

Print Reading: Welding Design

Unit: Graphic Agility

Problem Area: Print Reading—Lines and Symbols

Lesson: Print Reading: Welding Design

■ **Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

- 1 Analyze welding prints.
- 2 Interpret welding print symbols, abbreviations, and terms.

■ **Resources.** The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT, Inc. <http://www.mycart.com>.

“Engineering Symbols,” *Scribd.com*. Accessed Jan. 19, 2013.

<http://www.scribd.com/doc/7711916/Engineering-Symbols>.

Gregory, E.N., and A.A. Armstrong. *Welding Symbols on Drawings*. CRC, 2005.

Kubba, Sam, A. *Blueprint Reading: Construction Drawings for the Building Trades*. McGraw-Hill, 2009.

Traister, John. *Blueprint Reading for the Building Trades*. Craftsman, 2004.

Welding.com. Accessed Jan. 19, 2013. <http://www.welding.com/index.asp>.

“Welding Symbols for AutoCAD,” *YouTube*. Accessed Jan. 19, 2013.

<http://www.youtube.com/watch?v=fzuSPSQHe7c>.



■ **Equipment, Tools, Supplies, and Facilities**

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

■ **Key Terms.** The following terms are presented in this lesson (shown in bold italics):

- arc welding
- brazing
- contour welding
- field weld
- fillet weld
- resistance welding
- seam welding
- spot welding
- thermit welding
- weld symbol
- welding prints
- welding symbol

■ **Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Share the following with your students: The information on welding prints is extremely important, especially for worker safety. Every detail about a weld is located within the welding symbol, and nothing can be overlooked. It is a coded language. Print reading via sketches and drawings is a universal language that relays all the information a worker would need to fabricate or assemble an object or a part. Learning to read welding symbols gives the worker knowledge that can be used across all manufacturing and construction professions.

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Analyze welding prints.

Anticipated Problem: What do welding prints tell the engineer and fabricator?

I. Welding prints

- A. **Welding prints** are drawings that convey construction and fabrication information necessary to produce or assemble metalwork. The drawings have a series of standard information about the print plans, including:
1. The date produced
 2. Who produced the print plans
 3. What is represented by the plans
 4. Reference information
 5. Changes to the original plans
- B. Elements of a welding print
1. A title block is an area that includes the name of the company or organization that produced the drawing, the final issue date, and information about an individual part or project. It contains a print name and reference number (and/or letter). All information necessary to identify who produced the drawing and the specific intent of the drawing is located in the title block.
 2. A revision block is any drawing that has been revised from the original and is usually located in the upper right corner. Any changes are noted in this block; they are dated and identified by a number or letter.
 3. A reference number is an item used to identify a drawing within a set of drawing sheets. There are usually multiple sheets (drawings) for a project or product. Drawings that convey similar information will be grouped by the same number or by the same letter. A cover sheet lists all drawings with their corresponding numbers and letters.
 4. Some drawings contain multiple details or require additional drawings to describe a part; these drawings have additional reference numbers that generally appear in the title block followed by a dash and the extra digits identifying that particular set.
 5. Drawings always contain a scale located in the title block. Scale indicates the drawing size compared to the actual size of the part or assembly it represents. This is a reference only. It does not ensure that the drawing is printed exactly to that scale. The drawing's dimensions are used for fabrication.
- C. The weld symbol and welding symbols were developed by the American Welding Society and are standard across the United States. Welding prints must contain

clearly understood information that allows the engineer, designer, and fabricator to work together on a part and/or project. A **weld symbol** is a graphic that indicates the details of the specific type of weld. A **welding symbol** is assemblages of common weld symbols, abbreviations, and terms used to represent the full weld on a drawing. All the necessary information for each weld is contained in a welding symbol. The three main parts to the welding symbol are the reference line, arrow, and tail.

1. Reference line—The actual joint of the weld is the point of reference for the welding symbol. Information can be noted above or below the reference line; it is referred to as the “arrow side” and the “other side.” Symbols and abbreviations on the reference line provide information about the weld: contour, extent, dimensions, location, and any additional information that may be required.
2. Arrow—The arrow is drawn to locate the welding symbol to the joint or area to be welded. The terms “arrow side,” “other side,” and “both sides” are used to locate the weld with respect to the joint.
3. Tail—The welding and cutting processes are located on the tail of the symbol. The procedure, specifications, and any required additional information for making the weld are located on the tail.

Teaching Strategy: Use VM–A and VM–B to review. Demonstrate how a person can analyze a print to produce a weld, or arrange a field trip to a nearby fabrication shop. If the students can speaking to welders about their work and observe the welding process, it will be beneficial.

Objective 2: Interpret welding print symbols, abbreviations, and terms.

