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	1—Identify Welding Processes	1
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	*Assignment Sheets are located in the Student Workbook.	

Instructional
Plan**Suggested Activities****Preparation**

- Read the unit carefully and plan for instruction.
- Review “Teaching Suggestions.” Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See “Resources Used in Developing This Unit” and “Suggested Supplemental Resources” for more information.
- For self-paced instruction, review Learning Activities Sheet. Modify as appropriate to include additional activities and/or resources available in your classroom. Make one copy for each student.
- Make copies of any teacher supplements that will be provided for each student.
- Make transparencies from the transparency masters included in this unit. These appear in the teacher edition only.

TM1—Master Chart of Welding and Allied Processes
(Objectives 2, 3, and 4)

TM2—Master Chart of Welding and Allied Processes (continued)
(Objectives 2, 3, and 4)

Delivery and Application

Unit Introduction (self-paced instruction)

- Provide student with Learning Activities Sheet and unit of instruction.
- Review unit contents with student.
- Have the student complete the steps in the learning activities sheet.

Unit Introduction (group instruction)

- Provide students with unit of instruction.
- Discuss unit and specific objectives.

Suggested Activities

- Discuss the information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Teaching Suggestions

- Find a retired welder in your city or area and ask him or her to address the class about how welding has been as a career. Where was the job or where were the jobs? What were the working conditions? What was the pay? Were there company benefits? What made you want to become a welder? Did welding adversely affect your health? Would you pick welding as a career if you could do it all again?

Note: Surveys indicate that some students think of welding as just another dirty job. Associating welding with the human aspect, the career approach, and placing it in an historical perspective may provide a very positive experience for many students.

- Discuss the major welding processes in detail and impress upon students the advantages of having multiple welding and cutting skills in the workplace. As some job areas decline, those welders with skills versatility will survive economic ups and downs.
- Talk to students about general opportunities in welding as they are outlined in this unit. Better yet, try to pinpoint special welding opportunities in your city, area, or state. Have welders from those industries talk to the class about the type of welding involved and how to plan for job opportunities.

Evaluation

- Make copies of the written test. Add or modify test items as needed. The written test serves as both a pretest and posttest to assist in measuring each student's competency gains.
- Give and evaluate pretest. Modify lesson plan to include additional instruction for those areas where students were deficient.
- Evaluate the assignment sheets. Rate the student using the criteria listed on each assignment sheet. See Answers to Assignment Sheets for correct answers where applicable. If the student's performance is unacceptable, have the student review the appropriate materials and complete the assignment again.
- Give and evaluate the posttest.

Suggested Activities

Resources Used in Developing This Unit

- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Print Media

- Connor, Leonard P., ed. *Welding Handbook Eighth Edition, Vol 1, Welding Technology*. Miami, FL: American Welding Society, 1987.
- O'Brien, R. L., ed. *Welding Handbook Eighth Edition, Vol. 2, Welding Processes*. Miami, FL: American Welding Society, 1991.
- *Occupation Outlook Handbook 1998-99, Bulletin 2500*. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1998.

Suggested Supplemental Resources

Print Media

- Miller, R.T. *Welding Skills*, 2nd ed. Homewood, IL: American Technical Publishers, Inc., 1996.
- Jeffus, Larry. *Welding Principles and Applications*, 4th ed. Albany, NY: Delmar Publishers, Inc., 1998.
- The *Stabilizer®* is a magazine for people interested in welding and is published approximately every 8-10 months. Published by Lincoln Electric, the magazine has special features which recount welding projects by individual readers. "How I Did It" is a regular feature in the publication. For information, write, call, or visit their internet site.

The Stabilizer
The Lincoln Electric Company
22801 St. Clair Avenue
Cleveland, OH 44117
216-481-8100
www.lincolnelectric.com/stabilizer

- The *Welding Journal* is the official monthly publication of the American Welding Society. Monthly "Feature Articles" present in-depth coverage of significant welding information. For information, write, call, or visit their internet site.

American Welding Society
550 N.W. LeJeune Rd.
Miami, FL 33126
800-443-9353
www.aws.org/wj/wj.htm

- *The American Welder*, a supplement to the *Welding Journal*, is a bi-monthly publication that provides information in such areas as the basics of welding, safety, education, events, and people. For information, write, call, or visit their internet site.

