	N

13. Plasma Arc Cutting

1. *Demonstrate safety procedures for plasma cutting [K01] (E2-1)
2. *Describe theory of plasma cutting [K10]
3. *Set up and operate plasma cutting equipment [K02] (E2-3, E2-4)
4. *Lay out and make straight line cuts [K03]
5. *Lay out and make bevel cuts [K04]
6. Lay out and make circular cuts [K05] (E2-5)
7. Lay out and make pattern cuts [K06] (E2-5)
8. Lay out, cut and bevel pipe to a 30-37 1/2 degree angle [K07]
9. *Lay out and cut square and round solid stock [K08]

Other: _____

3	2	1	N

14. Metallurgy and Heat Treating

1. *Demonstrate safety procedures for metallurgy and heat treating [L01]
2. Identify the classification and physical properties of ferrous and nonferrous metals [L02]
3. Identify and apply principles of preheating and postheating [L03]
4. Describe and apply principles of metallurgy in annealing, hardening and tempering [L04]
5. Describe methods of testing metals [L05]
6. Identify types of ferrous metal by spark test [L06]
7. Describe the relationship between the hardness test of weld, heat-affected zone and base metal, and interpret the results [L07]

Other: _____

3	2	1	N

15. Carbon Arc Gouging

1. *Demonstrate safety procedures for carbon arc gouging [M01] (E1-1)
2. Describe theory of carbon arc gouging [M04]
3. *Identify and select electrode size, polarity, current and air pressure [M05]
4. Set up and operate carbon arc gouging equipment [M02] (E1-2, E1-3, E1-4)
5. *Remove weld material/backgouge [M03] (E1-4, E1-5)

Other: _____

3	2	1	N

16. Visual Weld Testing

1. *Prepare sample for visual test per appropriate standard [P01] (C1-7, F1-1, F1-2)
2. *Inspect for undercut, overlap, porosity, slag, spatter and weld size [P02] (C1-7, F1-2)
3. *Identify defects and take corrective action based on visual test [P03] (C1-7, F1-2)

Other: _____

3	2	1	N

17. Destructive Testing

1. Prepare coupon for bend test per appropriate standard [Q01]
2. Perform destructive test on weld [Q02]
3. Identify defects and take corrective action based on destructive test [Q03]

Other: _____

3	2	1	N

18. Non-Destructive Testing

1. Prepare sample for non-destructive test per appropriate standard [R01] (C1-7)
2. Perform non-destructive test per appropriate standard [R02] (C1-7)
3. Inspect for undercut, overlap, porosity, slag, spatter, and surface cracks [R03] (C1-7)
4. Identify defects and take corrective action based on non-destructive test [R04]

Other: _____

3	2	1	N

19. Leadership Competencies**

1. Demonstrate an understanding of VICA, its structure and activities [N01]
2. Demonstrate an understanding of one's personal values [N02]
3. Perform tasks related to effective personal management skills [N03]
4. Demonstrate interpersonal skills [N04]
5. Demonstrate etiquette and courtesy [N05]
6. Demonstrate effectiveness in oral and written communication [N06]
7. Develop and maintain a code of professional ethics [N07]
8. Maintain a good professional appearance [N08]
9. Perform basic tasks related to securing and terminating employment [N09]
10. Perform basic parliamentary procedures in a group meeting [N10]

Other: _____

NOTES: * = Core competencies (essential for the first day on the job). The numbers in brackets [e.g., A01] reflect the IDs used in computerized tracking software. Numbers in parentheses at the end of each competency apply to national skill standards by AWS (EG2.0-95). **NOTE: These competencies are addressed in the Missouri VICA Curriculum Guide lessons.

Welding

Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
01.1	HP.7	3.1					HP / V.C / 9-12 / 1 / a	
		3.2					HP / V.C / 9-12 / 2 / a	
		3.3						
		3.4						
		4.7						
01.2	HP.7	3.1					HP / V.C / 9-12 / 1 / a	
		3.2					HP / V.C / 9-12 / 2 / a	
		3.3						
		3.4						
		4.7						
01.3	HP.7	3.1					HP / V.C / 9-12 / 1 / a	
		3.2					HP / V.C / 9-12 / 2 / a	
		3.3						
		3.4						
		4.7						
01.4	HP.7	3.1					HP / V.C / 9-12 / 1 / a	
		3.2					HP / V.C / 9-12 / 2 / a	
		3.3						
		3.4						
		4.7						
01.5	CA.3	3.1						
		3.2						
		3.3						
		3.4						
		4.7						
01.6	CA.3	3.1						
		3.2						
		3.3						
		3.4						
		4.7						
01.7	CA.3	4.7						

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Competency Profile Date 1995

Welding

Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
01.8	HP.7	3.1 3.2 3.3 3.4 4.7						
02.1	MA.3	1.2 1.4 1.5 1.8 3.1	MA / VII.. / 9-12 / 4 / a					
02.2	MA.1 MA.2	1.10 3.7	MA / IV.. / 9-12 / 3 / c					
02.3	MA.1 MA.2	1.10 3.7	MA / VI.. / 9-12 / 3 / i					
02.4								
02.5								
02.6								
02.7	CA.3	1.10 3.7		CA / I.. / 9-12 / 1 / d				
02.8	SC.1	1.10			SC / I.A / 9-12 / 4 / a			
02.9		1.10						
03.1	CA.3	1.5 1.10						
03.2	CA.3	1.5 1.10						
03.3		2.1 2.5						
03.4	CA.5	2.5 2.6		CA / I.. / 9-12 / 6 / a				
03.5	MA.1		MA / V.. / 9-12 / 2 / a					
04.1	MA.1	1.10	MA / V.. / 9-12 / 1 / a					

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Cross-Reference to Show-Me Standards (main report)

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	MA.2	2.1	MA / V.. / 9-12 / 2 / a					
	MA.4		MA / V.. / 9-12 / 3 / a					
04.2	CA.3	4.6		CA / I.. / 9-12 / 1 / a				
04.3	CA.3	1.10		CA / I.. / 9-12 / 1 / a				
05.1		2.5						
		4.7						
05.2	SC.1	1.10			SC / III.B / 9-12 / 1 / a			
05.3	SC.1	1.10			SC / III.B / 9-12 / 1 / a			
05.4		1.10						
		4.7						
05.5		1.10						
		2.5						
05.6		1.10						
		2.5						
05.7		1.10						
		2.5						
05.8		1.10						
		2.5						
05.9		1.10						
		2.5						
05.10		1.10						
		2.5						
05.11		1.10						
		2.5						
05.12		1.10						
		2.5						
05.13		1.10						
		2.5						
		3.1						
		3.2						
		3.3						

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Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
		3.4						
05.14		1.10						
		2.5						
06.1		2.5						
		4.7						
06.2	SC.1	1.10			SC / III.B / 9-12 / 4 / a			
06.3	SC.1	1.10			SC / III.B / 9-12 / 4 / a			
06.4	SC.1	1.10			SC / III.B / 9-12 / 2 / a			
		2.6						
06.5		1.10						
		2.6						
06.6		3.1						
		3.2						
		3.3						
		3.4						
06.7		1.10						
		2.5						
06.8		1.10						
		2.5						
06.9		1.10						
		2.5						
07.1		1.10						
		2.5						
07.2		1.10						
		2.5						
07.3		1.10						
		2.5						
07.4		1.10						
		2.5						
07.5		1.10						
		2.5						

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Competency Profile Date 1995

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Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
07.6		1.10 2.5						
07.7		1.10 2.5						
07.8		1.10 2.5						
07.9		1.10 2.5						
07.10		1.10 2.5						
07.11		1.10 2.5						
07.12		1.10 2.5						
07.13		1.10 2.5						
08.1		1.10 2.5						
08.2		1.10 2.5						
08.3		1.10 2.5						
08.4		1.10 2.5						
08.5		1.10 2.5						
08.6		1.10 2.5						
08.7		1.10 2.5						
08.8		1.10 2.5						

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Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
08.9		1.10 2.5						
09.1		1.10 2.5						
09.2		1.10 2.5						
09.3		1.10 2.5						
09.4		1.10 2.5						
09.5		1.10 2.5						
09.6		1.10 2.5						
09.7		1.10 2.5						
09.8		1.10 2.5						
09.9		1.10 2.5						
09.10		1.10 2.5						
09.11		1.10 2.5						
09.12		1.10 2.5						
09.13		1.10 2.5						
09.14		1.10 2.5						
10.1		2.5 4.7						

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Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
10.2	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
10.3	SC.1	1.10 2.1 2.5			SC / III.B / 9-12 / 1 / a			
10.4	SC.1	1.8 1.10			SC / III.C / 9-12 / 2 / a			
10.5	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
10.6	SC.1	1.10 2.6			SC / III.C / 9-12 / 3 / a			
10.7		1.10 2.5						
10.8		1.10 2.5						
10.9		1.10 2.5						
10.10		1.10 2.5						
10.11		1.10 2.5						
10.12		1.10 2.5						
10.13		1.10 2.5						
10.14		1.10 2.5						
10.15		1.10 2.5						
10.16		1.10 2.5						
10.17		1.10 2.5						

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Competency Profile Date 1995

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
10.18		1.10 2.5						
10.19		1.10 2.5						
10.20		3.1 3.2 3.3 3.4						
10.21		1.10						
11.1		2.5 4.7						
11.2	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
11.3	SC.1	1.10 2.1 2.5			SC / III.B / 9-12 / 1 / a			
11.4	SC.1	1.8 1.10			SC / III.C / 9-12 / 2 / a			
11.5	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
11.6	SC.1	1.10 2.6			SC / III.C / 9-12 / 3 / a			
11.7		1.10 2.5						
11.8		1.10 2.5						
11.9		1.10 2.5						
11.10		1.10 2.5						
11.11		3.1 3.2 3.3						

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Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
		3.4						
11.12		1.10						
12.1		2.5						
		4.7						
12.2	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
12.3	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
12.4	SC.1	1.10			SC / III.B / 9-12 / 1 / a			
		2.1						
		2.5						
12.5	SC.1	1.10			SC / III.C / 9-12 / 3 / a			
		2.6						
12.6	SC.1	1.8			SC / III.C / 9-12 / 2 / a			
		1.10						
12.7		1.10						
		2.6						
12.8	SC.1	1.10			SC / III.C / 9-12 / 3 / a			
		2.6						
12.9		1.10						
		2.5						
12.10		1.10						
		2.5						
12.11		1.10						
		2.5						
12.12		1.10						
		2.5						
12.13		1.10						
		2.5						
12.14		1.10						
		2.5						
12.15		1.10						
		2.5						

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12.16		1.10 2.5						
12.17		1.10 2.5						
12.18		1.10 2.5						
12.19		1.10 2.5						
12.20		1.10 2.5						
12.21		1.10 2.5						
12.22		3.1 3.2 3.3 3.4						
12.23		1.10						
13.1		2.5 4.7						
13.2	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
13.3	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
13.4		1.10 2.5						
13.5		1.10 2.5						
13.6		1.10 2.5						
13.7		1.10 2.5						
13.8		1.10 2.5						

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Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
13.9		1.10 2.5						
14.1		2.5 4.7						
14.2	SC.1	1.10			SC / III.A / 9-12 / 1 / a			
14.3	SC.1	1.10 2.5			SC / III.B / 9-12 / 2 / a			
14.4	SC.1	1.10 2.5			SC / III.B / 9-12 / 2 / a			
14.5		1.10						
14.6	SC.1	1.10 2.5 4.1			SC / III.A / 9-12 / 1 / a			
14.7	SC.1	1.10 3.5			SC / III.B / 9-12 / 2 / a			
15.1		2.5 4.7						
15.2	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
15.3	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
15.4	SC.1	1.10			SC / III.C / 9-12 / 2 / a			
15.5		1.10 2.5						
16.1	CA.3	1.10 3.5 4.1						
16.2	CA.3	1.10 3.5 4.1						
16.3	CA.3	1.10 3.1 3.2						

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Welding

Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
		3.3						
		3.4						
		3.5						
		4.1						
17.1	CA.3	1.10						
		2.5						
17.2	CA.3	1.10						
		2.5						
17.3	CA.3	1.10						
		3.1						
		3.2						
		3.3						
		3.4						
		3.5						
		4.1						
18.1	CA.3	1.10						
		2.5						
18.2	CA.3	1.10						
		2.5						
18.3	CA.3	1.10						
		3.5						
		4.1						
18.4	CA.3	1.10						
		3.1						
		3.2						
		3.3						
		3.4						
		3.5						
		4.1						
19.1	CA.1	4.2		CA / I... / 9-12 / 1 / b				
	CA.3	4.3						
19.2		4.4						
		4.5						

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Welding

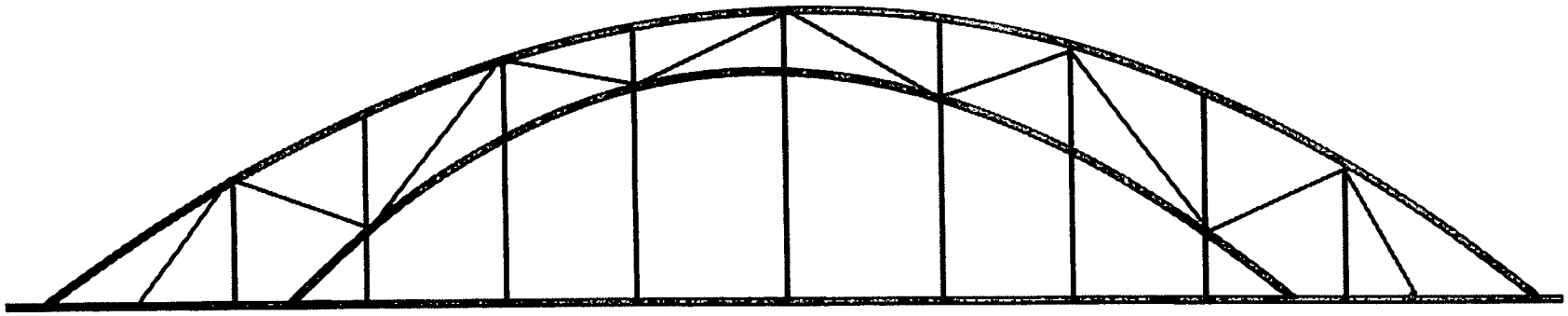
Cross-Reference to Show-Me Standards (main report)

Duty Band and Task Statement	Knowledge (Content)	Performance (Goals)	Math	Communication Arts	Science	Social Studies	Health / Physical Education	Fine Arts
		4.6						
19.3	CA.5	4.3		CA / I.. / 9-12 / 4 / a				
		4.4						
19.4	CA.1	2.1						
		2.2						
		2.3						
		2.7						
19.5		2.3						
		4.4						
19.6	CA.1	2.1		CA / I.. / 9-12 / 1 / b				
19.7		4.4						
19.8		4.3						
19.9		2.6						
		4.8						
19.10	CA.6	4.6						

KEY: * = may use all "to do" statements; # = same Frameworks as previous competency; 98 = same Frameworks as previous competency; 99 = "to know" statements may not be applicable

Performance Indicators for Welding:

A Bridge to Selected Instructional Materials



• National Skill Standards • Missouri Competencies • Show-Me Standards
• All Aspects of the Industry Objectives • VICA/SCANS Competencies

Instructional Materials Laboratory
University of Missouri-Columbia

February 1996

• *All Aspects of the Industry (65-9000-I).* University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Contact:
IML (see above)
• *Learning a Living: A Blueprint for High Performance (A SCANS Report for America 2000).* Washington, D.C., U.S. Department of Labor, 1992. *
• VIMS/VAMS Support Center, 324 Townsend Hall, UMC, Columbia, MO 65211, 573/882-2951, FAX 573/884=5455.