Anticipated Problem: How can a person interpret welding symbols, abbreviations, and terms shown on prints?

II. Symbols and abbreviations

- A. The location of the weld symbol on the reference line tells the welder where (on which side of the object) to make the weld. The weld symbol is located on the bottom of the reference line when the weld is to be made on the arrow side. When it is located on the top of the reference line, the weld is located on the opposite side of the arrow. If the symbol is on both sides of the line, the weld is on both sides.
- B. The basic weld symbol is the primary symbol shown within on the welding symbol. It notes the specific type of weld required. In addition to the weld type, the groove type is required. It is noted with a groove weld symbol.
- C. A standard set of supplementary weld symbols can be added to basic weld symbols. Supplements may include the weld contour and if the work is to be done on- or off-site.

- D. The exact location of the weld symbol on the reference line is important. The symbol can be on the arrow side, the other side, or both sides.
- E. The specifications on how to finish a weld and its contour are designated in the weld symbol. They can be used to produce refined welds with smooth finishes.
- F. Specific applications may require more than one weld. In some cases, multiple operators may produce the welds. In addition, each operator may be required to perform a different type of weld. This is noted with multiple reference lines or multiple symbols.
- G. The dimensions on welding symbols are used to designate the size, strength, length, pitch, and the number of welds (e.g., for a spot weld).
 - 1. This data has a very specific location on the welding symbol based on the reference line.
 - 2. Size dimensions applied to weld (type) symbols are located adjacent to the symbol.
- H. Special information is occasionally required for a weld. The additional information is often noted in the tail of the welding symbol. The required information may be in a separate drawing or alternate location; if so, a reference is given in the form of a letter, number, or another print (drawing) number.
- I. Abbreviations are common on welding prints and in welding symbols. They typically designate the welding process or the cutting process. The abbreviations are usually the first letter of each word used. If a redundancy exists, the first and second letters are used in one of the words. For example, the abbreviation TB designates the welding process of torch brazing.
- J. Welding terminology
 - 1. **Arc welding** (shielded metal) is the process of joining two metal pieces using a flux-covered electrode. The electrode is melted in an electric arc and becomes part of the pieces being welded.
 - 2. **Brazing** is the process of joining two pieces of metal with a metallic filler (the braze material). The filler is melted across the joint and then cools to form a solid bond.
 - 3. **Contour welding** is a welding process in which a laser is guided along a pre-determined pattern. The material only melts on the path on which the laser is directed.
 - 4. A **field weld** is a weld that is an operation performed at the construction site.
 - 5. A **fillet weld** is the most common type of weld. It is used to join two pieces of flat stock (steel) at a 90-degree angle. It is produced by running a weld bead at a 45-degree angle to a 90-degree corner. It looks like a triangle when viewed from the side.
 - 6. **Resistance welding** is a process that joins two pieces of metal by passing current between electrodes positioned on opposite sides of the pieces.
 - 7. **Seam welding** is a type of resistance welding that creates a lengthwise seam in sheet metal by a butt joint or an overlap joint. It is usually an automated process.

8. **Spot welding** is a type of resistance welding in which materials are fused together by the heat from a flow of electric current through the pieces held together under pressure by the electrodes.
9. **Thermit welding** is a group of welding processes in which fusion is produced by superheating copper alloy to permanently join the conductors.

Teaching Strategy: Share a real set of welding prints with the students. Seeing the actual prints and symbols on real drawings helps the students visualize and register the information. Use VM–C through VM–L. Assign LS–A, which uses VM–M.

■ **Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may be used in the Review/Summary.

■ **Application.** Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

■ **Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

■ **Answers to Sample Test:**

Part One: Matching

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

Part Two: True/False

1. T
2. F
3. T
4. T
5. F
6. T

Part Three: Short Answer

The three main parts of the welding symbol are:

- a. Reference line—The actual joint of the weld is the point of reference for the welding symbol. Information can be noted above or below the reference line; it is referred to as the “arrow side” and the “other side.” Symbols and abbreviations on the reference line provide information about the weld: contour, extent, dimensions, and location, as well as any additional information that may be required.
- b. Arrow—The arrow is drawn to locate the welding symbol to the joint or area to be welded. The terms “arrow side,” “other side,” and “both sides” are used to locate the weld with respect to the joint.
- c. Tail—The welding and cutting processes are located on the tail of the symbol. The procedure, specifications, and any required additional information for making the weld are also located on the tail.

Print Reading: Welding Design

► Part One: Matching

Instructions: Match the term with the correct definition.