Suggested Activities

American Welding Society
550 N.W. LeJeune Rd.
Miami, FL 33126
800-443-9353
www.aws.org/wj/wj.htm

- *Welding Design and Fabrication* calls itself “The magazine of welding management and technology.” Published by Penton Media, Inc., of Cleveland, Ohio, the magazine features articles of interest to industries that use welding processes in their activities. The magazine has feature articles on all facets of the industry, both domestic and international. For information, write, or visit their internet site.

Penton Media, Inc.
Welding Design and Fabrication
P.O. Box 901979
Cleveland, OH 44190-1979
www.penton.com

- *Design News*, as the name implies, is written for design engineers, but its frequent publication of articles related to metallurgy and welding, make it an important publication for companies active in welding fabrication. For information, write, call, or visit their internet site.

Design News
Marketing Services
1350 Touhy Avenue
Des Plaines, IL 60018
800-323-4958
www.manufacturing.net/magazine/dn

Electronic Media

- Welding: Making It Happen (23 Minutes)

This video effectively portrays the many ways welding touches our everyday lives. An excellent choice for general presentations to parents, career counselors and vo-tech candidates.

- Welding as a Career (15 Minutes)

Promoted are student opportunities in welding as a career and educational opportunities at a typical technical school. Portrayed are a range of welding career options and their benefits, such as possessing a productive skill, interesting work, good pay, and growth opportunities.

- Welding: So Hot, It's Cool (11 Minutes)

The American Welding Society's career education video; provides students with information on career possibilities in welding. Designed for kids 13–15.

Order the preceding videos online from the American Welding Society at www.aws.org, or call (800) 334-9353.

Answers to Assignment Sheets

**Assignment
Sheet 1**

Identify Welding Processes

- a. 3
- b. 2
- c. 4
- d. 1
- e. 7
- f. 6
- g. 5

**Assignment
Sheet 2**

Compare Employment Opportunities in Welding

Should be evaluated to the evaluation criteria listed on Assignment Sheet 2.

Written Test

Name _____

Date _____ Score _____

Objective 1

Define terms related to welding orientation. Write the correct definition beside the word.

a. Base metal: _____

b. Coalescence: _____

c. Fusion welding: _____

d. Welding: _____

Objective 2

Complete statements about welding processes by circling the information that best completes each of the following statements.

a. Oxyfuel Gas Welding (OFW)—A group of welding processes that produces coalescence by heating materials with an oxyfuel gas flame or flames, with or without pressure, and **(with) (with or without)** the use of filler material

b. Shielded Metal Arc Welding (SMAW)—An arc welding process that produces coalescence of materials by heating them with an arc between a covered electrode and a workpiece; shielding is obtained from decomposition of the electrode cover, pressure is not used, and filler metal is obtained from **(the electrode) (the electrode cover)**

c. Gas Tungsten Arc Welding (GTAW)—An arc welding process that produces coalescence of materials by heating them with an arc between a **(nonconsumable) (consumable)** tungsten electrode and a workpiece; shielding is obtained from a gas, and filler metal may or may not be used

Written Test

- d. Gas Metal Arc Welding (GMAW)—An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal electrode and a workpiece; shielding is obtained entirely from **(an externally supplied gas) (the reaction with the base metal)**
- e. Flux-Cored Arc Welding (FCAW)—An arc welding process that produces coalescence of metals by heating them with an arc between a continuous filler metal electrode and a workpiece; shielding is provided by a flux contained within the tubular electrode, and additional shielding **(must) (may or may not)** be obtained from an externally supplied gas or gas mixture
- f. Submerged Arc Welding (SAW)—An arc welding process that produces coalescence of metals by heating them with an arc or arcs between a bare metal electrode or electrodes and a workpiece; the arc and molten metal are shielded by **(chemical reactions) (a blanket of granular, fusible material)** on the workpiece; pressure is not used, and filler metal is obtained from the electrode or sometimes from a supplemental source
- g. Plasma Arc Welding (PAW)—An arc welding process that produces coalescence of metals by heating them with a constricted arc between a **(nonconsumable) (consumable)** electrode and a workpiece (transferred arc), or the electrode and a constricting nozzle (nontransferred arc)
- h. In PAW, shielding is obtained from the hot, ionized gas issuing from the torch, and this may be supplemented with an auxiliary source of shielding gas; shielding gas may be an inert gas or a mixture of gases, and filler metal **(must) (may or may not)** be used.