*These resources are available to Missouri educators for free loan from the Missouri Vocational Resource Center (MVRC), University of Missouri-Columbia, 8 London Hall, Columbia, MO 65211 (800/392-7217, FAX 573/882=9935).

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2316 Industrial Drive, Columbia, MO 65202
800/669-2465 or 573/882-2883

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Missouri Competency		Previous Mo. Competencies	Show-Me Standards	AAOI Objectives	VICA/SCANS Competencies
3.4	Make sketches - pictorial and orthographic [B04]	B4 (same)	Goals 1, 2, 3, 4	D1, D7, E5	3
3.5	Convert English measurements to metric and vice-versa [B06]	A8	Goals 1, 3	D1	3, 5
4. Layout, Fit-Up and Fabrication					
4.1	Make layout of material for plate, structural and pipe fabrication [D01]	D1 (same)	Goals 1, 3, 4	D1, D2, D7	3, 5
*4.2	Prepare material for weld procedure specification (WPS) [D02]	B3	Goals 1, 4	D7, D16, E5	3, 4, 5
4.3	Fabricate parts from a drawing or sketch [D03]	B3	Goals 1, 3, 4	D1, D2, D7, E5	3, 5
5. Oxyfuel Cutting/Brazing					
*5.1	Demonstrate safety procedures for oxyfuel cutting/brazing [C01]	C1	Goals 1, 2, 3, 4	E5, H2, H9	3, 4
5.2	Describe theory of oxyfuel cutting/brazing [C20]		Goals 1, 2	D3, D15, E5	3
*5.3	Identify types of fuel gases and their applications [C02]	C2	Goals 1, 2	D15, E5	3, 5
*5.4	Handle, make preliminary safety inspection and store cylinders properly [C03]	C3 (same)	Goals 1, 3, 4	E5, H1	3, 5
*5.5	Identify, select and set up oxyfuel welding and cutting equipment [C04]	C4 (same)	Goals 1, 3, 4	D15, E5	3, 5
*5.6	Light and adjust flame for welding and cutting [C05]	C5 (same)	Goals 1, 4	D15, E5	3, 5
*5.7	Pierce holes and cut slots [C06]	C6 (same)	Goals 1, 3, 4	D15, E5	1, 5
*5.8	Make straight 90 degree and beveled cuts on mild steel plate and pipe [C07]	C7 (same)	Goals 1, 3, 4	D1, D2, D15, E5	1, 5
5.9	Make circle cuts - off hand and with guide [C08]	C8 (same)	Goals 1, 3, 4	D1, D15, E5	1, 5
5.10	Lay out, cut and fit materials (such as pipe, plate and structural shapes) [C09]	C9	Goals 1, 3, 4	D1, D2, D15, E5	1, 5
5.11	Braze weld materials [C21]	C15, C16	Goals 1, 3, 4	D15, E5	5
*5.12	Prepare coupon for testing and pass visual test [C17]	C17	Goals 1, 3, 4	D15, E5	5
5.13	Identify brazing and cutting problems, their causes and take corrective action [C18]	C18	Goals 1, 2, 3, 4	D13, E5	3,4,5
5.14	Identify and select correct brazing rod and flux, if applicable [C19]	C19	Goals 1, 2, 3, 4	D15, E5	3, 4, 5
6. Shielded Metal Arc - General					
*6.1	Demonstrate safety procedures for shielded metal arc welding [E01]	E1	Goals 1, 2, 3, 4	E5, H2, H9	3, 4
6.2	Describe theory of shielded metal arc welding [E02]	E2 (same)	Goals 1, 2	D15, E5	2, 3
*6.3	Select polarity and current for electrode [E17]	E3	Goals 1, 3, 4	D15, E5	3, 5
*6.4	Identify and make proper electrode selection for base material and material thickness or follow WPS (weld procedure specification) [E04]	E4	Goals 1, 2, 3, 4	D15, E5	3, 5

Missouri Competency		Previous Mo. Competencies	Show-Me Standards	AAOI Objectives	VICA/SCANS Competencies
8.7	Make weld in 5G position, vertical down, with E-6010 or E-6011 [G13]	G7	Goals 1, 3, 4	D15, E5	5
8.8	Make weld in 6G position, vertical up, with E-6010 or E-6011 [G14]	G9	Goals 1, 3, 4	D15, E5	5
8.9	Make weld in 6G position, vertical up, with E-7018 [G15]	G10	Goals 1, 3, 4	D15, E5	5
9. Shielded Metal Arc - 16 Ga. Steel					
*9.1	Make weld in 1F position with E-6010 or E-6011 [H01]	H1 (same)	Goals 1, 3, 4	D15, E5	5
*9.2	Make weld in 1F position with E-6013 [H17]	H2	Goals 1, 3, 4	D15, E5	5
*9.3	Make weld in 2F position with E-6010 or E-6011 [H03]	H3 (same)	Goals 1, 3, 4	D15, E5	5
*9.4	Make weld in 2F position with E-6013 [H18]	H4	Goals 1, 3, 4	D15, E5	5
9.5	Make weld in 3F position with E-6010 or E-6011 [H05]	H5 (same)	Goals 1, 3, 4	D15, E5	5
9.6	Make weld in 3F position with E-6013 [H06]	H6	Goals 1, 3, 4	D15, E5	5
9.7	Make weld in 4F position with E-6010 or E-6011 [H07]	H7 (same)	Goals 1, 3, 4	D15, E5	5
9.8	Make weld in 4F position with E-6013 [H08]	H7	Goals 1, 3, 4	D15, E5	5
*9.9	Make butt weld in horizontal position with E-6010 or E-6011 (qualifies flat position) [H11]	H11	Goals 1, 3, 4	D7, D15, D16, E5	5
*9.10	Make butt weld in horizontal position with E-6013 (qualifies flat position) [H19]	H12	Goals 1, 3, 4	D7, D15, D16, E5	5
9.11	Make butt weld in vertical down position with E-6010 or E-6011 [H13]	H13	Goals 1, 3, 4	D15, E5	5
9.12	Make butt weld in vertical down position with E-6013 [H20]	H14	Goals 1, 3, 4	D15, E5	5
9.13	Make butt weld in overhead position with E-6010 or E-6011 [H15]	H15	Goals 1, 3, 4	D15, E5	5
9.14	Make butt weld in overhead position with E-6013 [H21]	H16	Goals 1, 3, 4	D15, E5	5
10. Gas Metal Arc Welding - Plate and Pipe					
*10.1	Demonstrate safety procedures for gas metal arc welding [I01]	I1	Goals 1, 2, 3, 4	E5, H2, H4, H9	3, 4
*10.2	Describe theory of gas metal arc welding [I34]		Goals 1, 2	D15, E5	3
*10.3	Identify, select and safely handle shielding gases for various metals [I02]	I2	Goals 1, 3, 4	D15, E5, H1	3, 5
*10.4	Adjust current, voltage, pulse, wire feed rate and gas flow [I03]	I3	Goals 1, 3, 4	D1, D15, E5	3, 5
*10.5	Identify, select and set up equipment [I04]	I4	Goals 1, 3, 4	D15, E5	3, 5
*10.6	Identify and select solid wire electrode for carbon steel, aluminum and stainless steel [I35]	I4, I5, I7	Goals 1, 4	D15, E5	5

Missouri Competency	Previous Mo. Competencies	Show-Me Standards	AAOI Objectives	VICA/SCANS Competencies
*11.9 Make weld in 2G position with carbon steel and cored wire (qualifies 1G position) [O09]	I26	Goals 1, 3, 4	D7, D15, D16, E5	5
11.10 Make weld in 3G position, vertical up, with carbon steel and cored wire [O10]	I27	Goals 1, 3, 4	D15, E5	5
11.11 Identify welding problems, their causes and take corrective action [O11]	I32 (same)	Goals 1,2, 3, 4	D13, D15, E5	3, 4, 5
11.12 Prepare flux cored arc weld for test [O12]	I33	Goals 1, 3, 4	D7, D15, D16, E5	5
12. Gas Tungsten Arc Welding (Carbon Steel, Stainless Steel, Aluminum)				
*12.1 Demonstrate safety procedures for gas tungsten arc welding [J01]	J1	Goals 1, 2, 3, 4	H2	3, 4
12.2 Describe theory of gas tungsten arc welding [J35]		Goals 1, 2	D3, D15, E5	3
*12.3 Identify, select and set up equipment and explain function [J02]	J2 (same)	Goals 1, 3, 4	D3, D15, E5, H2	3, 5
*12.4 Identify, select and safely handle shielding gases [J03]	J3 (same)	Goals 1, 2, 4	D15, E5, H2	3, 5
*12.5 Identify, select, shape and install tungsten electrode [J04]	J4 (same)	Goals 1, 2, 4	D15, E5	3, 5
*12.6 Adjust polarity, pulse, current, gas flow setting and post flow timer and strike arc [J05]	J5	Goals 1, 4	D1, D15, E5	3, 5
12.7 Identify joint design and prepare material for weld procedure specification (WPS) [J06]	J6	Goals 1, 4	D7, D15, D16, E5	3, 5
12.8 Select filler rod for base material [J07]	J7 (same)	Goals 1, 4	D15, E5	3, 5
12.9 Make weld in 2F position, stainless steel (qualifies 1F position) [J15]	J15	Goals 1, 3, 4	D7, D15, D16, E5	5
12.10 Make weld in 2F position, aluminum (qualifies 1F position) [J16]	J16	Goals 1, 3, 4	D7, D15, D16, E5	5
12.11 Make weld in 2F position, carbon steel (qualifies 1F position) [J17]	J17	Goals 1, 3, 4	D7, D15, D16, E5	5
12.12 Make weld in 3F position, stainless steel [J18]	J18 (same)	Goals 1, 3, 4	D15, E5	5
12.13 Make weld in 3F position, aluminum [J19]	J19 (same)	Goals 1, 3, 4	D15, E5	5
12.14 Make weld in 3F position, carbon steel [J20]	J20 (same)	Goals 1, 3, 4	D15, E5	5
12.15 Make weld in 2G position, stainless steel (qualifies 1G position) [J27]	J27	Goals 1, 3, 4	D7, D15, D16, E5	5
12.16 Make weld in 2G position, aluminum (qualifies 1G position) [J28]	J28	Goals 1, 3, 4	D7, D15, D16, E5	5
12.17 Make weld in 2G position, carbon steel (qualifies 1G position) [J29]	J29	Goals 1, 3, 4	D7, D15, D16, E5	5
12.18 Make weld in 3G position, vertical up, on stainless steel [J30]	J30	Goals 1, 3, 4	D15, E5	5
12.19 Make weld in 3G position, vertical up, on aluminum [J31]	J31	Goals 1, 3, 4	D15, E5	5
12.20 Make weld in 3G position, vertical up, on carbon steel [J32]	J32	Goals 1, 3, 4	D15, E5	5

Missouri Competency	Previous Mo. Competencies	Show-Me Standards	AAOI Objectives	VICA/SCANS Competencies
15. Carbon Arc Gouging				
*15.1 Demonstrate safety procedures for carbon arc gouging [M01]	M1	Goals 1,2, 3, 4	D15, E5, H2, H4	3, 4
15.2 Describe theory of carbon arc gouging [M04]		Goals 1, 2	D15, E5	3, 5
*15.3 Identify and select electrode size, polarity, current and air pressure [M05]	M2	Goals 1, 2, 3, 4	D15, E5	3, 5
15.4 Set up and operate carbon arc gouging equipment [M02]	M2	Goals 1, 3, 4	D13, D15, E5	2, 3, 4, 5
*15.5 Remove weld material/backgouge [M03]	M3	Goals 1, 3, 4	D15, E5	3, 4, 5
16. Visual Weld Testing				
*16.1 Prepare sample for visual test per appropriate standard [P01]		Goals 1, 3, 4	D7, D15, D16, E5	2, 3, 5
*16.2 Inspect for undercut, overlap, porosity, slag, spatter and weld size [P02]		Goals 1, 3, 4	D15, E5	2, 3, 4, 5
*16.3 Identify defects and take corrective action based on visual test [P03]		Goals 1, 3, 4	D15, E5	3, 4, 5
17. Destructive Testing				
17.1 Prepare coupon for bend test per appropriate standard [Q01]		Goals 1, 3, 4	D1, D2, D7, D15, D16, E5	2, 3, 5
17.2 Perform destructive test on weld [Q02]		Goals 1, 3, 4	D15, D16, E5	3, 4, 5
17.3 Identify defects and take corrective action based on destructive test [Q03]		Goals 1, 3, 4	D15, D16, E5	3, 4, 5
18. Non-Destructive Testing				
18.1 Prepare sample for non-destructive test per appropriate standard [R01]		Goals 1, 3, 4	D1, D2, D7, D15, D16, E5	2, 3, 5
18.2 Perform non-destructive test per appropriate standard [R02]		Goals 1, 3, 4	D15, D16, E5	3, 4, 5
18.3 Inspect for undercut, overlap, porosity, slag, spatter, and surface cracks [R03]		Goals 1, 4	D2, D13, D15, D16, E5	3, 4, 5
18.4 Identify defects and take corrective action based on non-destructive test [R04]		Goals 1, 3, 4	D13, D15, D16, E5	3, 4, 5
19. Leadership Competencies				
19.1 Demonstrate an understanding of VICA, its structure and activities [N01]	N1	Goal 1		
19.2 Demonstrate an understanding of one's personal values [N02]	N2	Goal 1		
19.3 Perform tasks related to effective personal management skills [N03]	N3	Goal 4	I4	
19.4 Demonstrate interpersonal skills [N04]	N4	Goal 2	I4	G1

AMERICAN WELDING SOCIETY
ENTRY-LEVEL WELDER PROGRAM OUTLINE, 1995

Source: *Guide for the Training and Qualification of Welding Personnel: Entry Level Welder (AWS EG2.0-95).* Miami: American Welding Society, 1995.