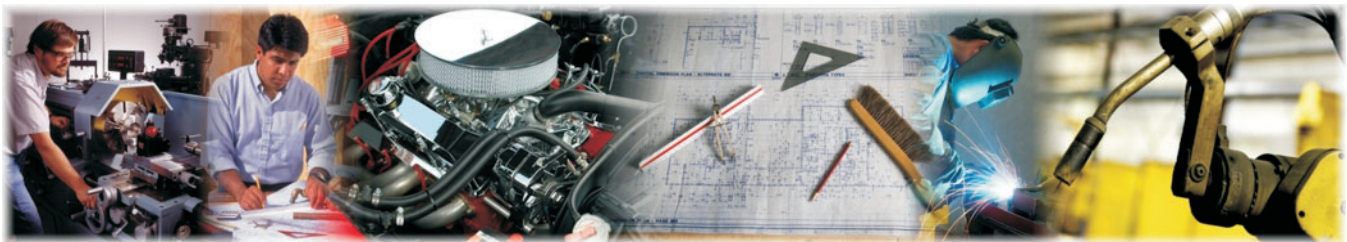
- | | |
|-----------------------|--------------------|
| a. field weld | d. brazing |
| b. fillet weld | e. arc welding |
| c. resistance welding | f. contour welding |

- _____ 1. The process of joining two metal pieces using a flux-covered electrode
- _____ 2. The process of joining two pieces of metal with metallic filler
- _____ 3. A welding process in which a laser is guided along a predetermined pattern
- _____ 4. A weld that is an operation performed at the construction site
- _____ 5. A process that joins two pieces of metal by passing current between electrodes positioned on opposite sides of the pieces
- _____ 6. A weld used to join two pieces of flat stock (steel) at a 90-degree angle

► Part Two: True/False

Instructions: Write *T* for true or *F* for false.

- _____ 1. The abbreviations on welding prints are typically used to designate the welding process or cutting process.
- _____ 2. The exact location of the weld symbol on the reference line is not important.
- _____ 3. Size dimensions that are applied to weld (type) symbols are located adjacent to the symbol.
- _____ 4. Some drawings that contain multiple details or require additional drawings to describe a part will have additional reference numbers.



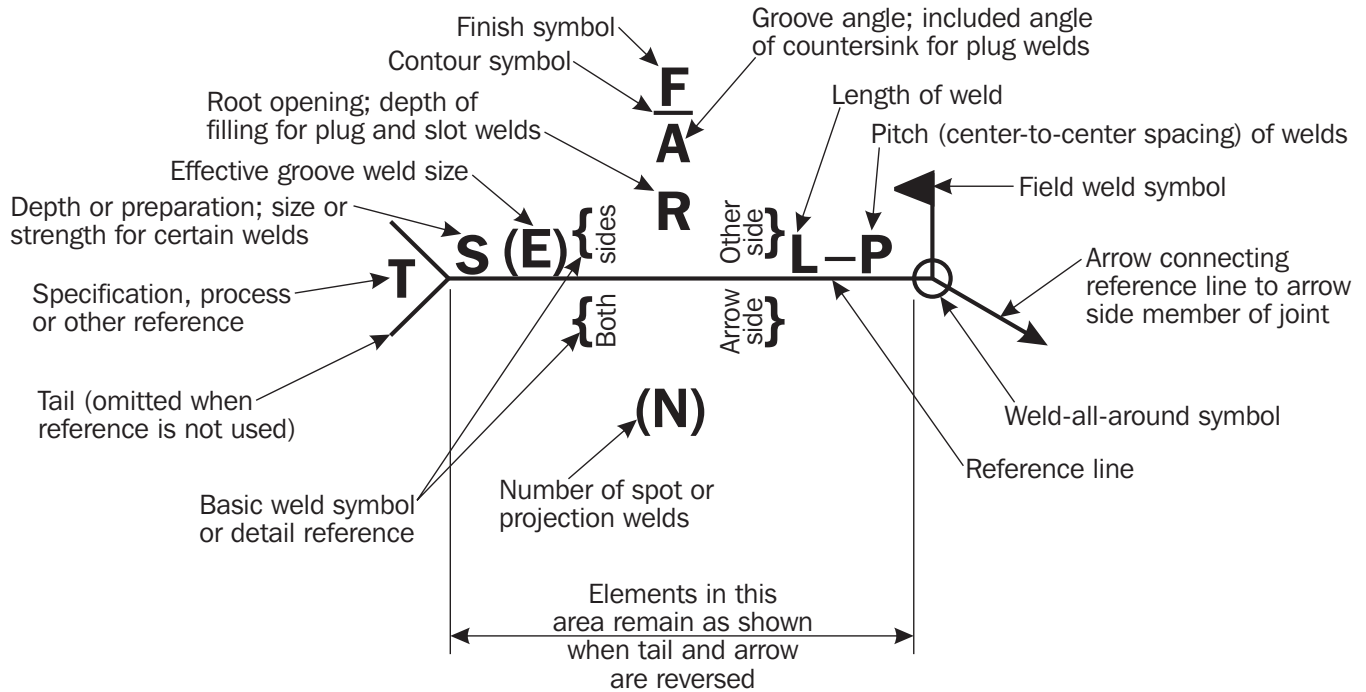
- _____ 5. The actual joint of the weld is not referenced on the welding symbol.
- _____ 6. Welding prints are used to convey construction and fabrication information necessary to produce or assemble metalwork.