Objective 3

Select true statements about brazing and braze welding by placing an “X” in the blanks next to the true statements.

- _____ a. Brazing is a group of welding processes that produces coalescence of materials by heating them to the brazing temperature in the presence of a filler metal having a melting point above 840°F and below the melting point of the base metal.
- _____ b. In brazing processes, the filler metal is distributed between the closely fitted surfaces of the joint by capillary action.
- _____ c. Braze welding is a welding process variation that uses a filler metal with a melting point above 840°F and above the melting point of the base metal.
- _____ d. Like brazing, in braze welding, the filler metal is distributed in the joint by capillary action.

Objective 4

Complete statements about cutting processes by circling the correct answers.

- a. Oxyfuel Gas Cutting (OFC)—A group of cutting processes used to sever metals by means of **(burning) (the chemical reaction of oxygen with a base metal)** at elevated temperatures; the necessary temperature is maintained by means of gas flames obtained from the combustion of a specified fuel gas and oxygen
- b. Carbon Arc Cutting (CAC)—A group of cutting processes that sever or remove metal by **(melting) (chemical reaction)** with the heat of the arc between an electrode and the workpiece.

Objective 5

Select true statements about where welders work by placing an “X” in the blanks next to the true statements.

- _____ a. In 1996, welders, cutters, and welding machine operators held over 500,000 jobs.
- _____ b. About 9 out of 10 welders and cutters were employed in manufacturing, services, construction, or wholesale trade.
- _____ c. The majority of those in manufacturing were employed in transportation equipment, industrial machinery and equipment, or fabricated metal products.
- _____ d. All welding machine operators were employed in the automobile industry.

Objective 6

Complete statements about what welders earn by circling the information that best completes each of the following statements.

- a. The median earning for welders and welding machine operators was about **(\$478) (\$600)** a week in 1996.
- b. Beginners and lesser paid welders averaged \$278 a week, but welders in the top 10 percent income bracket earned over **(\$700) (\$800)** a week.
- c. Many welders work in situations where **(company benefits) (top wages)** make the job more attractive, and over one-fourth of all welders belong to a union.

Objective 7

Select true statements about the job outlook for welders by placing an “X” in the blanks next to the true statements.

- _____ a. Employment of welders and cutters is expected to increase by 8.3% from 1998 through the year 2008.
- _____ b. In some areas, the need for welders will rise through the year 2008, and many job openings will arise because of the need to replace experienced workers who transfer or retire.

Written Test

Objective 8

- _____ c. The areas that look best for good welding jobs are in construction and business services (repair) because these are areas that are difficult to automate.
- _____ d. Many jobs will be open in manufacturing, but they will be jobs in maintenance, repair, and other areas where the work cannot be automated.

Complete statements about what it takes to become a good welder by circling the information that best completes each of the following statements.

- a. Training for welding should start early in high school and include courses in shop math, mechanical drawing, print reading, physics, chemistry, and **(metallurgy) (electricity)**.
- b. Some welding machine operators can learn their jobs **(at special company classes) (in a few days or weeks)**, but employers prefer applicants who have high school, vocational, and/or post-secondary training in welding.
- c. Welders and cutters need manual dexterity, good eyesight, and good **(eye-hand coordination) (concentration)**.
- d. Good welders should also be able to concentrate on detailed work for long periods, and be able to bend, stoop, and **(work in awkward positions) (stand in one position a long time)**.

Objective 9

Select career opportunities for welders. Circle the number of the information that best reflects each welder opportunity.