Course A: Occupational Orientation

1. Follow safe practices
2. Prepare time or job cards, reports or records
3. Perform housekeeping duties
4. Follow verbal instructions to complete work assignments
5. Follow written details to complete work assignments

Course B: Drawing and Welding Symbol Interpretation

1. Interpret basic elements of a drawing or sketch
2. Interpret welding symbol information
3. Fabricate parts from a drawing or sketch

Course C: Arc Welding Principles and Practices

Unit 1: Shielded Metal Arc Welding (SMAW)

1. Perform safety inspections of equipment and accessories
2. Make minor external repairs to equipment and accessories
3. Set up for shielded metal arc welding operations on plain carbon steel
4. Operate shielded metal arc welding equipment
5. Make fillet welds, all positions, on plain carbon steel
6. Make groove welds, all positions, on plain carbon steel
7. Perform 2G-3G limited thickness qualification tests on plain carbon steel plate

Unit 2: Gas Metal Arc Welding (GMAW, GMAW-S)

1. Perform safety inspections of equipment and accessories
2. Make minor external repairs to equipment and accessories
3. Set up for gas metal arc welding operations on plain carbon steel)
4. Operate gas metal arc welding equipment

Short circuit transfer

5. Make fillet welds, all positions, on plain carbon steel
6. Make groove welds, all positions, on plain carbon steel

Spray transfer

7. Make 1F-2F welds on plain carbon steel
8. Make 1G welds on plain carbon steel

Unit 3: Flux Cored Arc Welding (FCAW, FCAW-G)

1. Perform safety inspections of equipment and accessories
2. Make minor external repairs to equipment and accessories
3. Set up for flux cored arc welding operations on plain carbon steel
4. Operate flux cored arc welding equipment
5. Make fillet welds, all positions, on plain carbon steel
6. Make groove welds, all positions, on plain carbon steel

Unit 4: Gas Tungsten Arc Welding (GTAW)

1. Perform safety inspections of equipment and accessories
2. Make minor external repairs to equipment and accessories
3. Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel
4. Operate gas tungsten arc welding equipment
5. Make fillet welds, all positions, on plain carbon steel
6. Make groove welds, all positions, on plain carbon steel
7. Make 1F - 2F welds on aluminum
8. Make 1G welds on aluminum
9. Make 1 F - 3F welds on stainless steel
10. Make 1G - 2G welds on stainless steel

SHOW-ME STANDARDS

The new educational goals and standards are a result of the Outstanding Schools Act of 1993, which calls on Missouri citizens and educators . . . to define appropriate, rigorous expectations for children's learning. Committees of teachers, citizens, parents, lawmakers and state officials have been working on the proposed goals and standards since then.

To lead productive and fulfilling lives and to continue learning, students in Missouri public schools will acquire the knowledge and skills to:

Goal 1: Gather, analyze and apply information and ideas;

Goal 2: Communicate effectively within and beyond the classroom;

Goal 3: Recognize and solve problems; and

Goal 4: Make decisions and act as responsible members of society

Source: "The Show-Me Standards." Jefferson City, MO: Missouri Department of Elementary and Secondary Education, January 1996.

B17 Describe how a company's marketing affects all its employees.

C. Finance

C1 List typical ways a business obtains capital.
C2 Describe the importance of accounting in a business.
C3 Describe key implications for a company which grants credit.
C4 Describe how a company estimates and bids for a contract.
C5 Describe how paycheck deductions affect a worker.
C6 Describe the importance of cost containment in a company.

D. Technical and Production Skills

D1 Demonstrate a basic math ability.
D2 Demonstrate the capability to measure quickly and accurately.
D3 Demonstrate the ability to speak and write the English language effectively.
D4 Demonstrate the ability to listen effectively.
D5 Demonstrate the ability to use effective negotiation skills.
D6 Demonstrate the ability to manage time effectively.
D7 Demonstrate the ability to read blueprints and drawings.
D8 Demonstrate the ability to perform basic computer operation.
D9 Describe the importance of deadlines and schedules.
D10 Demonstrate the ability to use team player skills.
D11 Demonstrate the ability to use supervisory and delegation skills.
D12 Demonstrate the ability to utilize good public speaking skills.
D13 Describe the importance of using troubleshooting techniques.
D14 Cite one example of a job that is inter-related with another job.
D15 Demonstrate the ability to obtain technical information.
D16 Identify certification requirements for a specific job.

E. Principles of Technology

E1 Describe the key characteristics of the technology used in your industry.
E2 Describe the importance of analyzing new equipment for possible use.
E3 Describe the importance of continuously upgrading one's job skills.
E4 Describe the importance of adaptability and learning from experience.
E5 Describe the importance of acquiring and analyzing information effectively and making sound decisions.
E6 Describe the importance of cross-training.

F. Labor

F1 Describe the importance of a written job description.
F2 Describe the importance of knowing your rights as a worker.
F3 Describe the role labor organizations play in your industry (if any).
F4 List advantages/disadvantages of hourly and salaried pay.
F5 List differences between being a self-employed worker and a worker employed by a company.
F6 Describe the importance of participating in quality enhancement programs.
F7 Describe the importance of understanding why a worker is asked to occasionally work longer hours.
F8 Describe the importance of cultural sensitivity.

G. Community

G1 Describe the importance of recognizing a worker should contribute special skills through volunteer work.

SCANS COMPETENCIES

SCANS *foundation skills* identified by the U.S. Department of Labor describe generic skills needed by nearly everyone. The SCANS *competencies*, however, are more specific in nature and are listed below. (SCANS is the acronym for the Secretary [of Labor]'s Commission on Achieving Necessary Skills.) National VICA's *Total Quality Curriculum* incorporates SCANS competencies and Total Quality Management (TQM) principles in a 17-module set of activities.

1. **Resources**
   - Allocates time
   - Allocates money
   - Allocates material and facility resources
   - Allocates human resources

2. **Interpersonal**
   - Participates as a member of a team
   - Teaches others
   - Serves clients/customers
   - Exercises leadership
   - Negotiates to arrive at a decision
   - Works with cultural diversity

3. **Information**
   - Acquires and evaluates information
   - Organizes and maintains information
   - Interprets and communicates information
   - Uses computers to process information

4. **Systems**
   - Understands systems
   - Monitors and corrects performance
   - Improves and designs systems

5. **Technology**
   - Selects technology
   - Applies technology to task
   - Maintains and troubleshoots equipment

POST-SECONDARY INSTITUTIONS OFFERING TRAINING IN WELDING

Construction Craft Laborer Apprenticeship ** Articulation with Lewis & Clark

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Crowder College
Student Services
601 Laclede
Neosho, MO 64850
(417) 451-3223
* Two Year/Public Institution

East Central College
Office of Admissions
Hwy 50 & Prairie Dell Road
Union, MO 63084
(314) 583-5193
* Two Year/Public Institution

Jefferson College
Director of Admissions
1000 Viking Drive
Hillsboro, MO 63050
(314) 789-3951
* Two Year/Public Institution

Linn State Technical College
One Technology Drive
Linn, MO 65051
(800) 743-8324
* Two Year/Public Institution ** Articulation with Lewis & Clark

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Maple Woods Community College
Office of Admissions
2601 North East Barry Road
Kansas City, MO 64156
(816) 437-3100
* Two Year/Public Institution

Ranken Technical College
Admissions Office
4431 Finney Avenue
St. Louis, MO 63113
(314) 371-0233, ext. 4809
* Two Year/Private Institution

State Fair Community College
3201 West 16th Street
Sedalia, MO 65301
(816) 530-5800
* Two Year/Public Institution

St. Louis Area Construction Training
Tech Prep Consortium

Construction Craft Laborers Articulation Agreement With Approved Missouri Area Vocational-Technical Schools (Electrical, Welding, Building Maintenance, Small Engines, Industrial Maintenance Programs)

What does this mean to you?

If you meet the Construction Craft Laborers articulation criteria, you can:

- Receive credit for 250 on the job training hours toward your journey-level card
- Earn up to 40 hours of training credit toward your journey-level card

For more information see www.k4cybertech.net/laborersagc or contact:

Donald A. Griesenauer, Jr., Coordinator
Construction Craft Laborer Apprenticeship Program
35 Opportunity Road
High Hill, Missouri 63350
(314) 585-2391
e-mail: laborers@highhill.net

OR

Dr. Janis Beacham, Coordinator
St. Louis Area Construction Training Tech Prep Consortium
6301 Knox Industrial Drive
St. Louis, MO 63139
(314) 653-9012
e-mail: tbeachargh@aol.com

LINN STATE
Technical College

Agreement of Understanding

Linn State Technical College seeks to expand educational opportunities to students through advanced and professional technical education. The program specifics outlined below provide a baseline of courses available for articulated credit. To allow responsible flexibility for individual secondary school differences, changes in program specifics may be made with the mutual assent of the secondary school and LSTC prior to finalizing/signing the articulation agreement. Contact LSTC should course changes be required. **Refer to LSTC program content, Syllabi and course descriptions (following) for clarification of articulated course learning objectives.**

Welding Courses

Articulation Agreement with:

Lewis & Clark Career Center

COURSES THAT QUALIFY FOR ARTICULATED CREDIT			
LSTC COURSE DESCRIPTION	COURSE NO.	CREDIT HOURS	SECONDARY COURSES TITLE/DESCRIPTION
Basic Welding	MPT 165	3.0	Advanced Welding

SIGNATURES:

LSTC agrees to grant college credit to students based on the "Goals, Guidelines, Procedures and the program specific guidelines/amendments" provided in the agreement. As such, we have reviewed this instrument and agree to the terms of this articulation agreement.

Linn State Technical College

W. Schuh Date: 9-27-07

Dean of Instruction

Date: 9.26.07

Department Chair

Lewis & Clark Career Center

Date: 9/18/07

Secondary Director

Date: 9/19/07

Secondary Instructor

Welding Advisory Board Meeting

04/01/2007
Lewis & Clark Career Center

Meeting called by:	**Rick Massey**	**Facilitator:**	**Rick Massey**

Attendees: **Pat Calloway, Robert Lawrence, Bob Dorn**

Agenda

Work Opportunities

Discussion: When asked what the future of welding was in our area the advisory board members made the comments below: (see special notes)

Conclusion: The future of welding is looking up especially in Boilermaking, but things have been slow in general. Pat Calloway says he was looking to hire a few new employees, but things are on hold at the present time at Didion.

Additional Information

Special notes:

1. **Pat Callaway:** With Didion Manufacturing: States that his company might hire some students in the work program. Their business is slow not but they are anticipating an increase soon. He is providing scrap metal next week.
2. **Robert Lawrence:** With American iron: they are slow but always are in the 1st quarter. He has been notified by the Ironworkers Local 396 that we should be prepared because there will be a shortage of ironworkers very soon. Robert has employed 1 of my students, Adam Lawrence. He may hire 1 more this summer. Robert will send some scrap metal for our program.
3. **Bob Dorn:** With Praxair: He states that the market looks good and so does the future of welding in this area. Sales are strong , and he has a positive outlook for the future. He will continue to work with us on product and pricing.
4. **Curt Eggen:** With Lincoln Electric: He agrees that the future of welding is looking very strong. There is just a lot of companies on hold for production.

Welding Advisory Board Meeting

02/06/2007
Lewis & Clark Career Center

Meeting called by:	**Rick Massey**	**Facilitator:**	**Rick Massey**

Attendees: **Mark Eggen, Pat Calloway, Robert Lawrence, Bob Dorn**

Agenda

Work Opportunities and Scrap Metal

Discussion: When asked what the future of welding was in our area the advisory board members made the comments below: (see special notes)

Conclusion: The future of welding is looking up and board members have agreed to supply us with scrap metal for our shop.

Additional Information

Special notes:

1. **Pat Callaway:** With Didion Manufacturing: States that his company might hire some students in the work program. Their business is slow not but they are anticipating an increase soon. They had been working a lot of overtime up until the time of the slow down. He is providing scrap metal next week.
2. **Robert Lawrence:** With American iron: they are slow but always are in the 1st quarter. He has been notified by the Ironworkers Local 396 that we should be prepared because there will be a shortage of ironworkers very soon. Robert has employed 2 of my students, Eric Fromme and Adam Lawrence . Robert will send some scrap metal for our program.
3. **Bob Dorn:** With Praxair: He states that the market looks good and so does the future of welding in this area. Sales are strong , and he has a positive outlook for the future. He will continue to work with us on product and pricing.
4. **Curt Eggen:** With Lincoln Electric: He agrees that the future of welding is looking very strong.

Course: Combination Welding

Teacher: Massey

Instructional Methods Used:

Lecture:

Lectures are used to bring the books to life and to fill in the knowledge gained by reading. These are often intermingled with demonstrations of certain theories or points of understanding. Often they are used to lead in to Lab or other Hands-on type work activities.

Lab Activities:

Extensive use of the lab/shop is the basic staple of the welding course. The hands on experience is crucial to becoming a professional welder, as the students perfect the many processes used in welding and fabrication. All of the group projects are done in the lab as these hands on activities are some of the most valuable parts of the whole curriculum.

Demonstrations:

Both in the classroom and the lab/shop, demonstrations provide needed lessons when beginning a new welding process or position. Many of the "tricks" of the trade are passed on to the students in these demonstrations. Many of these techniques cannot always be explained by lecturing, but are best shown by demonstrations.

Problem Based Learning:

One of the best advantages of having a working lab is the ability to accept equipment for repair on a learning basis. The students use all applicable tools, and under the instructors' guidance, troubleshoot, and effect repair of actual equipment. A wide variety of equipment is involved in such repairs, providing priceless experience to the student while building community rapport for the Technical Center.

Co-Operative/Mentoring:

Many of the learning activities involve small group and/or mentoring. Teams are rotated on a regular basis and students will work with all others during the year. The students will critique their own work as well as that of the other team members, and valuable experience is gained in both leadership and in working with others towards common goals.

Conventional Audio-Visual Products:

Audio and Videotapes, as well as overhead projections and other standards are used on occasion to provide training for the students. Safety films, tapes on special techniques and procedures, and tours of outside facilities are some examples of times where such media are used. Overhead projections and slides are used to emphasize and assist when lecturing.

Basic Metals and Metallurgy
Unit 4

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify metals by appearance, color, and corrosion characteristics, and conduct magnet tests, spark tests, and chisel tests to identify common metals used for welding. The student should demonstrate these competencies by completing the assignment and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to basic metals and metallurgy with their correct definitions.
2. Select true statements about advantages of proper metal identification.
3. Match basic metals, alloys, and properties with their definitions.
4. Select true statements about metal identification tests and their characteristics.
5. Match mechanical properties of metals with their characteristics.
6. Match types of mechanical strengths with their characteristics.
7. Select true statements about physical properties of metals and their characteristics.
8. Solve problems about steel identification systems and their characterisitcs.
9. Complete a chart of carbon steel classifications, characteristics, and typical uses.
10. Match principal steel alloys with their uses.
11. Complete a chart of alloy steel classifications, characteristics, and typical uses.
12. Complete a chart of iron classifications, characteristics, and typical uses.

Objective Sheet

13. Complete statements about guidelines for identifying metals by color and characteristics.

14. Select true statements about aluminum, its characteristics, and uses.

15. Complete statements about basics of the *commercial* system for identifying aluminum.

16. Select true statements about the 1XXX group commercial identification system.

17. Select true statements about the 2XXX plus group commercial identification system.

18. Solve problems about other elements of commercial aluminum identification and their meanings.

19. Complete definitions of aluminum quality designations and their meanings.

20. Arrange in order the steps in using the commercial system to identify aluminum.

21. Match other nonferrous metals with their typical uses.

22. Select true statements about guidelines of testing properties of metals.

23. Select true statements about equipment requirements for spark testing.

24. Complete statements about guidelines for spark testing.

25. Complete statements about characteristics of residual stresses.

26. Select true statements about causes of residual stresses and distortion.

27. Select true statements about guidelines for controlling expansion and contraction.

28. Identify routes for heat expansion in basic welds.

29. Identify results of longitudinal and transverse stress in basic welds.

30. Complete statements about heat applications and their uses in weld quality control.

31. Select true statements about guidelines for preheating in special conditions.

32. Complete statements about methods of preheating and postheating and their applications.

Objective Sheet

33. Match torch preheating techniques with their applications.

34. Match types of steels with their recommended preheat temperatures.

35. Match temperature-sensing devices with their uses.

36. Identify methods for controlling distortion with the welding process.

37. Select true statements about guidelines for controlling distortion with mechanical means.

38. Match methods for controlling distortion with restraining devices with their applications.

39. Identify selected metals by appearance, color, and corrosion characteristics. (Assignment Sheet 1)

40. Conduct magnet tests to identify common metals used for welding. (Job Sheet 1)

41. Conduct chisel tests to identify common metals used for welding. (Job Sheet 2)

42. Conduct spark tests to identify common metals used for welding. (Job Sheet 3)

Basic Metals and Metallurgy
Unit 4

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.