► **Part Three: Short Answer**

Instructions: Answer the following.

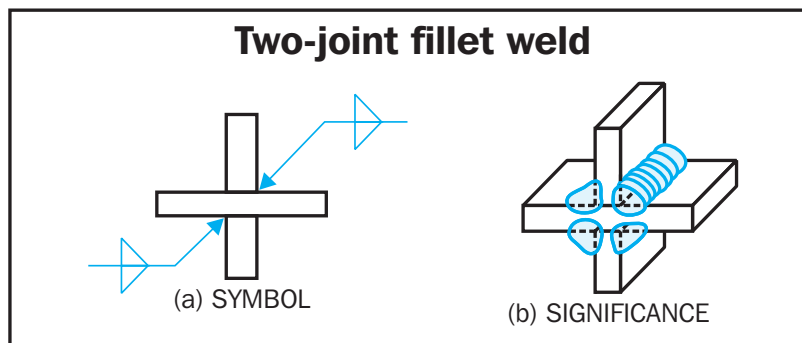
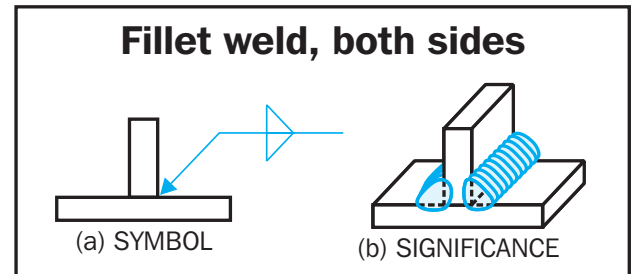
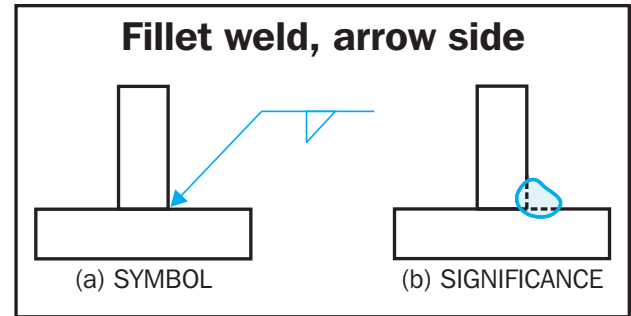
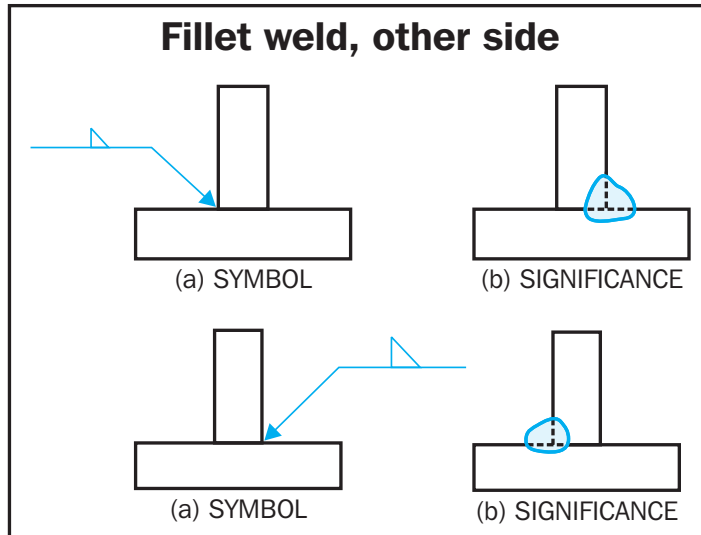
List and describe the three main parts of the welding symbol.