- a. A maintenance shop is looking for someone who can perform many different welding jobs. Chances are they will hire:
 - (1) A combination welder
 - (2) A welder-fitter who can also work with pipe
 - (3) The welder who is good at GTAW
- b. A firm that makes restaurant equipment and stainless steel salad bars needs a replacement welder. They will hire:
 - (1) A combination welder
 - (2) A specialist welder, probably a GTAW specialist
 - (3) A welder-fitter who is good with joint preparation
- c. A company is looking for a welder to supervise a field crew that will be working on a special project. Chances are they will look for an experienced supervisor, but they could:
 - (1) Promote from within their own labor supply
 - (2) Select a welder who has demonstrated leadership abilities
 - (3) Look for a specialist welder

Objective 10

Match to their definitions, the terms standard, code, and specification. Write the corresponding numbers on the blanks provided.

1. Standard 2. Code 3. Specification

- _____ a. Generally associated with a process, uses the words *shall* and *will* to indicate the mandatory use of certain materials or actions, or both
- _____ b. Describes the technical requirements for a material, process, product, system, or service
- _____ c. Generally associated with a product, uses the words *shall* and *will* to indicate the mandatory use of certain materials or actions, or both

Objective 11

Complete statements about standards and their importance to the welding industry by circling the information that best completes each of the following statements.

- a. In 1936, the Committee on Standard Qualification Procedures issued its first report to the American Welding Society; the report called for general qualification standards for **(procedures and performances)** **(the classification)** of welders.
- b. Today, standards guide many industrial producers, and standards affecting welding are produced by other groups who have welding **(processes)** **(minimums)** that must be met and procedures that must be followed.
- c. The American Welding Society has various committees who meet to update and change standards as needs require, and among these standards, three are important to all welders, including beginners:
- (1) Standard for Welding **(Procedure)** **(Process)** and Performance Qualification
 - (2) Standards Symbols for Welding, **(Brazing)** **(Cutting)**, and Nondestructive Examination
 - (3) Standard Welding **(Terms and Definitions)** **(Equipment)**

*Permission to duplicate this test is granted.

Answers to Written Test

Objective 1	<ul style="list-style-type: none">a. Base metal: The metal or alloy that is welded, brazed, soldered, or cutb. Coalescence: The growing together or growth into one body of the materials being weldedc. Fusion welding: The melting together of filler metal and base metal, or of base metal only, to produce a weldd. Welding: A joining process that produces coalescence of materials by heating them to a melting point, with or without the application of pressure and with or without the use of filler metal
Objective 2	<ul style="list-style-type: none">a. With or withoutb. The electrodec. Nonconsumabled. An externally supplied gase. May or may notf. A blanket of granular, fusible materialg. Nonconsumableh. May or may not
Objective 3	a, b
Objective 4	<ul style="list-style-type: none">a. The chemical reaction of oxygen with a base metalb. Melting
Objective 5	b, c
Objective 6	<ul style="list-style-type: none">a. \$478b. \$800c. Company benefits
Objective 7	a, c, d
Objective 8	<ul style="list-style-type: none">a. Metallurgyb. In a few days or weeksc. Eye-hand coordinationd. Work in awkward positions
Objective 9	<ul style="list-style-type: none">a. 1b. 2c. 2
Objective 10	<ul style="list-style-type: none">a. 2b. 1c. 3

Answers to Written Test

Objective 11

- a. Procedures and performances
- b. Minimums
- c.
 - (1) Procedure
 - (2) Brazing
 - (3) Terms and Definitions

Teacher Supplement 1—An Abbreviated History of Arc Welding

Early welding history

In Germany, metals were joined by electric fusion as early as 1782. English, French, and Russian experiments in the 1800s established the principles of striking and maintaining an electric arc with controlled voltage, and the first arc welding process resulted from ongoing efforts.

Early 1900 events

The first patent was issued for a covered electrode, and arc-welding methods were used to weld ship hulls and produce armaments during World War I.

Middle 1900 events

A new manufacturing process greatly reduced the cost of covered electrodes and arc welding applications expanded into the aircraft, manufacturing, and construction industries.

Later 1900 events

World War II inspired many advances in arc welding technology. Improvements in electrodes and improved applications of shielding gases brought high speed applications for the thousands of all-welded ships produced in World War II, in aircraft production, and in armaments.

