After completing Unit 16, you will be able to:

- Differentiate a groove weld from other types of welds.
- Interpret dimensions for preparing groove welds, including the depth of preparation, groove angle, bevel angle, and root opening size.
- Determine the preparation size and effective throat of groove welds.
- Apply groove weld dimensioning standards.
- Interpret surface finish and contour symbols.
- Interpret melt-through, back, and backing weld symbols.
- Explain uses for backing, joint spacers, and runoff weld tabs.

**Key Words**

- backing
- groove radii
- bevel angle
- joint root
- effective throat
- joint spacers
- flare-groove welds
- root faces
- groove angle
- root opening
- groove face
- runoff weld tabs

Groove welds are made in the space between two sections of metal, Figure 16-1. With the exception of the square-groove and flare-groove joints, one or more of the members being joined is prepared by removing metal to form a V-, J-, or U-shaped trough. This joint preparation provides for deeper or full penetration of the weld into the joint and provides clearance for the electrode. Burning, grinding, arc gouging, chiseling, or machining removes the metal.

**Root Opening, Groove Angle, and Bevel Angle**

It is important to be familiar with the common terms associated with groove joints and the preparation of groove welds. The root opening is the gap at the joint root workpieces, Figure 16-2. The joint root refers to the part of a joint to be welded where the members align closest to each other. The root opening is used to provide access to the joint for the electrode and improved weld penetration.

When additional clearance or penetration is needed for thicker material, an angle is placed on the edge of the material. A groove angle is the total angle formed between the groove face on one workpiece and the groove face on the other workpiece. The groove face is the joint member surface included in the groove. A bevel angle is the angle formed between the bevel of one piece and a plane perpendicular to the surface of the piece. The angle may be placed on one side of the joint, as with a single-bevel-groove, or the angle may be placed on both sides, as in a V-groove.

**Preparation Size and Effective Throat of Groove Welds**

The effective throat is the minimum distance (minus any convexity) between the weld root and the face of the weld. It describes the weld size (penetration), Figure 16-4. When specified for a weld, the effective throat is shown in parentheses to the left of the weld symbol. As shown in Figure 16-4, it appears to the right of the depth of bevel. The depth of bevel indicates the depth of preparation for preparing the joint.

The effective throat of a groove weld is specified when the weld extends only partially through the members being joined. Complete joint penetration is indicated when no dimension is given on the welding symbol for a

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**Figure 16-1.** Single-groove and double-groove weld joints are shown.

**Figure 16-2.** Common terms describing the parts of a groove joint.

**Figure 16-3.** A V-groove weld with its parts identified. The welding symbol shows the root opening size and the groove angle.

**Figure 16-4.** A dimension in parentheses to the left of the weld symbol gives the effective throat (weld size) of the groove weld when the weld extends partly through the members being joined.

**Figure 16-5.** When no dimension is given on the welding symbol, the weld should completely penetrate the joint.
Single-groove or a symmetrical double-groove weld. Figure 16-5 illustrates complete weld penetration for a double-groove joint.

A dimension not in parentheses on the left of a bevel-, V-, J-, or U-groove weld symbol—in cases where the effective throat is not specified, or is specified elsewhere on the print—indicates the size of the weld preparation only. Figure 16-6. No such dimension is needed with a square-groove weld.

Optional groove preparation with complete penetration is indicated when the letters CJP are shown in the tail of the reference line. Figure 16-7.

The weld size of a flare-groove weld is considered only to the tangent point (the point where the curved surfaces meet), Figure 16-8.

**General Use of Groove Weld Symbol**

Different conventions are used for groove welding symbols depending on the dimensions that are specified and the information required. As previously discussed, dimensions for the preparation of groove welds are shown on the same side of the reference line as the weld symbol. See Figure 16-9. This example shows a J-groove weld. The information specified includes the depth of preparation, groove angle, and root opening.

Double-groove welds are dimensioned on both sides of the reference line if no general note appears on the print, Figure 16-10. If the welds differ in size, they are dimensioned as in Figure 16-11. Groove welding symbols will not include dimensions when a general note determining groove weld size appears on the print. Figure 16-12. When a break in the arrow is used with bevel- and J-groove welds, the arrow points toward the member to be beveled, Figure 16-13.