WELDING SYMBOL



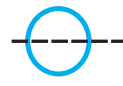
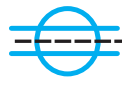
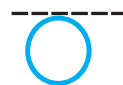
(Adapted from Shanghai Jiao Tong University, Shanghai, China)

TWO-JOINT FILLET WELD: ARROW SIDE AND OTHER SIDE



(Adapted from Shanghai Jiao Tong University, Shanghai, China)

BASIC WELD TYPE AND GROOVE SYMBOLS

GROOVE WELD SYMBOLS							
Square	Scarf	V	Bevel	U	J	Flare-V	Flare Bevel
							
							
Fillet	Plug or Slot	Stud	Slot or Projection	Seam	Back or Backing	Surfacing	Edge
							
							
							

NOTE: ----- (dashed line) represents reference line

(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

SUPPLEMENTARY WELD SYMBOLS

Contour			Melt-thru	Consum- able Insert	Backing or Spacer	Weld All Around	Field Weld
Flush	Convex	Concave					

*With reference to the backing material symbol, the letter "R" is placed within the backing material symbol to specify removal of backing material upon completion of welding.

(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

BASIC WELD SYMBOLS AND THE SIGNIFICANCE OF THEIR LOCATION ON THE REFERENCE LINE

Location Significance	Fillet	Plug or Slot	Spot or Projection	Stud	Seam	Back or Backing**	Surfacing	Edge
Arrow Side								
Other Side				NOT USED			NOT USED	
Both Sides		NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	
No Arrow Side or Other Side Significance	NOT USED	NOT USED		NOT USED		NOT USED	NOT USED	NOT USED

Location Significance	Groove							
	Square	V	Bevel	U	J	Flare-V	Flare-Bevel	Scarf
Arrow Side								
Other Side								
Both Sides								
No Arrow Side or Other Side Significance		NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED

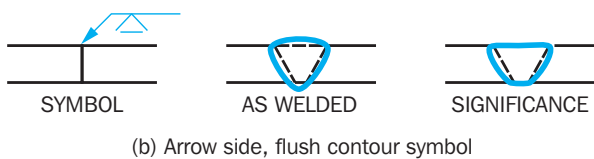
*Used for ESW and EGW

**Back or backing is specified in tail of welding of symbol having a single reference line.

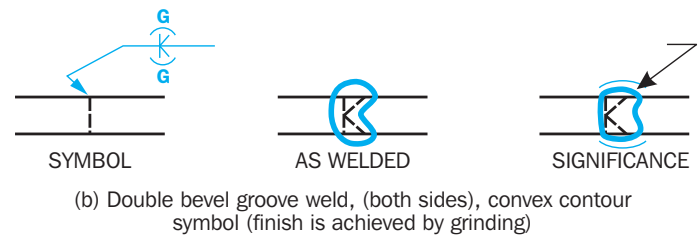
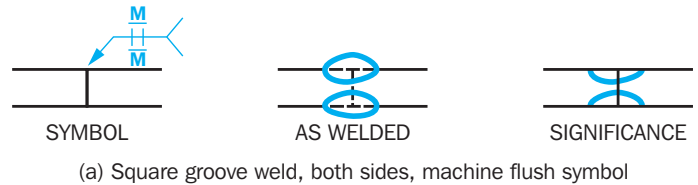
(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

WELD CONTOURS AND FINISHES

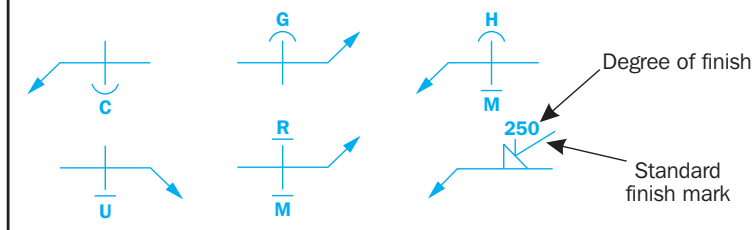
Contour weld symbols and their final result



Finish weld symbols and their final result



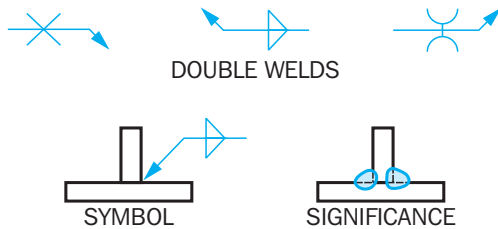
Finish weld symbols



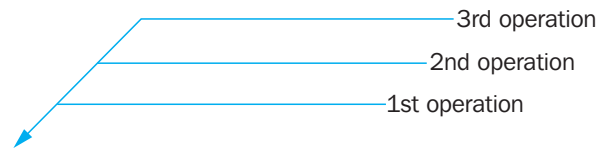
(Adapted from Shanghai Jiao Tong University, Shanghai, China)