2. Review Teaching Suggestions that follow. Plan for classroom activities.

3. Plan presentation for enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TMs 1 and 2—Spark Test Characteristics (Objective 24)
   TM 3—Metal Melting Points and Other Temperatures (Objective 5, 6, 7, and 8)
   TM 4—Heating Ranges for Ferrous Metals (For use with Teacher Supplement 1)
   TM 5—Aluminum Hardness and Tempering Designations (Objective 18)

5. Obtain films, videotapes and other resources to supplement instruction of this unit. See ordering information in the Suggested Supplemental Resources that follow.

6. Develop teaching plan. Adjust for different learning styles.

7. Make copies of Unit Evaluation Form.

Delivery and Application

8. Provide students with unit of instruction.

9. Discuss unit and specific objectives.

10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

11. Discuss assignment and job sheets. Review criteria for evaluation of these activities.

Suggested Activities

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

13. Make copies of the written test. Add or modify test questions as needed.

14. Give written test.

15. Compile assignment and job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments.

16. Reteach and retest and required.

Teaching Suggestions

Note: Skill areas appearing in bold face type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These ASTD skill areas have been adapted by MAVCC.

1. This is a long unit of instruction. Teach the unit in related segments, and break the test up to reflect the segments so students will not be faced with an extremely long test. Objective 25 through 30 concern themselves with residual stresses and distortion and how to control them. Teach these objectives together and provide adequate demonstration of items related to distortion control. Ideally, this part of the unit should be integrated with the teaching of Oxyacetylene Welding or Shielded Metal Arc Welding. In other words, provide students the opportunity to work with distortion control as it really happens on the job. Distortion control should be on students minds in all welding activities. Skill areas: **learning to learn**.

2. When teaching Objective 7, demonstrate thermal conductivity as it is shown in the objective. Have students assist with the demonstration so they will become personally involved. Skill areas: **foundation skills** and **science**.

3. Prepare a testing demonstration for Objective 22. If you have a Brinell or Rockwell tester, use it to demonstrate a hardness test. Prepare test coupons properly notched to demonstrate the Izod and Charpy tests. Have students help with the testing. Skill areas: **foundation skills** and **science**.

Suggested Activities

4. Demonstrate the equipment required for spark testing as it is outlined in Objective 23 and Job Sheet 3. Be sure to stress proper grinding wheel rpm, and show students manufacturer's information about rpm adjustment for a stationary or a disc grinder. Demonstrate how to clean a grinding wheel with a wire brush. Next, demonstrate the spark testing procedure outlined in Objective 24. Have students help by getting involved with color identification and stream identification. Wait until last to demonstrate a nonferrous metal, and then grind a piece of ferrous metal long enough to clean the grinding wheel so it will be ready for use in Job Sheet 3. If you do grind aluminum, use a grinding wheel or disc designed to grind aluminum. Skill areas: **foundation skills** and **science**.

Resources Used in Developing This Unit

1. Fortney, Clarence and Mike Gregory. *Introduction to Welding.* Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1984.

2. *The Procedure Handbook of Arc Welding, Twelfth Edition.* Cleveland, OH: The Lincoln Electric Company, 1973.

3. *New Lessons in Arc Welding.* Cleveland, OH: The Lincoln Electric Company, 1981.

4. *Welding Kaiser Aluminum, First Edition.* Oakland, CA: Kaiser Aluminum and Chemical Sales, Inc., 1967.

5. Repp, Victor E., Willar J. McCarthy and Oswald A. Ludwig. *Metalwork Technology and Practice, Seventh Edition.* Bloomington, IL: McKnight Publishing Company. 1982.

6. Neely, John E. *Practical Metallurgy and Materials of Industry.* New York: John Wiley & Sons, Inc., 1979.

7. *Welding Handbook, Seventh Edition, Volume 4, Metals and Their Weldability.* Miami, FL: American Welding Society, 1982.

8. Connor, Leonard P., ed. *Welding Handbook, Eighth Edition, Vol. 1, Welding Technology.* Miami, FL: American Welding Society, 1987.

9. O'Brien, R. L., ed. *Welding Handbook, Eighth Edition, Vol. 2, Welding Processes.* Miami, FL: American Welding Society, 1991.

Suggested Activities

Suggested Supplemental Resource

An excellent video titled *Prevention and Control of Distortion* is available from the Lincoln Electric Company. The 20-minute production was made especially for Lincoln by Walt Disney Studios. The video features an animated cartoon character called Mr. Shrink. It is a color production, available in VHS format. The video may be ordered by title or by number, which is ED-211. The video costs $30, and prepaid orders should be sent to:

Book Department
The Lincoln Electric Company
22801 St. Clair Avenue
Cleveland, OH 44117

For further information, call 216-383-2211.

Basic Metals and Metallurgy
Unit 4

Unit Evaluation Form

Student Name _____ Unit Rating _____

Assignment Sheet 1—Identify Selected Metals by Appearance, Color, and Corrosion Characteristics Rating _____

Comments: _____

_____

Job Sheet 1—Conduct Magnet Tests to Identify Common Metals Used for Welding Rating _____

Comments: _____

_____

Job Sheet 2—Conduct Chisel Tests to Identify Common Metals Used for Welding Rating _____

Comments: _____

_____

Job Sheet 3—Conduct Spark Tests to Identify Common Metals Used for Welding Rating _____

Comments: _____

_____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other _____

_____

Teacher Signature _____ Date _____

Student Signature _____ Date _____

Basic Metals and Metallurgy
Unit 4

Teacher Supplement 1—Heating Ranges of Ferrous Metals

The heating ranges for steels with different carbon content reveal significant information about the reaction of no-carbon steels to heat. Use the following information along with Transparency 2 to introduce students to heat ranges. Relate heat changes to specific changes in characteristics of steel at varying temperatures so students will gain the basics of a metallurgical approach to metals.

Start at the bottom of the transparency with the sub-zero temperature range. Point out to students the extent of the range, from 0°F to minus 300°F. The significant changes in almost all metals in the sub-zero range is that they show a decrease in impact resistance. In fact, the lower the temperature, the lower the impact resistance.

Now as you move up the heat range chart to the color-coded heat ranges—black heat range, red heat range, white heat range—note that the color-coded ranges are based on steel with zero percent carbon. The rule of thumb for using the chart for other steels is: as carbon content in steel increases, preheating temperatures increase and temperatures above the transformation range decrease. With that rule of thumb in mind, you should be able to use steel samples from your own shop to demonstrate temperature ranges.

Start with the black heat range which extends from 0°F to 1000°F. The black heat range includes the preheating range for welding, a range which runs from about 60°F to just above 700°F. Note that the black heat range includes the blue brittle range from 300°F to 700°F. The blue brittle is the range where peening or working of steels should not be attempted. Metals are more brittle at the blue brittle range than they are above or below the blue brittle range. Note too that the black heat range includes the nitriding range from about 950°F to 1000°F. In manufacturing, certain steels are subjected to ammonia gas for long periods to give them extremely hard surfaces as the metals absorb nitrogen.

The red heat range extends from 1000°F to 2050°F. The red heat range includes the stress relieving range which runs from about 1120°F to 1250°F. Stress relief means the metal is held at the stress relieving range long enough to relieve locked-up stresses. Then, the metal is cooled slowly to produce what is called "process annealing."

The spheroidizing range is also in the red heat range. When a metal is held long enough at a temperature between 1250°F and 1350°F, it becomes soft enough to provide good machinability. This is accomplished in the spheroidizing range.

The range from 1350°F to 1690°F is called the transformation range. In the transformation range, steels undergo radical changes which affect their properties.

Austenite steel is produced in the annealing and normalizing range that extends from 1400°F to 1750°F. When steels are held at this temperature long enough, then slowly cooled, it produces a steel that has small grain size, softness, and good ductility.

Teacher Supplement 1

The carburizing range extends from about 1600°F to 1810°F. In this range, carbon can be dissolved into the surface of steel to create hard, high-carbon steel.

The forging range extends from 1810°F to 2400°F. Temperatures in the forging range permit metals to be mechanically worked or fused together.

Heating ranges play a significant role in metal manufacturing. A knowledge of heating ranges is a valuable asset for welders because heat and its proper application can help control distortion and produce a quality product.

Spark Test Characteristics

Low-Carbon Steel

Color-white

Average length of stream with power grinder - 70 in.

Volume -moderately large

Shafts shorter than wrought iron and in forks and appen-dages

Forks become more numerous and sprigs appear as carbon content increases

High-Carbon Steel

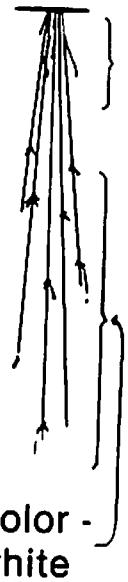
Color -white

Average stream length with power grinder - 55 in.

Volume -large

Numerous small and repeating sprigs

Stainless and Other Alloy Steel



Color -straw yellow

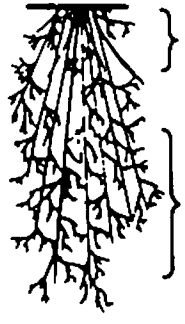
Stream length varies with type and amount of alloy content

Shafts may end in forks, buds or arrows, frequently with break between shaft and ar-row. Few, if any, sprigs

Color - white

Spark Test Characteristics
(Continued)

White Cast Iron



Color - red

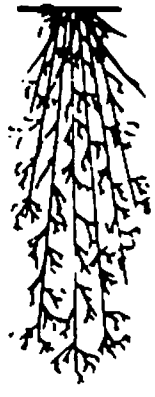
Color -straw yellow

Average stream length with power grinder - 20 in.

Volume -very small

Sprigs -finer than gray iron, small and repeating

Gray Cast Iron



Color - red

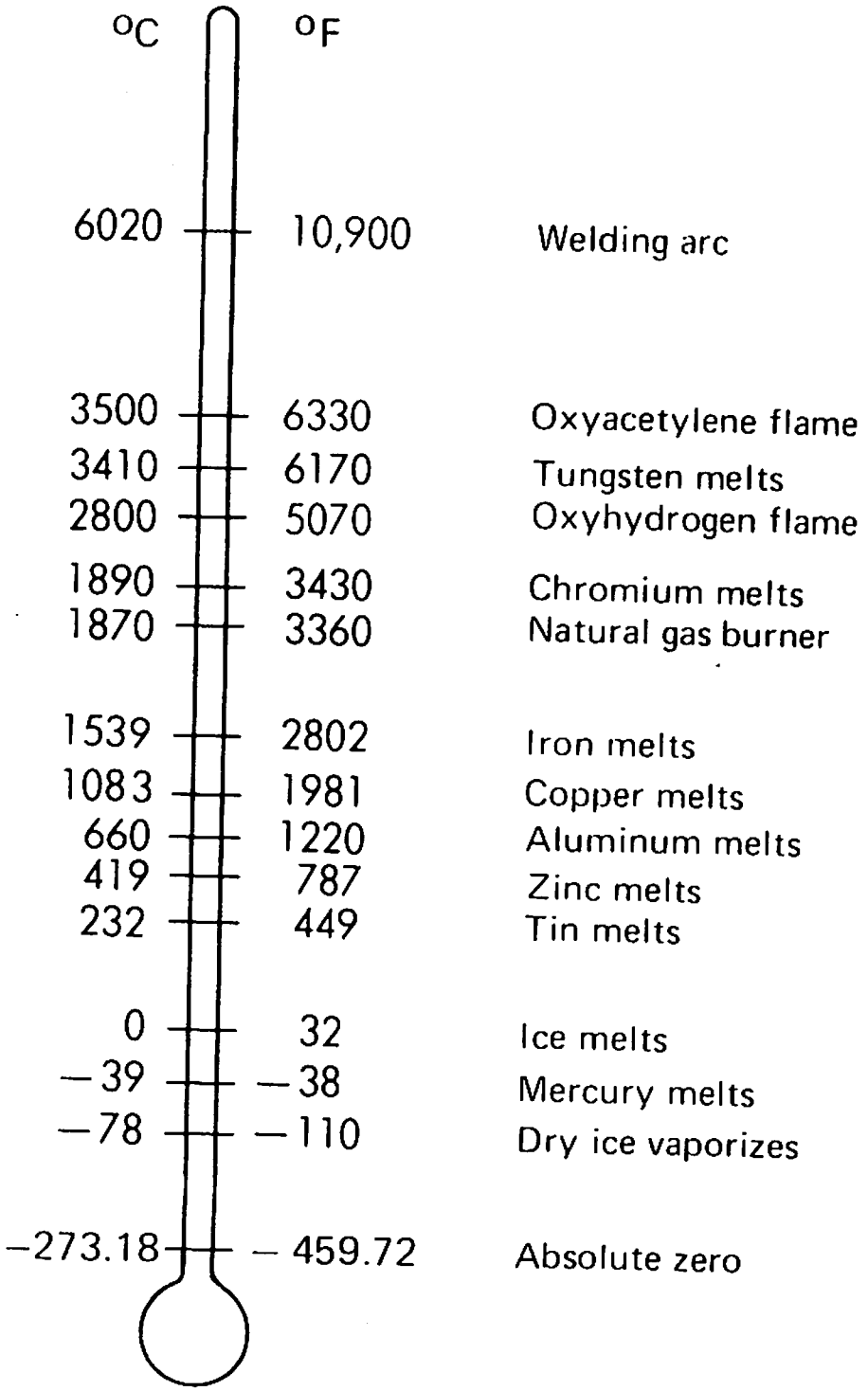
Color -straw yellow

Average stream length with power grinder - 25 in.