**Groove Dimensions**

Many companies have established their own standards for groove weld dimensions. These standards are observed unless otherwise noted on the print. When company standards for groove welds are not indicated, the following applies:

- The root opening is indicated inside the weld symbol, Figure 16-14.
- The groove angle or bevel angle is specified, Figure 16-15.
- The groove radii (used to form the shape of J- or U-groove welds) and root faces (the parts of the groove face within the joint root) are shown by cross section, detail, or other means with a reference on the welding symbol, Figure 16-16.

Study how groove angles of groove welds are specified.
Weld deposited flush with base metal

Desired weld Symbol

Figure 16-17. A flush contour symbol is placed above the weld symbol when the groove weld is to be made approximately flush and without the use of grinding, chipping, hammering, or machining.

Melt-Through, Back, and Backing Welds

The melt-through, back, and backing weld symbols show that a melt-through to the other side, bead-type back, or backing weld is needed with a single-groove weld. Points to remember include:

- A back weld is made after the groove weld.
- A backing weld is made before the groove weld.
- A melt-through is a visible reinforcement produced in a groove weld from one side.

A note states whether a back or backing weld is to be made. This note is placed in the tail of the welding symbol, Figure 16-20. As shown, a back or backing weld symbol is located on the side of the reference line that is opposite the groove weld symbol.

A flush contour symbol, added to the back or backing weld symbol, indicates the weld should be approximately flush with the base metal, Figure 16-21. If the back or backing weld is to be made flush by mechanical means, the method of making the weld flush is added to the flush contour symbol, Figure 16-22.

When a back or backing weld is to be finished to a convex contour, a note indicates whether to make a back or backing weld. A note is placed in the tail of the reference line, indicating whether to make a back weld or backing weld symbol. Backing is thoroughly penetrated by the weld and usually left in place.

Back, Joint Spacers, and Runoff Welds

Back is used to withstand molten weld metal, Figure 16-25. It is employed when full penetration groove welds are required and welding can only be done from one side. Backing is specified by a convex contour symbol and finish symbol are added to the weld symbol.

With the exception of height, which is optional, no other back or backing weld dimensions are shown with the weld symbol, Figure 16-23. If other dimensions are required, they are shown on the drawing. A melt-through weld assures full joint penetration. The melt-through weld symbol is similar to the back or backing weld symbol with the bead filled in as shown in Figure 16-24. A dimension to the left of the symbol specifies the amount of melt-through.
Joint spacers are metal parts inserted in the joint root as backing and to maintain the root opening during welding, Figure 16-26. Joint spacers are sometimes used, especially if the weld is in thick material and the minimum possible V-angle is specified. In such welds, the root must be gouged out completely, including the spacer bar, before the second side of the groove is welded. Runoff weld tabs provide an extension of the groove beyond the pieces being joined when a full-length groove weld is specified, Figure 16-27. Runoff tabs provide a place to strike the arc and material at the end of the weld to eliminate the weld crater. The angle or contour of the runoff weld tab must be identical to that of the groove. Since welding symbols give no indication of the backing, spacer, or extension bar requirements, note that unless covered by reference to AWS prequalified joints or fabricators’ standards, special sketches of the weld profile are provided.

Flare-Groove Welds

Flare-groove welds are used to join round or formed metal parts. The groove that is formed when curved surfaces are placed together does not have straight sides on one or both members. Two round steel bars laid side-by-side, such as reinforcing rod, have sides that are curved. The joint that is formed does not have straight sides like a V-groove weld.

Figure 16-28 shows an example of a flare-V-groove weld. Either two round parts (members) or two formed parts (members) can be used to form the V-groove. The symbol for the flare-V-groove weld can be placed on a single side, or the symbol can indicate that the weld should be made on both sides. The depth dimension for a flare-V-groove weld is given as the distance from the top of the member to the point of tangency (where it touches the other member or part). Figure 16-29 shows a dimension of .31 to the point of tangency and a weld size of .25. Notice that the weld size is placed in parentheses. The weld size is the distance from the surface of the part to the root of the weld.

For round parts, the first dimension is the radius of the round part. Figure 16-28 shows the round bar has a radius of 1.00 and a weld size of .75. If only one part is round or formed, then the formed part and a straight part form a flare-bevel-groove weld. Figure 16-30 shows a formed part welded to a straight part. The dimensions used to describe the flare-bevel-groove weld have the same meaning as those used for the flare-V-groove weld. The first dimension indicates the distance from the top of the part to the point of tangency (the radius of the round part) and the second dimension indicates the size of the weld.