MULTIPLE WELDS AND MULTIPLE OPERATORS

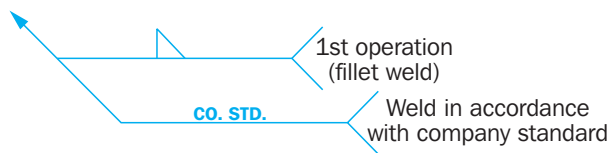
Weld symbols for more than one weld



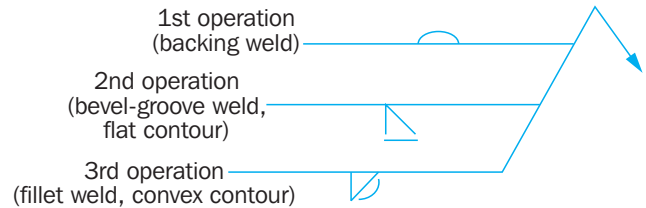
Multiple reference lines for multiple operator



Additional or supplementary info for second reference line only

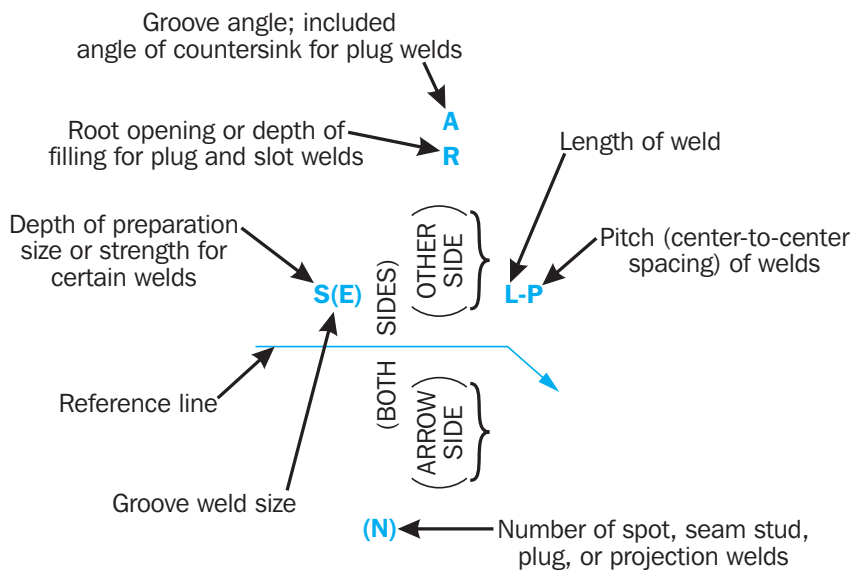


Multiple operators with multiple weld types



(Adapted from Shanghai Jiao Tong University, Shanghai, China)

THE LOCATION OF DIMENSIONS ON A WELDING SYMBOL LOCATED OFF OF THE REFERENCE LINE



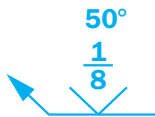
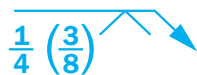
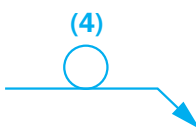
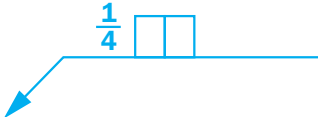
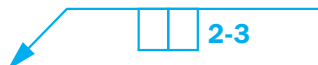
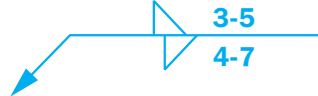
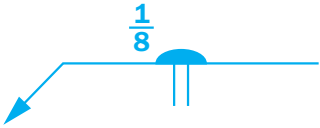
(a) Location of dimension when weld symbol is on other side of reference line