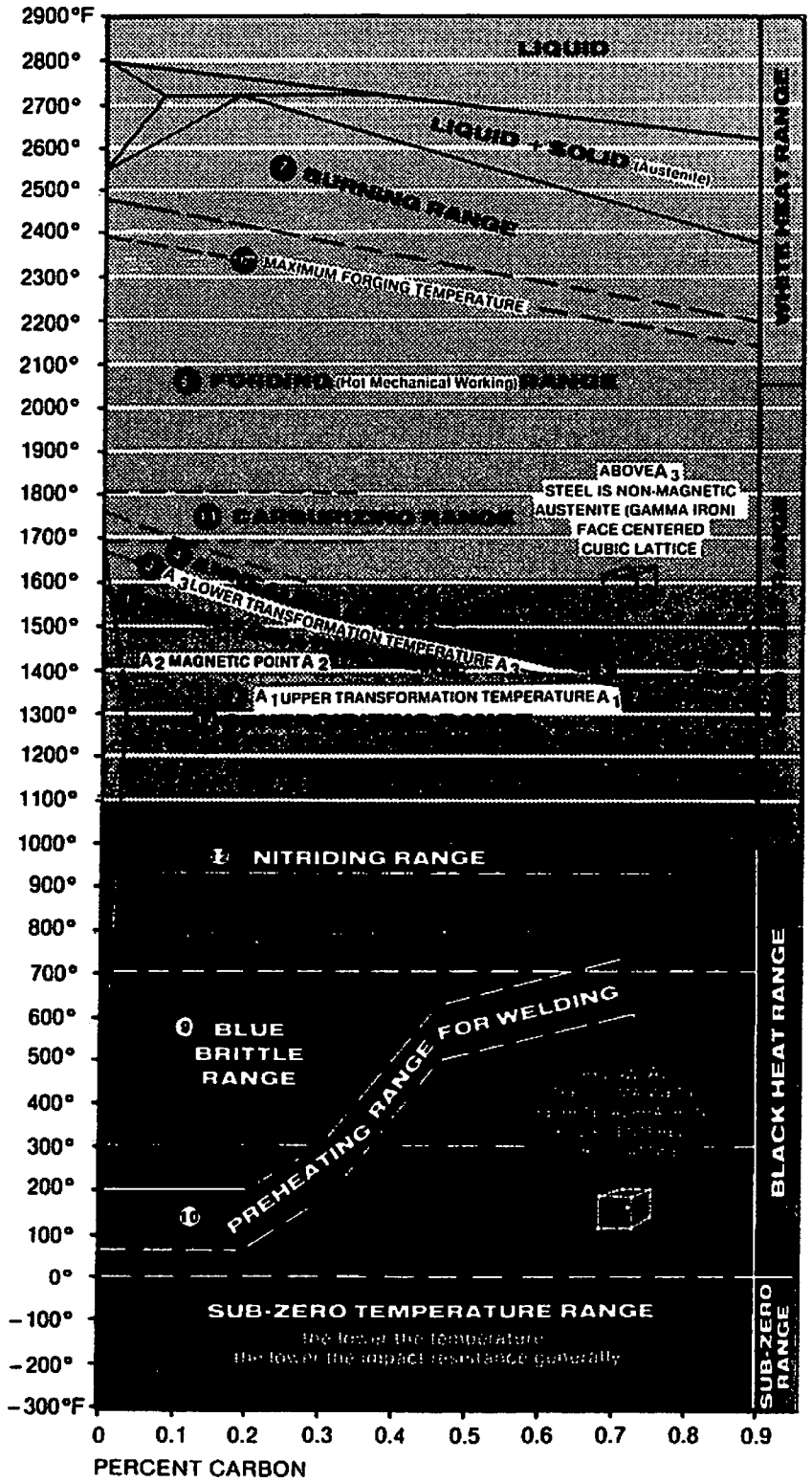
Volume -small

Many sprigs, small and repeating

Metal Melting Points and Other Temperatures



Heating Ranges for Ferrous Metals



Aluminum Hardness and Tempering Designations

T#	Process	Applications
T1	Naturally aged to a substantially stable condition	Castings which have their strength increased by room-temperature aging from the as-cast condition
T2	Annealed cast products only	Casting which have their ductility improved and dimensional stability increased with an annealing treatment
T3	Solution heat-treated and then cold worked	Products cold worked to improve strength or to achieve the effect of cold work in flattening or straightening
T4	Solution heat-treated and naturally aged to a substantially stable condition	Products which are not cold worked after solution heat-treatment
T5	Artificially aged from the as-cast condition	Products which are aged at elevated temperatures from the as-cast condition to improve mechanical properties or dimensional stability or both
T6	Solution heat-treated and then artificially aged	Products which are not cold worked after solution heat-treatment
T7	Solution heat-treated and then stabilized	Products which are stabilized to carry them beyond the point of maximum strength to provide control of special characteristics
T8	Solution heat-treated, cold worked, then artificially aged	Products which are cold worked to improve strength for certain applications
T9	Solution heat-treated, artificially aged, and then cold worked	Products which are cold worked to improve strength for certain applications
T10	Artificially aged and then cold worked	Products which are artificially aged after an elevated-temperature, rapid-cool process, and then cold worked to improve strength

Basic Metals and Metallurgy
Unit 4

Information Sheet

1. **Terms and definitions**

   a. **AA** — Aluminum Association

   b. **AISI** — American Iron and Steel Institute

   c. **Compatibility** — Two or more metals that have similar properties that can readily be joined

   d. **Extruding** — The process of forcing a metal through a special die to give it shape and length

   e. **Filler metals** — Metals added in making a brazed, welded, or soldered Joint

   f. **Interpass temperature** — Maintenance of heat to a base metal and weld passes during a welding process

   g. **Metallurgy** — The science that explains the properties, behavior, and internal structure of metals

   h. **Postheating** — Application of heat to a weld and/or a base metal after a welding operation to promote a slower cooling rate and relieve stresses in the base metal and the weldment

   i. **Preheating** — Application of heat to a base metal before welding or cutting

   j. **SAE** — Society of Automotive Engineers

   k. **Strain-hardened** — A metal that has had its strength, hardness, and brittleness increased with or without heating

   l. **Weldment** — Assembly of two or more metal parts with welding

2. **Advantages of proper metal identification**

   a. Proper metal identification helps determine the welding processes that are most effective and economical with a particular metal.

   b. Proper metal identification helps establish requirements for preheating, interpass heating, and postheating.

   c. Proper metal identification helps establish what metals are compatible so that proper filler metals can be selected.

Information Sheet

3. Basic metals, alloys, and properties and their definitions

a. **Ferrous metals** — Metals that contain iron as the major element

Example: Low, mild, medium, and high-carbon steels, and cast iron

b. **Nonferrous metals** — Metals that contain no iron or an extremely small amount of iron

Example: Aluminum, copper, zinc, lead, tin, nickel, silver, titanium, and gold

c. **Alloy** — A single element dissolved together with a metal or metals in a solid solution

d. **Alloy steels** — Steels formed by adding one or more additional elements to give the steels special properties

Note: Alloys may be either ferrous or nonferrous, but alloy steels are always ferrous.

e. **Mechanical properties** — The measure of how materials behave under applied loads

f. **Physical properties** — Properties such as melting point or thermal conductivity which are affected when metals are subjected to heat

g. **Chemical properties** — Properties which involve corrosion, oxidation, and reduction

4. Metal identification tests and their characteristics

a. Appearance—Surface color reveals the presence of oxidation; when exposed to weather, some metals will rust, others tarnish, and others remain oxidation free.

b. Chemical—Certain chemicals or acids applied to metals cause different reactions in different metals.

Example: When applied to stainless steel, a weak solution of nitric acid or copper sulfate remains clear, but when applied to carbon steel, it darkens.

c. Chisel—When chipped with a chisel, certain metals produce a continuous chip, others break up into small particles, and others cannot be chipped.

Example: Low-carbon steel chips easily and leaves a continuous chip, but cast iron is difficult to chip and breaks up into small pieces.

Information Sheet

d. File—Nonferrous metals are usually easy to file, but ferrous metals are difficult to file.

e. Magnet—A magnet sticks to ferrous metals, but it will not stick to nonferrous metals.

f. Sound—When struck with a hammer, most metals have a characteristic ring or lack of it.

Example: Steel has a higher-pitched ring than cast iron

g. Spark—Ferrous metals have definite spark patterns, but nonferrous metals have no spark pattern.

5. **Mechanical properties of metals and their characteristics**

a. **Brittleness** — The tendency of certain metals to break or fracture if bent or struck sharply

b. **Ductility** — The capacity of a metal to be permanently stretched without breaking

c. **Elasticity** — The capacity of a metal to return to its original size and shape when the force that changed it is removed

d. **Elastic limit** — The incapacity of a metal to return to its original size and shape when the force that changed it is removed

e. **Elongation** — The measure of ductility of material measured in a tension test

f. **Fatigue** — The tendency of some metals to break or fracture under a repeated or sustained load

g. **Hardness** — The capacity of metal to resist penetration, abrasion, and deformation

h. **Impact resistance** — The capacity of a metal to absorb without failure the impact of a load applied rapidly

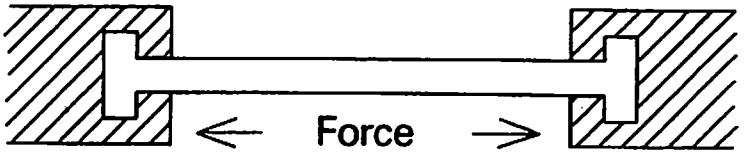
i. **Malleability** — The capacity of a metal to be hammered or rolled into shape without breaking

j. **Strength** — The capacity of a metal to resist changing its shape or size when exposed to external forces

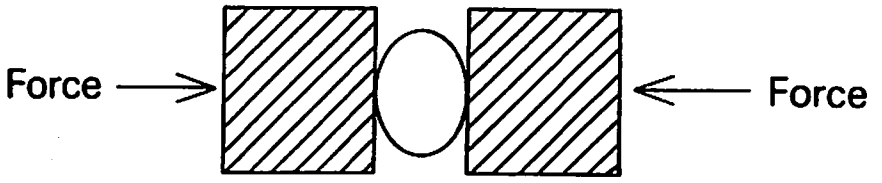
Information Sheet

6. Types of mechanical strengths and their characteristics

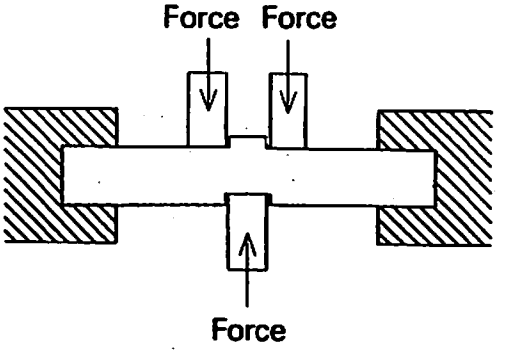
a. Tensile strength — The capacity of a metal to resist being pulled apart



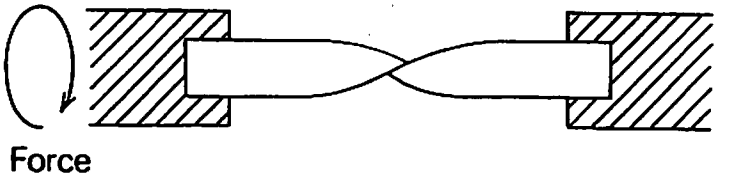
b. Compressive strength — The capacity of a metal to resist being pushed or crushed together



c. Shear strength — The capacity of a metal to withstand a sustained load across its cross section



d. Torsional strength — The capacity of a metal to resist twisting forces



7. Physical properties of metals and their characteristics

a. Density is the weight of a given piece of metal in relation to a unit size.

Example: A cubic foot of aluminum weighs less than a cubic foot of steel, so steel has a greater density than aluminum.

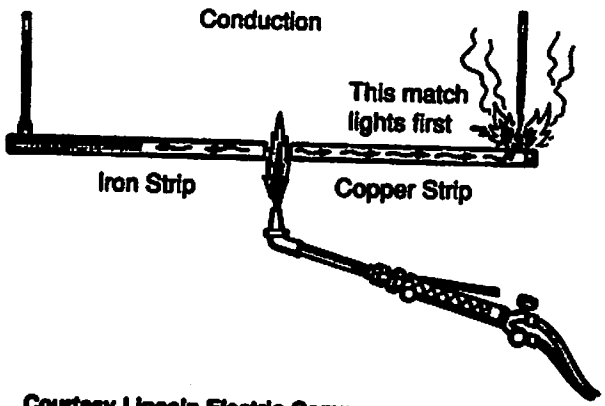
b. Electrical conductivity is the capacity of a metal to conduct electrical current.

Example: Copper has a much high electrical conductivity than steel and is used in many electrical wires.

Information Sheet

c. Thermal conductivity is the capacity of a metal to conduct heat.

Example: Silver and copper are metals that have high thermal conductivity.



Courtesy Lincoln Electric Company

d. Thermal expansion is the tendency of metals to expand when heated, as expressed in terms of coefficient of expansion.

Note: Thermal expansion is extremely important in welding because a metal such as aluminum which has a high coefficient of thermal conductivity will readily spread heat throughout the workpiece and minimize distortion at the weld zone, but metals such as stainless steel with a low coefficient of thermal conductivity will localize the heat in the weld zone and cause a greater amount of distortion.

e. Melting point is the point to which a metal must be heated before it will melt.

8. Steel identification systems and their characteristics

a. The SAE (Society of Automotive Engineers) and AISI (American Iron and Steel Institute) steel with a number system for the principal alloying ingredients in the steel.

(1) 1 indicates carbon.

(2) 2 indicates nickel.

(3) 3 indicates nickel-chromium.

(4) 4 indicates molybdenum.

(5) 5 indicates chromium.

(6) 6 indicates chromium-vanadium.

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(7) 7 indicates tungsten.

(8) 8 indicate nickel-chromium-molybdenum.

(9) 9 indicates silicon-manganese.

b. The AISI (American Iron and Steel Institute) also identifies steel with a letter system to designate how the steel was produced.

(1) A references open-hearth alloy steel.

(2) B references acid Bessemer carbon steel.

(3) C references basic open-hearth carbon steel.

(4) D references acid open-hearth steel.

(5) E references steel processed in an electric furnace.

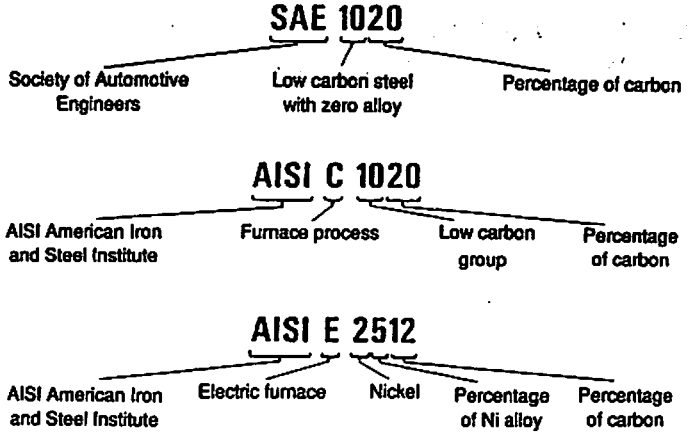
c. SAE and AISI identification systems both give place values to four-digit number codes.

(1) The first digit indicates the type of alloy.

(2) The second digit indicates the percentage of the alloy designated in the first digit.

(3) The last two digits indicate the percentage of carbon in the steel.

Examples:



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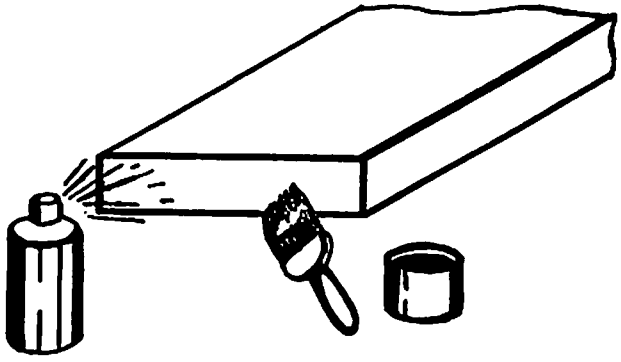
d. Color coding is a system that uses colors painted on the ends of steel bars or sheets to indicate the type of steel.

Note: Color coding varies with each manufacturer, so identification requires a guide from the mill that produced the steel; when working with color coded stock, start from the opposite end of the coloring so the stock can still be quickly identified even after part of it has been used.



Spray Brush

e. UNS (Unified Numbering System) is a system that uses a five-digit number with a letter prefix that designates a general ferrous metal or alloy group.