Recent welding history

New arc welding processes such as GTAW and GMAW were developed to meet the special needs of industrial production and there were ongoing improvements and advances in electrode technology.

Modern welding history

Advances continued in electric arc welding and brought such processes as arc spot welding, atomic-hydrogen welding, electro-slag and electro-gas welding, plasma-arc welding and cutting, submerged arc welding, and other processes to answer special industry needs.

Teacher Supplement 2—Professional Organizations That Benefit Welders

Since welding is a metals and materials industry, the professional organizations that benefit welders do so by keeping pace not only with the world of welding, but changes, improvements, and trends in the many products associated with welders and welding. A few of those organizations are listed here for the purpose of providing references to assist with the variety of information that welding programs sometimes require.

Aluminum Association

900 19th Street, NW
Washington, DC 20006
202-862-5100
www.aluminum.org

American Iron and Steel Institute

1101 17th Street, NW, Suite 1300
Washington, DC 20036
202-452-7100
www.steel.org

American National Standards Institute

11 West 42nd Street, 13 Floor
New York, NY 10036
212-642-4900
www.ansi.org

American Petroleum Institute

1220 L Street, NW
Washington, DC 20005
202-682-8000
www.api.org

American Society of Mechanical Engineers

Three Park Avenue
New York, NY 10016-5990
212-705-7722 — 800-843-2763
www.asme.org

American Welding Society

550 N.W. LeJeune Rd.
Miami, FL 33126
800-443-9353
www.aws.org

National Safety Council

1121 Spring Lake Drive
Itasca, IL 60143-3201
630-285-1121
www.nsc.org

National Welding Supply Association

1900 Arch Street
Philadelphia, PA 19103-1498
215-564-3484
www.nwsa.com

Society of Automotive Engineers

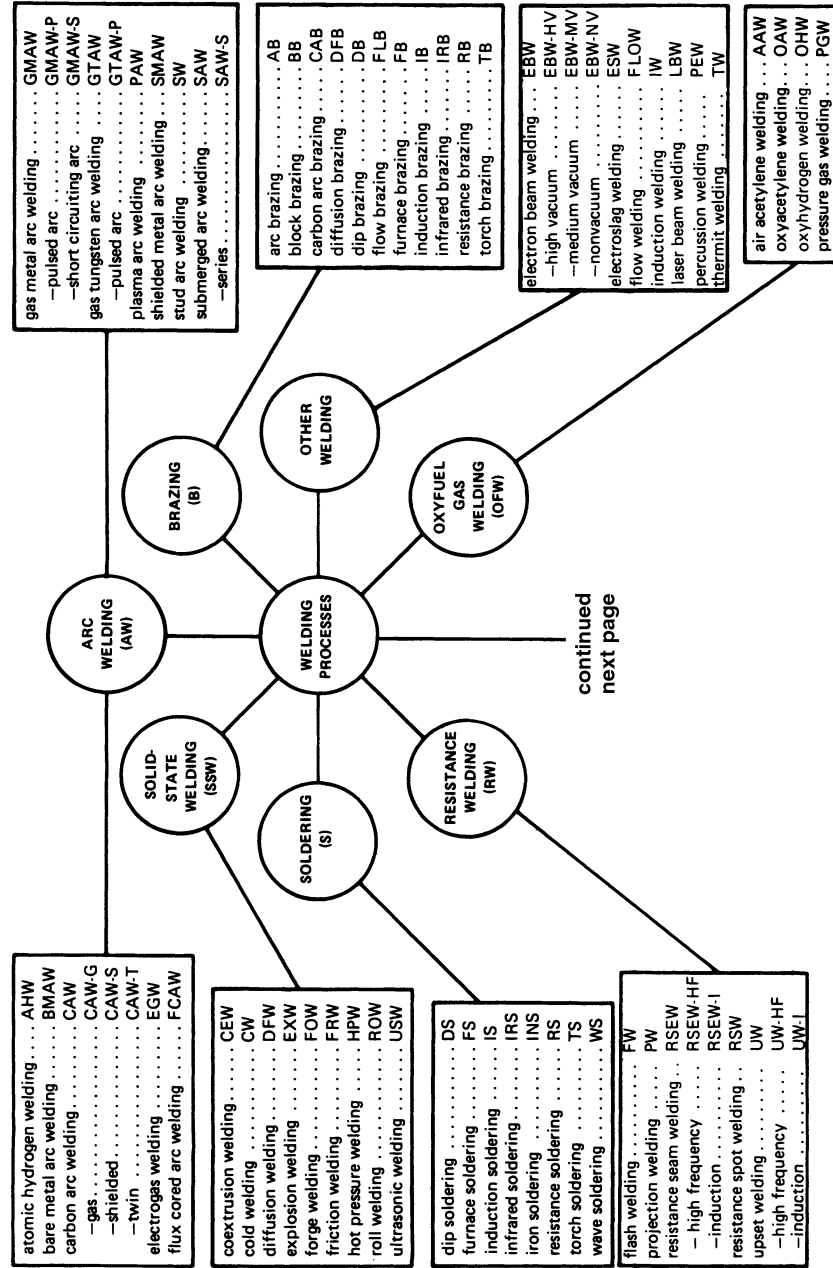
400 Commonwealth Drive
Warrendale, PA 15096-0001
724-776-4970
www.sae.org