(b) Location of dimensions when weld symbol is on arrow side of reference line

(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

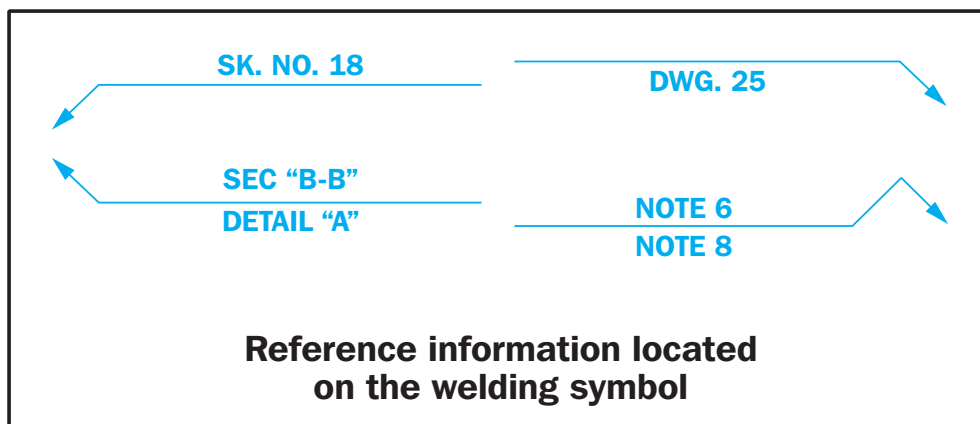
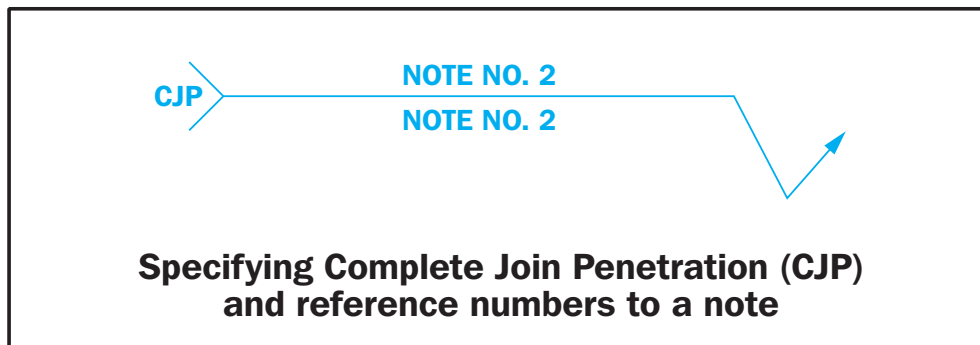
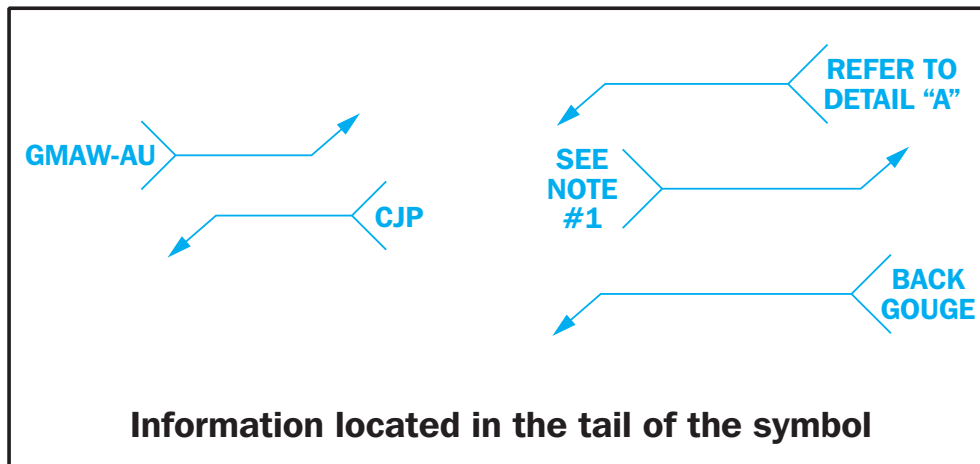
LOCATION OF SIZE DIMENSIONS FOR WELD SYMBOLS

 Size	 Shear strength	 Length	 Length and pitch
 Root opening	 Groove angle	 Groove angle and root opening	 Size of groove and groove weld size
	 Depth of fill	 Angle of countersink	 Number of welds
 Size		 Height of surface build up	
 Length and pitch		 Radius of flare V-groove	
 Dimensioning for staggered intermittent fillet welds		 Height of weld reinforcement	

(Courtesy, Shanghai Jiao Tong University, Shanghai, China)

ADDITIONAL REFERENCE INFORMATION

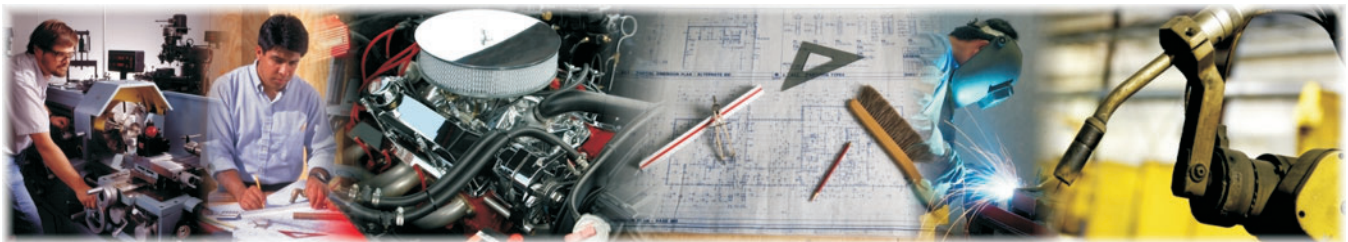
Welding symbols with additional information