Unified Numbering System
Ferrous Metals

ID Letter and Number	General Metal or Alloy Group
000001-D99999	General Metal or Alloy Group
F00001-F99999	Cast iron, carbon, and low-alloy steel castings
G00001-G99999	Carbon and alloy steels (AISI and SAE)
H00001-H99999	H steels (AISI)
K00001-K99999	Other steels and ferrous alloys
S00001-S99999	Stainless steels
T00001-T99999	Tool steels

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9. Carbon steel classifications, characteristics, and typical uses

Classification	Characteristics	Typical Uses
Low carbon	0.07% to 0.15% carbon	Nails, iron bars and rods, auto bodies, and pipes
Mild steel	0.15% to 0.30% carbon	Gears, shafts, bolts, metal frames, angles, and channels
Medium carbon	0.30% to 0.50% carbon	Axles, shafts, machine bolts, boilers, hammers, and sledges
High carbon	0.50% to 1.00% carbon	Screwdrivers, crow bars, axes, springs, razor blades, and fine cutters

10. Principal steel alloys and their uses

a. Carbon — Used to make steels hard and strong

Note: The largest tonnage of all steel produced is low, medium, or high-crbon steel, with low carbon steel the most produced of the three.

b. Cobalt — Used to make steels that will remain hard when subjected to very high temperatures

c. Nickel — Used to make special steels with improved ductility while maintaining strength and toughness and a high resistance to corrosion and shock

d. Silicon — Used to make special steels that are hard and brittle

e. Molybdenum — Produces the greatest hardening effect of any element except carbon

f. Chromium — Increases tensile strength and hardness, as well as resistance to corrosion and oxidation

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11. Alloy steel classifications, characteristics, and typical uses

Classification	Characteristics	Typical Uses
Nickel steel	Strong and hard, resists corrosion, withstands shocks, vibration, and wear	Wire cables, railroad and car axles, and steel rails
Chromium steel	Fine grain, tough and strong, resists corrosion, shocks, and scratches	Auto bearings and safes
High chromium steel (Stainless steel)	Does not corrode, has a bright, silvery finish that looks good	Sinks, tables, and food service items subject to high standards of cleanliness
Chrome-nickel steel	Hard and strong	Auto gears, springs, axles, and armor plate
Manganese steel	Tough and strong, can resist strain, shock, and hammering	Jaws of rock crushers, chains, gears, and safes
Molybdenum steel	Tough and strong, resists heat and impact wear	Auto parts, high-grade machinery, and roller bearings
Tungsten steel	Hard, fine grained, and resists heat	High-speed metal cutting tools
Tungsten steel (Magnet steel)	Holds magnetism well	Electrical measuring instruments
Tungsten steel (Tungsten carbide)	Hardest man-made metal	Cutting tools and dies
Vanadium steel	Tough, but lightweight, fine grained, and resists shock	Auto axles, gears, and springs
Stellite steel	Extremely hard	Heavy cutting tools
High-speed steel	Self-hardening steel	Cutting tools, taps, and drills

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12. Iron classifications, characteristics, and typical uses

Classification	Characteristics	Typical Uses
Wrought iron	Resists corrosion, withstands shock, is malleable and easy to bend hot or cold	Rivets, bolts, nails, horseshoes, and ornamental iron
Gray cast iron	Relatively inexpensive, high compressive strength, but low tensile strength and brittle	Large pipes, stoves, water hydrants, and machinery frames
White cast iron	Very hard and brittle	Machine parts subjected to extreme wear or abrasion
Malleable cast iron	Tougher and more impact resistant than other cast irons	Farm tools, implement parts, and railroad equipment

13. Guidelines for identifying metals by color and characteristics

a. For low, medium, and high-carbon steels, look for new stock to be dark gray; these grades of steel rust with age, and rust rapidly when stored outside.

b. For manganese steels, look for a dull metallic surface on new stock; these steels rust with age, and rust rapidly when stored outside.

c. For stainless steels, look for bright, silvery-smooth surfaces; some grades of stainless rust with age and other grades tarnish.

d. For cast iron, look for a dull, gray color with evidence of the sand mold on new stock; cast irons rust rapidly in almost any environment.

e. For wrought iron, look for new stock to be light gray and smooth; wrought irons rust rapidly in almost any environment.

f. For aluminum, look for new stock to have a silvery-white, smooth surface; this light-weight metal has high corrosion resistance.

g. For copper, look for a reddish-brown, dull finish on new stock; copper resists corrosion, but it will tarnish.

h. For nickel, look for a hard, white finish; nickel resists rust and corrosion.

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14. Aluminum, its characteristics and uses

a. Aluminum is most used and most abundant of the nonferrous metals.

b. Aluminum is a silvery-white metal with a brilliant surface beauty that resists corrosion and is maintenance free.

c. Pure aluminum is very soft and difficult to use, so it is usually combined with an alloy to change its characteristics.

d. Aluminum is a good conductor of electricity, an excellent thermal reflector when it is polished, and a good thermal conductor in other forms.

e. Aluminum is both malleable and ductile and can easily be formed into shapes or into wire.

f. Aluminum is available in sheets, plates, bars, wires, pipes, tubes, and a great number of extruded forms.

15. Basics of the *commercial* system for identifying aluminum

a. The commercial system identifies aluminum by groups:

(1) The 1XXX group indicates aluminum of 99% or higher purity.

(2) The 2XXX group indicates aluminum with copper as the principal alloying element.

(3) The 3XXX group indicates aluminum with manganese as the principal alloying element.

(4) The 4XXX group indicates aluminum with silicon as the principal alloying element.

(5) The 5XXX group indicates aluminum with magnesium as the principal alloying element.

(6) The 6XXX group indicates aluminum with silicon and magnesium in approximate proportions as the principal alloying element.

(7) The 7XXX group indicates aluminum with zinc as the principal alloying element.

Note: There are other aluminum identification systems, but the *commercial* system was developed by the Aluminum Association to reflect common product references used by consumers and producers.

b. In the commercial identification system. there is a four-digit ID system especially for group 1XXX, and another four-digit ID system for the 2XXX plus group.

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16. Elements of the 1XXX group identification system

a. In the 1XXX group four-digit code, the first digit indicates a minimum of 99% aluminum.

b. The second digit indicates the degree of special control of impurities, with 0 indicating no special control and 9 indicating the highest special control.

c. The last two digits indicate the percent of aluminum beyond 99%.

Example: In the code 1030, the first digit indicates aluminum of 99% minimum, the second digit indicates no special controls for impurities, and the last two digits indicate .30% aluminum beyond 99% or 99.30% aluminum. In the codes 1130, 1230, and 1330, the second digits show there has been a degree of control for impurities.

17. Elements of 2XXX plus group commercial identification system

a. In the 2XXX plus group four-digit code, the first digit indicates the major alloying element in the aluminum.

b. The second digit indicates the amount of modification to the alloy, with 0 indicating no modification and 9 indicating the highest modification.

c. The last two digits have no special significance, but serve only to identify the different alloys in the groups as they pertain to manufacturing.

Example: In the code 2017, the first digit indicates a copper alloy and the second digit indicates no modification to the alloy. The last two digits have significance only to the manufacturer. However, the second digit in the code 2317 indicates a modification was made to the copper alloy.

18. Other elements of commercial aluminum identification and their meanings

a. Commercial aluminum identification uses both letters and numbers to indicate temper designations, the method and degree of tempering during the manufacturing process.

b. The basic designations are:

(1) F means as fabricated with no special tempering.

(2) O means annealed to produce a soft temper.

(3) H means strain hardened to produce a stronger temper.

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c. The H designation reflects the hardness of the temper on a scale of 1 through 9, working on a base 8 system.

Example: With the base 8, the number 2 indicate ⅜ or ¼ hard, 4 indicates ⅝ or ½ hard, 6 indicates ⅞ or ¾ hard, 8 indicates full hard, and 9 indicates extra hard.

d. In addition to the H designations for strain hardening, T designations are used to indicate product that has been thermally treated with or without strain hardening to produce stable tempers.

Note: There are 10 basic T designations ranging from 1 to indicate room temperature aging to 10 to indicate artificial aging and cold working. See Transparency 5 for details of the T designations.

19. Aluminum quality designations and their meanings

a. AQ—Aircraft quality

b. CQ—Commercial quality

c. HTQ—High-tensile quality

20. Steps in using the commercial system to identify aluminum

a. Determine the number code series.

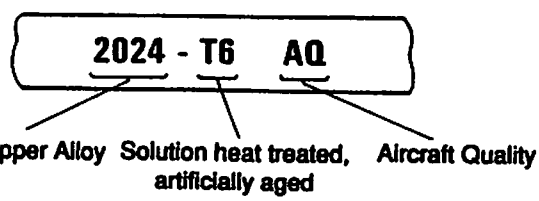
b. Determine the principal alloying element.

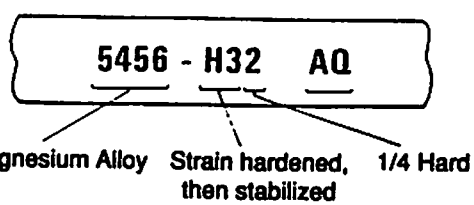
c. Determine the H or T designation.

d. Determine the degree of hardness.

e. Determine the quality designation.

Examples:





Information Sheet

21. Other nonferrous metals and their typical uses

a. Beryllium—Used in the space program because of its light weight and high heat resistance

b. Copper—Used in electric and telephone wires and in industrial applications because it is the second best conductor of electricity; also alloyed with zinc or tin to make brass or bronze

c. Gold—Used for jewelry, coins, and coating electrical devices; usually alloyed with copper or nickel because it is too soft for general use

d. Lead—Used in auto batteries and alloyed with tin to make solder

e. Magnesium—Used in everything from lawnmower engine blocks to space vehicles because it is lightweight

f. Nickel—Used primarily as an alloy to toughen steel

g. Tin—Used for coating tin cans, and used as an alloy to make bronze, babbitt, pewter, and solder

h. Titanium—Used in supersonic aircraft because of its high heat resistance and capacity to withstand vibration; used in petrochemical applications because of its high corrosion resistance

i. Silver—Used in coins, jewelry, tableware, and in industrial applications because it is the best conductor of electricity

j. Zinc—Used to galvanize iron and steel for protection from rust

22. Guidelines for testing properties of metals

a. To test for hardness, use a Brinnel hardness tester or a Rockwell tester.

Note: The Brinell tester measures hardness by penetrating the metal with a hard sphere, and the Rockwell tester measures hardness by penetrating with a hard sphere or a sharp diamond point, depending on the hardness of metal.

b. To test for weld strength or ductility, use a hydraulic testing device that will have the power required to break or bend a welded sample.

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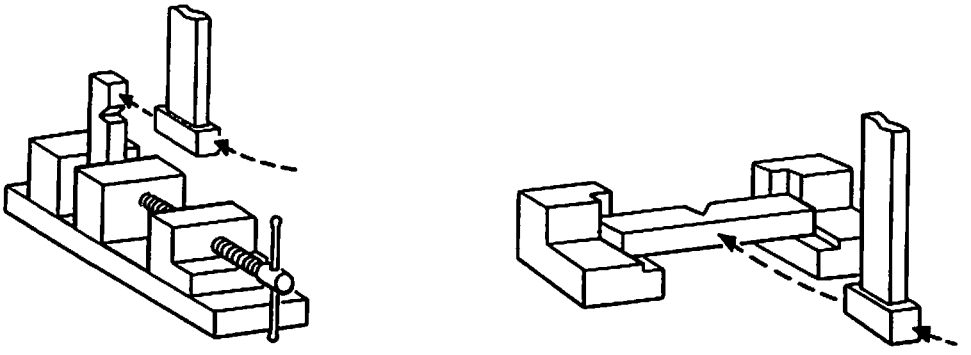
c. To test for impact resistance, use an Izod or a Charpy test with the specimen properly secured for accepting the test load impact.



Courtesy Lincoln Electric Company

d. To test for alloys by type and amount, use a spark test, and be sure the grinding wheel used in the test is free of residue.

23. Equipment requirements for spark testing

a. Spark testing requires a stationary or portable grinder with a medium-grit grinding wheel.

Note: 40 to 60 grit is the best range.

b. For spark testing with a stationary grinder, use an 8" diameter grinding wheel with a turning rate of 3,600 rpm.

c. For spark testing with a protable grinder, use a 7" disc with a turning rate of 5,000 rpm.

Note: Check the manufacturer's literature to determine rpm variance. Literature should indicate how rpm can be modified by changing the grinding wheel or disc diameter.

d. Use a clean grinding wheel for spark testing, and use a wire brush if the grinding wheel needs cleaning.

Note: Do not use a regular aluminum oxide grinding wheel when grinding aluminum because the grinding wheel will "load up" and be almost impossible to clean. When testing aluminum, use only a silicon carbide grinding wheel or disc.

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24. Guidelines for spark testing

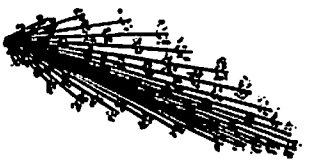
a. Learn to recognize the types of sparks produced by the metals you grind.

(1) An arrow looks like this: 

(2) A shaft looks like this: 

(3) A fork looks like this: 

(4) A spring looks like this: 

(5) A stream looks like this: 

b. Look for specific colors as sparks fly from the grinding wheel.

(1) A red color usually indicates cast iron.

(2) A straw color at the end of a stream also indicates cast iron.

(3) A white color usually indicates low- or high-carbon steel.

(4) An orange color usually indicates chromium.

c. Evaluate the volume of sparks that fly from the grinding wheel.

(1) Nonferrous metals produce a small volume.

(2) Gray cast iron produces a small volume, and white cast iron produces a very small volume.

(3) Low-carbon steel produces a moderately large volume.

(4) High-carbon steel produces a large volume.

(5) Stainless steel produces a moderate to large volume, depending on the type and amount of alloy in the steel.

d. Note the distance the sparks fly from the grinding wheel.

(1) Low-carbon steels throw shafts that terminate in forks about 70 inches long.

Note: Shafts become shorter and more numerous as carbon content increases.

(2) High-carbon steels throw numerous sprigs that look like sparklers about 55 inches long.

(3) Stainless and other alloy steels throw shafts and arrows at varying distances, depending amount of alloy.

25. Characteristics of residual stresses

a. Residual stresses are the undesirable elements of distortion left in a part or an assembly after a welding operation is completed.

b. The forces and counterforces of residual stress can produce shrinkage, fractures, and other forms of distortion that make parts difficult or impossible to fit up.

c. Residual stresses can produce in base metals structural and metallurgical changes so severe that a welded assembly could fail in service and damage property or injure people.

26. Causes of residual stresses and distortion

a. In a welding process, filler metals and base metals expand uniformly in any direction if they are not restricted, but if they are restricted, they cannot expand uniformly.

b. After a welding process, filler metals and base metals contract as they cool, and will assume their original shape if unrestricted, but if restricted, they will not contract uniformly.

c. The lack of uniformity in expansion and contraction means that residual stresses will vary with joint design, welding procedure, and metal type and thickness.

d. Welding thick metals promotes residual stresses, and the thicker the metal, the more problems with residual stresses.

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27. Guidelines for changing the welding procedure to control stresses

a. Modify the joint design.

b. Minimize the heat input by modifying the welding process.

Example: Back step or intermittent welds

c. Select alternate filler metals or base metals.

d. Peen the weld lightly to help it stretch.

Note: Peen with care, because too much peening will add stresses or cause the weld to strain harden and become brittle.