American Society of Non-Destructive Testing

4153 Arlingate Plaza, Caller #28518
Columbus, OH 43228-0518
www.asnt.org

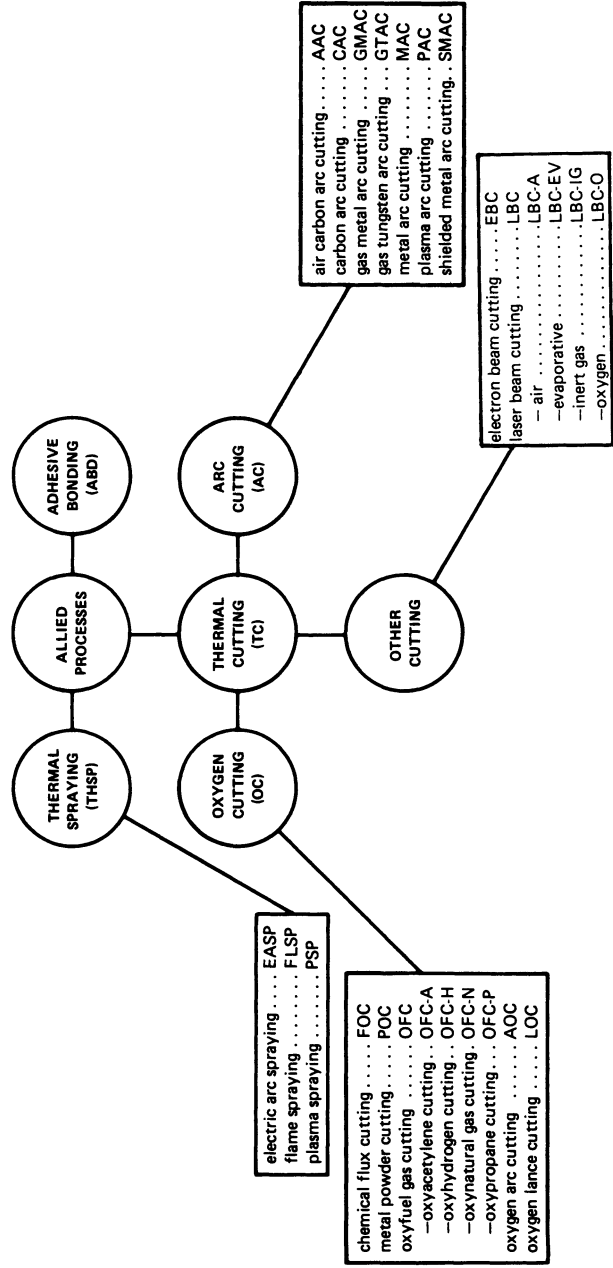
•Permission to duplicate this supplement is granted.

Master Chart of Welding and Allied Processes



Courtesy American Welding Society

Master Chart of Welding and Allied Processes (continued)



Courtesy American Welding Society