(Adapted from Shanghai Jiao Tong University, Shanghai, China)

ABBREVIATIONS OF WELDING PROCESSES AND APPLICATION METHODS

Welding Process	Abbreviation (Letter Designation)
Brazing	
Torch brazing	TB
Twin carbon-arc brazing	TCAB
Furnace brazing	FB
Induction brazing	IB
Resistance brazing	RB
Dip brazing	DB
Block brazing	BB
Flow brazing	FLB
Flow welding	FLOW



Welding Process	Abbreviation (Letter Designation)
Resistance welding	
Flash welding	FW
Upset welding	UW
Percussion welding	PEW
Induction welding	IW
Arc welding	
Bare metal-arc welding	BMAW
Stud welding	SW
Gas shielded stud welding	GSSW
Submerged arc welding	SAW
Gas tungsten-arc welding	GTAW
Gas metal-arc welding	GMAW
Atomic hydrogen welding	AHW
Shielded metal-arc welding	SMAW
Twin carbon-arc welding	TCAW
Carbon-arc welding	CAW
Gas carbon-arc welding	GCAW
Shielded carbon-arc welding	SCAW
Flux cored-arc welding	FCAW

Welding Process	Abbreviation (Letter Designation)
Thermit welding	
Nonpressure thermit welding	NTW
Pressure thermit welding	PTW
Gas welding	
Pressure gas welding	PGW
Oxyhydrogen welding	OHW
Oxyacetylene welding	OAW
Air-acetylene welding	AAW
Forge welding	
Roll welding	RW
Die welding	DW
Hammer welding	HW

Welding Application Method	Abbreviation (Letter Designation)
Automatic welding	AU
Machine welding	ME
Manual welding	MA
Semi-automatic welding	SA

ABBREVIATIONS OF CUTTING PROCESSES AND METHODS

Cutting Process	Abbreviation (Letter Designation)
Arc cutting	AC
Air-carbon-arc cutting	AAC
Carbon-arc cutting	CAC
Metal-arc cutting	MAC
Oxygen cutting	OC
Chemical flux cutting	FOC
Metal powder cutting	POC
Arc-oxygen cutting	AOC

Cutting Method	Abbreviation (Letter Designation)
Automatic cutting	AU
Machine cutting	ME
Manual cutting	MA
Semi-automatic cutting	SA

BLANK WELDING SYMBOL



Welding Print Locations

Purpose

The purpose of this activity is to accurately place weld symbols on prints.

Objectives

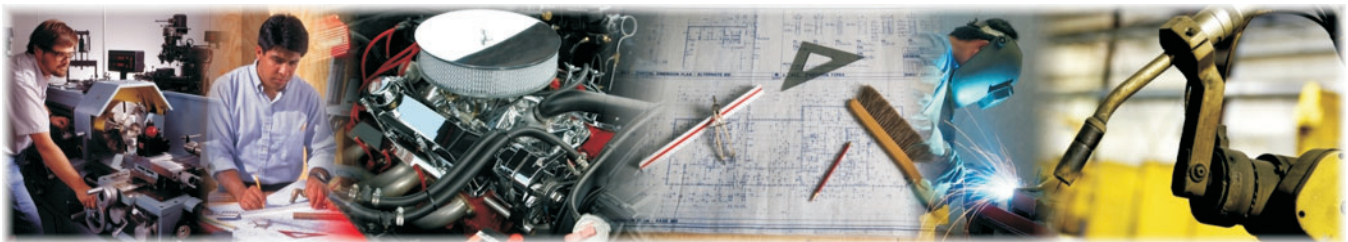
1. Demonstrate knowledge of weld symbols, welding symbols, and terms.
2. Label a welding symbol.

Materials

- ◆ VM-M projected for student use
- ◆ writing utensil
- ◆ paper

Procedure

1. Work independently.
2. Redraw the welding symbol on your paper using VM-M. Then identify the two symbols already shown.
 - a.
 - b.
3. Note where the existing field weld symbol is on the welding symbol, and draw an arrow. Label it as “field weld symbol.”
4. Next, note where the existing weld-all-around symbol is on the welding symbol, and draw an arrow to it. Label it as weld-all-around symbol.



5. Finally, note where the following information should be located on the symbol, and use the appropriate letters as provided.
 - a. Where would you locate the length of the weld? Place the letter “L” at that correct location.
 - b. Where would you locate the number of spot or projection welds? Place the letter “N” at that/those locations.
 - c. Where would you locate the depth or preparation and size or strength of a weld? Place the letter “S” at that/those locations.
 - d. Where would you locate the effective groove weld size? Place the letter “G” at that location.
6. Turn in your lab sheet to your instructor.