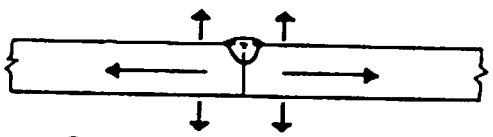
e. Stress relieve by using a postweld heat treatment.

f. Add thermal control by using preheating, interpass heating, postheating, or all three.

g. Add mechanical control by using clamps, wedges, or mechanical jigs and fixtures.

28. Routes for heat expansion in basic welds

a. In a normal butt weld, expansion occurs outward in all directions from the joint.



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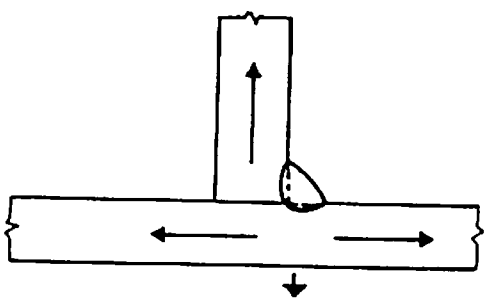
b. In a fillet weld, expansion also occurs outward in all directions.



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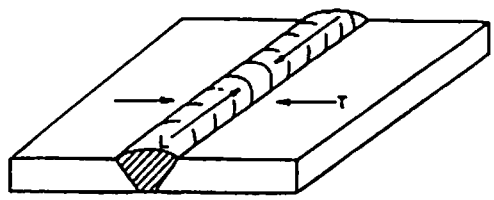
Note: Heat applied to a weld causes metal to expand, so how expansion occurs in basic welds provides valuable clues for controlling residual stresses.

Information Sheet

29. Results of longitudinal and transverse stress in basic welds

a. In a butt weld, the first passes can produce distortion **down** the length of the weld bead; this is called **longitudinal stress.**

b. In a butt weld, as the first passes solidify, the movement **across** the weld bead is restricted; this is called **transverse stress.**



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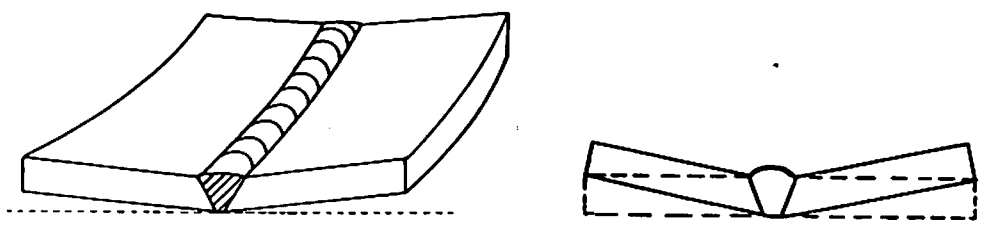
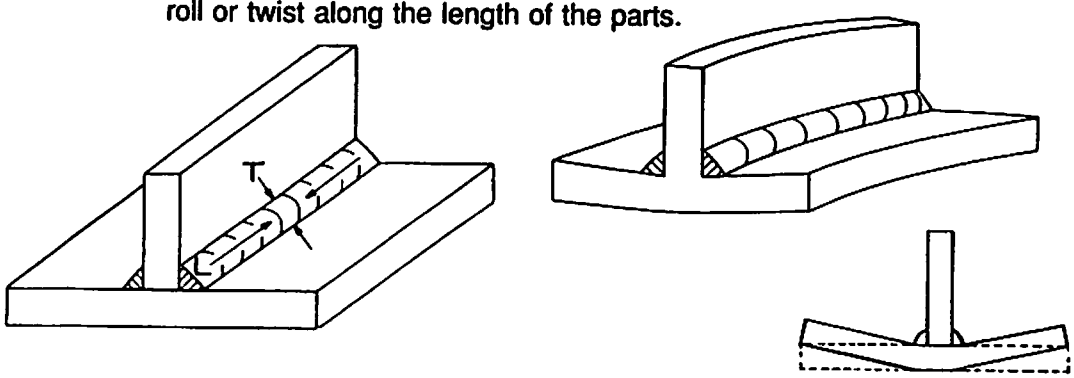
c. In a butt weld, the combination of longitudinal and transverse stresses results in distortion that usually causes the plates to rise from an even position to a slight angle.



Courtesy Lincoln Electric Company

d. In a fillet weld, the combination of longitudinal and transverse stresses not only causes a change from flat to a slight angle, but the combination can result in a roll or twist along the length of the parts.



Courtesy Lincoln Electric Company

Information Sheet

30. Heat applications and their uses in weld quality control

a. Preheating a part before a welding process starts can help control cracking, reduce stresses from shrinkage, and promote slower cooling to prevent excessive hardening.

b. Heating between welding passes with interpass heat helps maintain the required temperature.

Note: Most welding processes provide sufficient interpass heat, but on large assemblies, heating between passes may be required.

c. Postheating after the welding process ends allows slow cooling which promotes stress relief in the weld and the base metal.

31. Guidelines for preheating in special conditions

a. Preheat when welding large or bulky parts or when welding parts with complicated shapes.

b. Preheat when atmospheric temperature is cold or when the temperature of the part is cold.

c. Preheat when the carbon or alloy content of steel is high.

d. Preheat when a fast welding speed is specified.

e. Preheat when small-diameter welding rods are specified.

32. Methods of preheating and postheating and their applications

a. Preheat or postheat small parts in a furnace.

b. Preheat or postheat bulky parts by using acetylene, propane, or oil torches in banks of two or more.

c. Preheat or postheat long or wide parts with electrical strip heaters clamped parallel to joints, about 6″ from the seam.

d. For general service preheating or postheating, use a natural gas torch with compressed air and a single-orifice heating tip.

e. When preheating or postheating with a torch, use a heating tip the same size as the tip required to oxyacetylene weld the joint.

f. For torch heating large parts, use a torch with a multiflame head or rosebud.

Note: Torch heating is used frequently in shop work because it is handy, but it also provides a hot flame that burns clean to help avoid contaminating the weld zone.

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33. Torch preheating techniques and their applications

a. Spot heating—Applying heat at one specific point so that cooling will cause a slight inward movement around the joint and help control nondirectional distortion

b. Slot heating—Applying heat along a seam or perpendicular to a seam to control direction distortion

c. Convex—Applying heat along a side to shorten it, or applying other heating techniques to a certain side of a plate in order to flatten it

34. Types of steels and their recommended preheat temperatures

a. Mild steels—Preheating is not normally required, but if temperature is below 50°F, preheat to about 100°F or higher, if the plate thickness is over 1".

b. Medium-carbon steels—Preheat from 200°F to 400°F, retain the same interpass temperature, and postheat is recommended, especially on thicker metals.

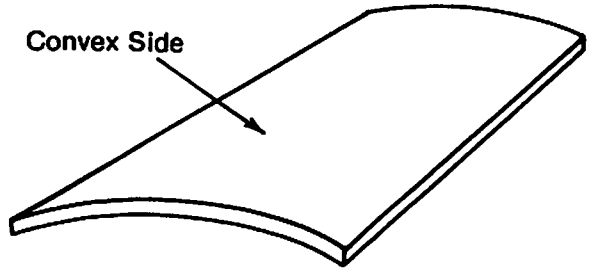
c. High-carbon steels—Preheat and interpass temperatures should be a minimum of 400°F, and postheat is recommended, especially on thicker metals.

35. Temperature-sensing devices and their uses

a. Pyrometers—Portable thermometers used to measure surface heat

b. Thermocouples—Temperature-sensing devices that may be attached to the work, but more often are used in heating ovens or postweld heat treatment processes

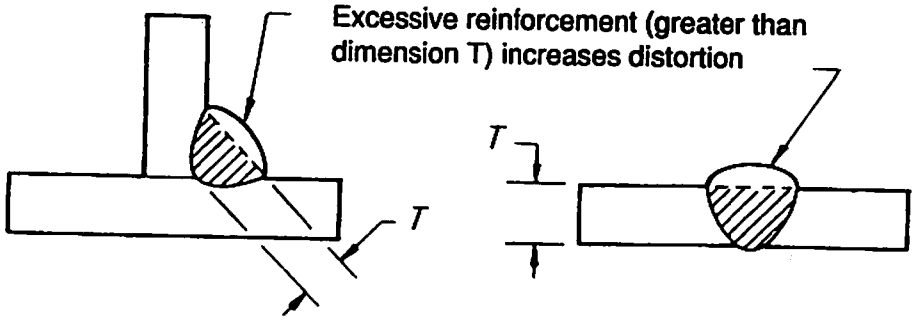
c. Crayons and pellets—Temperature-sensing devices available in different degrees; can be used to indicate a localized temperature; both crayons and pellets may be used in pairs to indicate a high and low temperature range



Information Sheet

36. Methods for controlling distortion with the welding process

a. Do not overweld because excessive filler metal added to the joint increases shrinkage forces, but does not increase weld strength.



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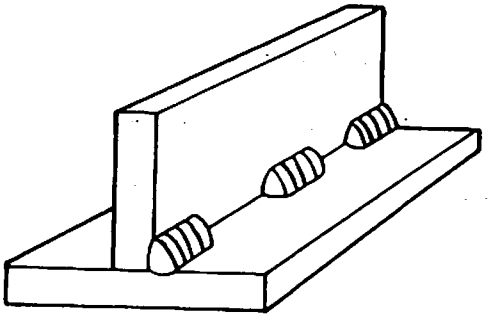
b. Use intermittent welds when you can because they provide strength, yet reduce the amount of heat and filler metal required.



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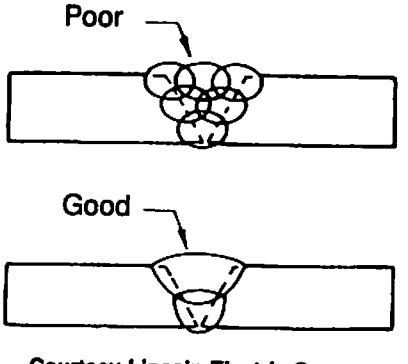
c. Use as few passes as specifications permit; larger electrodes and fewer passes are better than smaller electrodes and more passes.



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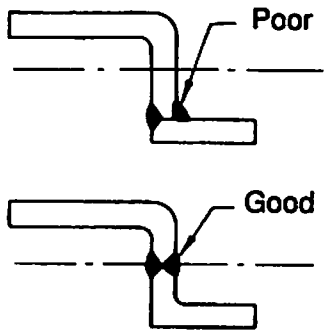
Information Sheet

d. Place welds at or along a neutral axis to lessen the leverage of forces that cause distortion.



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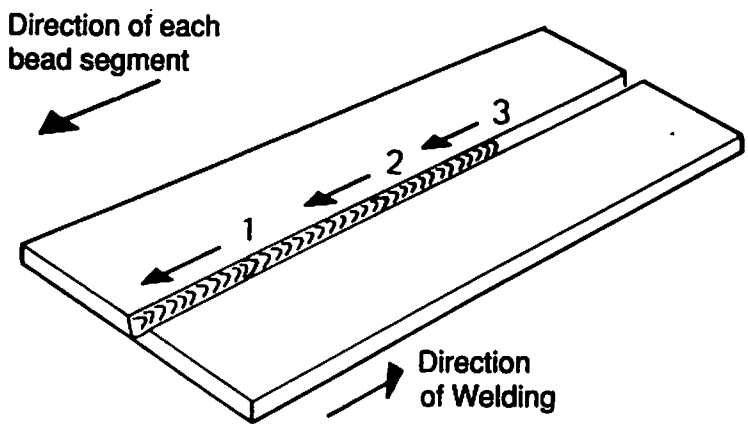
e. Use backstep welding; welding usually proceeds left to right, but place beads right to left in order to spread heat uniformly to the outer edges and to bring plates back into alignment.



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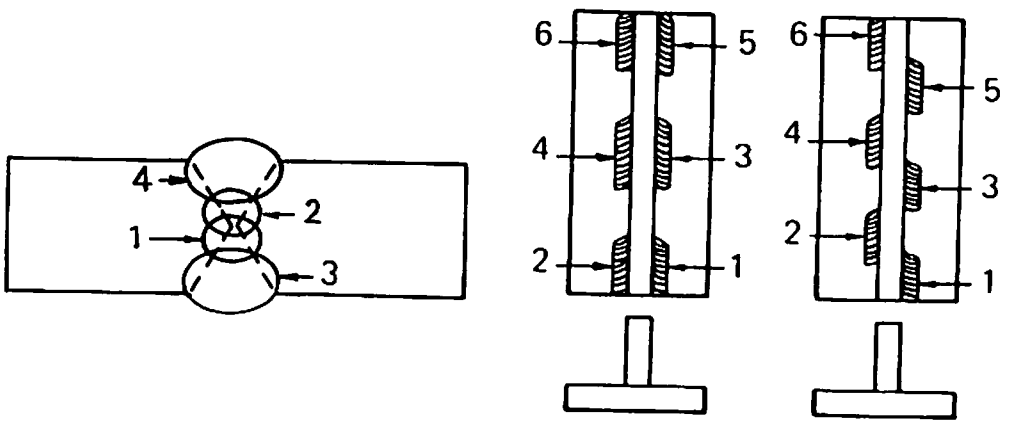
Information Sheet

f. Weld in an alternating sequence; use intermittent welds alternately on fillet welds so that shrinkage in the second weld will counterbalance shrinkage in the first weld, and other alternate welds will counterbalance each other.

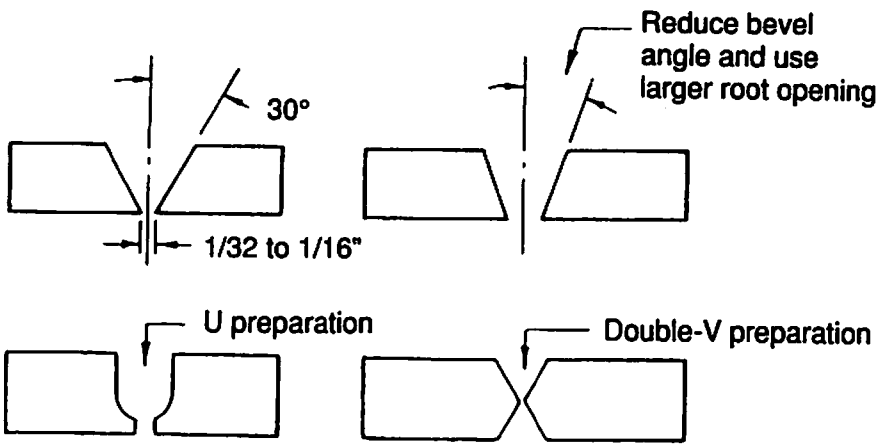


Courtesy Lincoln Electric Company

37. Guidelines for controlling distortion with mechanical means

a. Modify the edge preparation, especially on thicker metals; decrease the bevel angle and increase the root opening, or use a J- or U-joint design.

b. Use a double V-joint in place of a single V-joint because the double joint requires about half the weld metal for the same plate thickness.

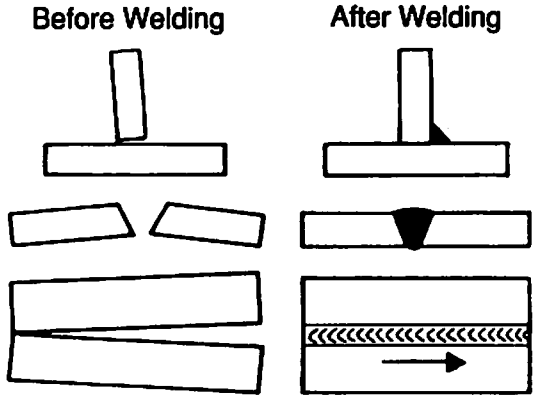


Courtesy Lincoln Electric Company

Information Sheet

c. Anticipate the places and amount of shrinkage and preset parts so that shrinkage forces will pull them into alignment during welding.