Combination Weld Symbols

Combination weld symbols are used when other types of welds are required with groove welds. Figure 16-32 shows a flare-bevel-groove weld with two fillet welds. The weld symbols specify a fillet weld over the flare-bevel-groove weld on the arrow side, and a fillet weld on the other side. The dimensions for the combination symbol are applied in the same manner as those used for the flare-groove weld symbol and the fillet weld symbol.

Figure 16-26. Joint spacers may be specified when thick sections are welded. Specifications are shown in the reference line tail.

Figure 16-27. A runoff weld tab is used when a full-length groove weld is specified. Specifications in the reference line tail or sketches on the drawing may be used to indicate a runoff weld tab.

Figure 16-28. A flare-V-groove weld applied to a joint formed by two round parts.

Figure 16-29. Dimensions for a flare-V-groove weld.

Figure 16-30. A flare-bevel-groove weld can be formed by one round, or formed, part, and a straight part.

Figure 16-31. Dimensions for a flare-bevel-groove weld joining a round part to a straight part. The first dimension in the welding symbol indicates the distance from the top of the part to the point of tangency (the radius of the round part) and the second dimension indicates the size of the weld.

Figure 16-32. A welding symbol with combination weld symbols for a flare-bevel-groove weld and two fillet welds. The dimensions for combination weld symbols are applied in the same manner as those for each type of weld symbol.
Print Reading Activities

Part I
Identify the groove weld joints shown below. Write your answers in the spaces provided.

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  

Part II
Sketch in the correct welding symbol for each groove weld shown in Part I. Sketch the symbol in the correct location on the view.

Part III
Study the drawings shown and sketch in the welding symbol(s) that will describe each joint.

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  
Part IV

Carefully study the drawing (B577891) below and answer the following questions.

1. List the name and drawing number.
   A. 
   B. 

2. What parts are to be joined by welding?
   A. 
   B. 

3. Interpret the types of welds required to make the weldment (joint of two sections.)
   A. 
   B. 

4. Joint and weld specifications can be found ________.

5. What type of welding rod is to be used? ________

6. What special requirements must be observed after the weldments are made?
   A. 
   B. 

7. Have any changes been issued against the drawing? If there have been, list the number made.
   A. 
   B. 

8. Joint and weld specifications can be found ________.

Part V

Carefully study the drawing (L-725) below and answer the following questions.

1. List the name and drawing number of the print.
   A. 
   B. 

2. How many parts make up the assembly? ________

3. What are the names of the parts that make up the assembly? _______________________________

4. Is more than one size unit indicated on the print?

5. If more than one size unit is indicated, how many are there and how is each unit identified?
   A. 
   B. 

6. List the stock size required to make each part of the assembly.
   Holder (1) 
   Holder (2) 
   Base plate 

7. Interpret the type of weld(s) required to make the weldment(s). 

8. What heat treatment is required after welding? ________

9. How is each weld to be inspected? ________

10. How many holes are drilled in the base? ________

11. The diameter of these holes is ________.

12. How many threaded holes are indicated in the holder?

13. The thread size is ________ and is tapped ________ deep.

14. Describe how the large hole in the holder is to be made.

15. Is a tolerance indicated for the final diameter? ________
   If so, what is it? 

16. What is the size of the key on the base? ________
Part VI
Explain each of the following welding symbols.

1.

2.

3.

4.

5.

Part VII
Draw the correct weld(s) as indicated by the welding symbol.

Part VIII
Use print 1104-wrp to answer the following questions.
1. List the overall length of the support bracket. ______
2. Determine the total number of holes required for the part. ________________________________
3. Determine the overall maximum height of the part. _____________________________________
4. List the center-to-center distance of the .50 diameter holes. _____________________________
5. List the typical plate thickness for the support bracket. _________________________________
6. Determine the maximum angle for the 27° angle of the gusset. ___________________________
7. What surface requires finishing? __________________
8. Explain the welding symbol at K. __________________
9. Explain the welding symbol at L. __________________
10. Explain the welding symbol at M. __________________

Part IX
Use print 1104-wrp to determine the following dimensions indicated on the print.
1. A __________________
2. B __________________
3. C __________________
4. D __________________
5. E __________________
6. F __________________
7. G __________________
8. H __________________
9. I __________________
10. J __________________
Pipe welding also extends to the auto industry. Shown are stainless steel exhaust manifolds fabricated mainly by welding. Each unit is carefully inspected because of danger of exhaust gas leakage to the vehicle’s driver and passengers. (American Iron and Steel Institute)