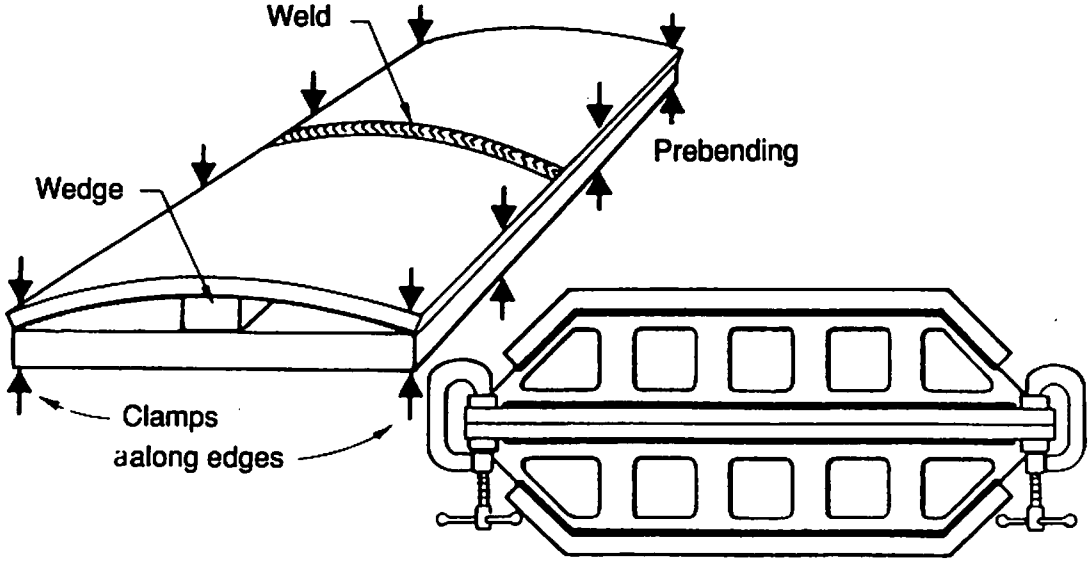
Note: Presetting parts requires good estimating, but a few practice welds should demonstrate how it works.



Courtesy Lincoln Electric Company

d. Prebend and clamp parts to make the joint longer so that shrinkage will cause the joint to lie flat as the plate cools and the clamps are removed.

e. Clamp parts front to back, if possible, to help distortion forces work against each other for shrinkage control.



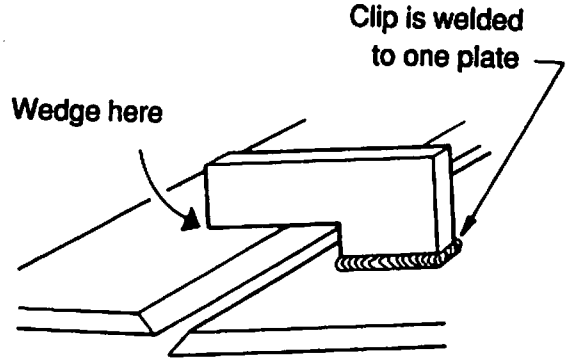
Back-to-Back Clamping

Courtesy Lincoln Electric Company

Information Sheet

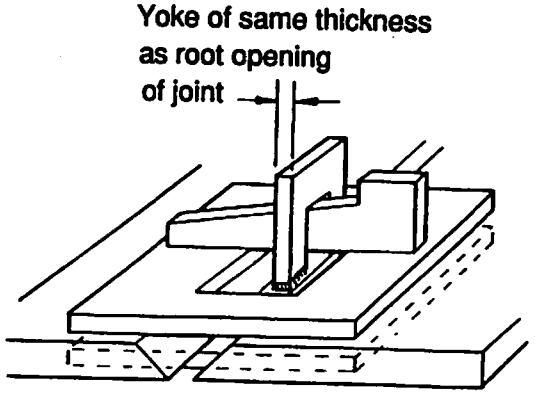
38. Methods for controlling distortion with restraining devices and their applications

a. When welding butt plates, tack weld clips along the edges of one plate, then drive wedges under the open side of the clips to force the edges into alignment.



Courtesy Lincoln Electric Company

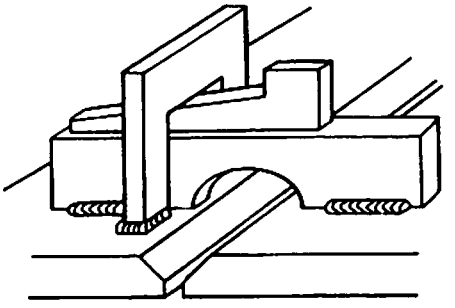
b. For aligning plates, tack weld a yoke to a backup strip, slip the yoke between the edges, then place a yoke guide on top of the plates and drive a wedge through the first yoke to complete alignment.



Courtesy Lincoln Electric Company

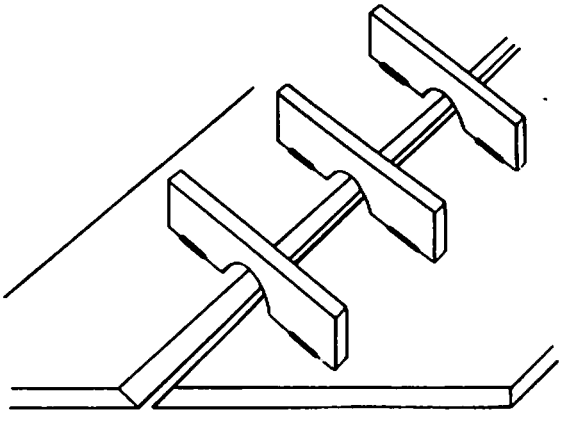
Information Sheet

c. For butt welds on thicker plates, tack weld a yoke on top of one plate, tack weld a bar to the top of the second plate, then drive a wedge between the yoke and the bar to complete alignment.



Courtesy Lincoln Electric Company

d. Several strongbacks together could restrain a weld so much that the weld could crack as it cools, so when several strongbacks are required, position them at a 45° angle across the joint to allow for transverse movement.



Courtesy Lincoln Electric Company

STUDENT EVALUATION
LEWIS & CLARK CAREER CENTER
2400 Zumbehl Road
St. Charles, MO 63301
Phone (636)946-7726 Fax (636)946-8472

_____	_____	_____	_____ To _____
Student	Employer	Supervisor	Time Period Covered

Please rate the student according to how well he/she performs the task or meets the specific objectives taking into consideration the amount of time or training received on the job.

Ratings:

1. Exceptional or superior performance.
2. Very good or above average performance.
3. Satisfactory or average performance.
4. Below average performance.
5. Unsatisfactory performance.

N. Does not apply or I have not had a chance to observe as yet.

Dates absent or late: _____
*Please call 723-4829 or 946-7726 on any days tardy or absent.

Specific Rating (use above scale):

_____ 1. Does the student report to work at the scheduled time?
_____ 2. Does the student notify you in case of illness with enough notice that you can get a replacement if needed?
_____ 3. Does the student keep requests to be absent from work to a minimum and give adequate notice to the employer?
_____ 4. Does the student attempt to get along well with other employees/customers?
_____ 5. Does the student attempt to get along well with the employer?
_____ 6. Does the student dress appropriately for work and is neat and clean about physical appearance?
_____ 7. Does the student keep confidences concerning business procedure or operations?
_____ 8. Does the student perform his/her task willingly?
_____ 9. Does the student accept criticism graciously and then attempt to correct the problem?
_____ 10. Does the student seek tasks to do when none are assigned?
_____ 11. Does the student, in general, use common sense and is he/she conscientious about the welfare of the company?
_____ 12. Does the student know and observe proper safety habits at all times?
_____ 13. Does the student remain attentive at all times and follow all instructions given?
_____ 14. Does the student correctly identify, use, and maintain hand tools, power tools, and equipment?
_____ 15. Does the student perform his/her tasks and duties to the best of his/her ability and is willing to learn from coworkers?

Overall rating of student: _____

Comments: _____ _____

_____ _____

LEWIS & CLARK CAREER CENTER

COOPERATIVE WORK RELEASE PROGRAM AGREEMENT

1. The cooperative work release program provides an opportunity for a student to work during the time he/she would normally be attending classes at Lewis & Clark Career Center. The program is available to students who have completed the first semester of their second year of instruction at Lewis & Clark.

2. To qualify for this program, a student must have **good attendance, good work habits, make at least a "B" average** for the current school year, and be **recommended by his/her vocational instructor**.
   *Current Grade:_____ *Days Missed this Year:_____
   *Must be initialed by vocational instructor.

3. The earliest beginning date for the work program will be the first day of the last semester of the program.

4. The work experience must be in the occupational field in which the student has received training at Lewis & Clark Career Center.

5. Students will not be allowed to work for members of their immediate families.

6. The work release program requires the approval of the vocational instructor, the high school principal, the student's parents, and the vocational director.

7. The student is responsible for providing a completed employer training agreement prior to the first day of employment.

8. The student must attend his/her classes at the home school. Should a student fail to attend classes on a day that he/she worked, the agreement is immediately terminated and the student must return to class at Lewis & Clark Career Center.

9. The student must be on the job during the agreed hours of employment.

10. Should the employment terminate for any reason, the student must report for classes at Lewis & Clark immediately.

11. Lewis & Clark Career Center and the home high school will not be responsible for any accidents or job related problems while the student is in route to the job site or during the employment.

This agreement has been read and approved by the following:

_____	_____
Student	Vocational Director
_____	_____
Vocational Instructor	Parent
_____	_____
High School Principal	Date

OVER ☞

EMPLOYER-STUDENT AGREEMENT

II Student's Name _____ Employer's Name _____

Employer's Address _____
City State Zip

Employer's Telephone _____ Starting Date _____

Hours of Employment _____ Days to Work M T W TH F
(Select one day)

Description of work to be performed: _____

_____

_____

_____

_____

III The EMPLOYER agrees to provide a training station which will offer as much variety in work experiences for the student as is practically and economically possible, so that the student will receive broad occupational training. This includes adequate supervision and instruction, evaluating the student's progress once every week, not discharging the student without first consulting the coordinator in regard to such matters, not discriminating against students on the basis of race, color, national origin, gender, or disability in making available opportunities in cooperative education; and paying a beginning wage of $_____ per hour for _____ hours per school week. The employer/supervisor agrees to notify the school in case the student is absent or if there are other problems relating to the student's employment.

_____ _____

Employer or Supervisor's Signature Date Student's Signature Date

NOTE: Return completed form to Lewis & Clark Career Center

Private Transportation Consent Form

Dear Parent or Guardian, and Student,

At times it becomes necessary to use private vehicles to transport students to and from school sponsored activities. When this occurs, the school district requires the student and their parent or guardian sign the Private Transportation Release Consent Form that appears below:

Name of Activity:_____

Location of Activity: _____

Date(s) of Activity: _____

Name of Sponsor: _____

RETURN THIS FORM TO THE SCHOOL BY: (Date) _____.

My child, _____, has my permission to travel from school property (or other location) to this activity by private transportation, either as the driver or as a passenger in a private automobile driven by another student, parent, or other person. I understand and acknowledge that the St. Charles R-VI School District will have no financial or legal responsibility for injuries arising out of such travel.

By signing this form, I hereby release the District, as well as its directors, officers, administrators, employees, and other agents from all liability for any and all injuries arising from my child's travel to this activity via private transportation. I further agree to indemnify and hold harmless the District, as well as its directors, officers, administrators, employees, and other agents, against any claims asserted by my child as a result of his or her travel to this activity via private transportation.

_____ _____

Parent or Guardian Parent or Guardian

_____ _____

Date Date

To be signed by students 16 years of age or older if either driving or riding in a private vehicle to a school sponsored event.

I acknowledge that the District will have no financial or legal responsibility for injuries arising out of my travel from school (or other location) to this activity. I further acknowledge that I have a responsibility to travel directly from school (or other location) to the activity and that failure to report to this activity on time may result in discipline, up to and including possible dismissal from this activity. I further acknowledge that inappropriate conduct during travel to this activity may result in such discipline, as well as additional discipline under Board of Education Policy, as such Policy applies to out-of-school misconduct.

_____

Student Signature

_____

Date

Lewis Clark Career Center

2005 - 2006 Placement Summary

Massey, Rick

Total Students:	14	
Total Placed:	14	100%
Total Placed Related:	3	21%
Positive MSIP Placement:	9	64%
Employed Related:	3	21%
Employed Not Related:	5	36%
Military Related:	0	0%
Military Not Related:	0	0%
Continuing Education Related:	0	0%
Continuing Education Not Related:	6	43%
Not Available:	0	0%
Not Placed:	0	0%
Status Unknown (Not Found):	0	0%

Teacher Name	*CIP Code*	*Number of Students*	*CENR*	*CER*	*ENR*	*ER*	*MNR*	*MR*
MASSEY								
	480508							
	Sum	*14*	*1*	*1*	*1*	*10*	*1*	
Sum		*14*	*1*	*1*	*1*	*10*	*1*	

EVALUATION OF THE WELDING PROGRAM AND INSTRUCTION

	Always	Usually	Seldom	Never
1. The subject matter was well organized.	☐	☐	☐	☐
2. The instructor was concerned about student progress.	☐	☐	☐	☐
3. The instructor was knowledgeable in subject area.	☐	☐	☐	☐
4. The instructor had the ability to explain difficult topics.	☐	☐	☐	☐
5. The use of visual aids was of value to me.	☐	☐	☐	☐
6. The use of handouts was of value to me.	☐	☐	☐	☐
7. The instructor's exams effectively evaluate your knowledge of the assigned material.	☐	☐	☐	☐
8. The instructor spoke plainly and clearly.	☐	☐	☐	☐
9. I always felt free to ask questions about the subject.	☐	☐	☐	☐
10. The instructor appeared enthusiastic about the subject.	☐	☐	☐	☐
11. The instructor was open-minded to other points of view.	☐	☐	☐	☐
12. The instructor was available for help outside of class hours.	☐	☐	☐	☐
13. The class workload was reasonable.	☐	☐	☐	☐
14. The instructor's lectures were interesting as well as informative.	☐	☐	☐	☐
15. The instructor was prepared for class.	☐	☐	☐	☐
16. The safety tests gave valuable information.	☐	☐	☐	☐
17. The instructor gave demonstrations.	☐	☐	☐	☐
18. The shop was clean and organized.	☐	☐	☐	☐
19. The equipment and tool functioned properly.	☐	☐	☐	☐

20. The instructor was readily available for help.	☐	☐	☐	☐
21. Welding competencies were explained.	☐	☐	☐	☐
22. Adequate time is given to complete competencies.	☐	☐	☐	☐
23. Competencies are evaluated per AWS codes.	☐	☐	☐	☐
24. The Director evaluates program.	☐	☐	☐	☐
25. The advisory committee works with the instructor.	☐	☐	☐	☐
26. The Welding program offers a work release for students.	☐	☐	☐	☐
27. Jobs are provided by the job placement department,	☐	☐	☐	☐
28. A follow up is provided after graduation.	☐	☐	☐	☐
29. Students may come back for a "refresher".	☐	☐	☐	☐
30. Graduates are encouraged to visit as examples.	☐	☐	☐	☐