# Basic Design and Pipe Drafting

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Lecture Times : Tuesdays EST 14-16 on class days

Tutorial Times: Sunday EST 14-15

# Pipe Fittings – Screwed & socket-weld fittings

Screwed and socket-weld fittings perform the same basic functions as butt-weld fittings. Like butt-weld fittings, elbows, tees, and reducers are manufactured for screwed and socket-weld applications.

There are, however, a few differences. Screwed and socket-weld fittings are normally reserved for installations where the nominal pipe size is 3" and smaller. Screwed and socket-weld fittings are also available in cast iron, malleable iron (used in low pressure and temperature lines, such as air, water), or forged steel (high pressure and temperature lines).

# Pipe Fittings – Screwed & socket-weld fittings

Pipe lines containing high pressure and temperature commodities, which are subject to substantial amounts of movement and vibration, mandate fittings made of forged steel. For these reasons, forged steel screwed and socket-weld fittings are manufactured in two pressure classes—3000# and 6000#. Figures 3.54 and 3.55 display a portion of the screwed and socket-weld fitting dimensioning charts found in Appendix A.

# Pipe Fittings – Screwed & socket-weld fittings

Figures 3.54 display a portion of the screwed and socket-weld fitting dimensioning charts found in Appendix A.

## SCREWED FITTINGS

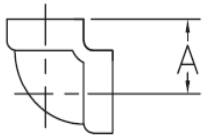
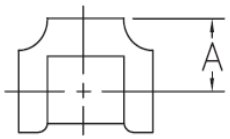
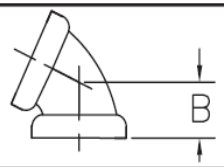
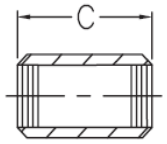
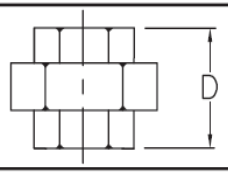
| NOMINAL PIPE SIZE – (INCHES) | | | $\frac{1}{2}$" | $\frac{3}{4}$" | 1" | $1\frac{1}{4}$" | $1\frac{1}{2}$" | 2" | $2\frac{1}{2}$" | 3" |
|---|---|---|---|---|---|---|---|---|---|---|
|  | 3000 # 90° ELL | A | $1\frac{5}{16}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{3}{8}$ | $2\frac{1}{2}$ | $3\frac{3}{8}$ | $3\frac{3}{4}$ |
| | 6000 # | A | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{3}{8}$ | $2\frac{1}{2}$ | $3\frac{3}{8}$ | $3\frac{3}{4}$ | $4\frac{3}{16}$ |
|  | 3000 # HALF TEE | A | $1\frac{5}{16}$ | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{3}{8}$ | $2\frac{1}{2}$ | $3\frac{3}{8}$ | $3\frac{3}{4}$ |
| | 6000 # | A | $1\frac{1}{2}$ | $1\frac{3}{4}$ | 2 | $2\frac{3}{8}$ | $2\frac{1}{2}$ | $3\frac{3}{8}$ | $3\frac{3}{4}$ | $4\frac{3}{16}$ |
|  | 3000 # 45° ELL | B | 1 | $1\frac{1}{8}$ | $1\frac{5}{16}$ | $1\frac{7}{16}$ | $1\frac{11}{16}$ | 2 | $2\frac{1}{16}$ | $2\frac{1}{2}$ |
| | 6000 # | B | $1\frac{1}{8}$ | $1\frac{5}{16}$ | $1\frac{11}{32}$ | $1\frac{11}{16}$ | $1\frac{23}{32}$ | $2\frac{1}{16}$ | $2\frac{1}{2}$ | $3\frac{1}{8}$ |
|  | 3000 # COUPLING | C | $1\frac{7}{8}$ | 2 | $2\frac{3}{8}$ | $2\frac{5}{8}$ | $3\frac{1}{8}$ | $3\frac{3}{8}$ | $3\frac{5}{8}$ | $4\frac{1}{4}$ |
| | 6000 # | C | $1\frac{7}{8}$ | 2 | $2\frac{3}{8}$ | $2\frac{5}{8}$ | $3\frac{1}{8}$ | $3\frac{3}{8}$ | $3\frac{5}{8}$ | $4\frac{1}{4}$ |
|  | 3000 # UNION | D | $2\frac{3}{8}$ | $2\frac{7}{16}$ | $2\frac{3}{4}$ | $2\frac{15}{16}$ | $3\frac{3}{16}$ | $3\frac{7}{16}$ | $4\frac{1}{16}$ | $4\frac{1}{2}$ |
| | 6000 # | D | $2\frac{3}{8}$ | $3\frac{3}{8}$ | $3\frac{5}{8}$ | $3\frac{7}{8}$ | $4\frac{3}{16}$ | $4\frac{5}{8}$ | | |
| NORMAL THREAD ENGAGEMENT | 3000 # | | $\frac{1}{2}$ | $\frac{9}{16}$ | $\frac{11}{16}$ | $\frac{11}{16}$ | $\frac{11}{16}$ | $\frac{3}{4}$ | $\frac{15}{16}$ | 1 |
| | 6000 # | | $\frac{1}{2}$ | $\frac{9}{16}$ | $\frac{11}{16}$ | $\frac{11}{16}$ | $\frac{11}{16}$ | $\frac{3}{4}$ | $\frac{15}{16}$ | 1 |

FIGURE 3.54 Screwed fittings dimensioning chart.

# Pipe Fittings – Screwed & socket-weld fittings

Figures 3.55 display a portion of the screwed and socket-weld fitting dimensioning charts found in Appendix A.

## SOCKET–WELD FITTINGS

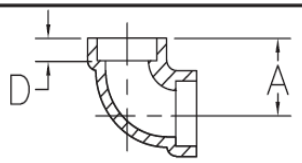
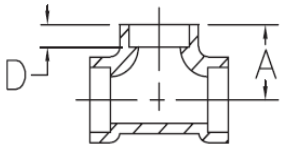
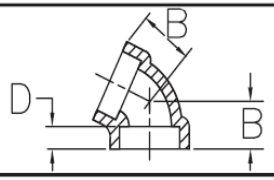
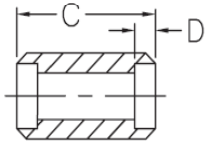
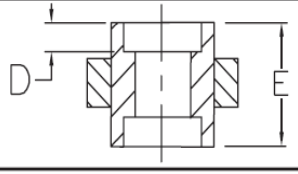
| NOMINAL PIPE SIZE–(INCHES) | | | 1/2" | 3/4" | 1" | 1 1/4" | 1 1/2" | 2" | 2 1/2" | 3" |
|---|---|---|---|---|---|---|---|---|---|---|
|  | 3000 # 90°ELL | A | 1 1/8 | 1 5/16 | 1 1/2 | 1 3/4 | 2 | 2 3/8 | 3 | 3 3/8 |
| | 6000 # | A | 1 5/16 | 1 1/2 | 1 3/4 | 2 | 2 3/8 | 2 1/2 | 3 1/4 | 3 3/4 |
|  | 3000 # HALF TEE | A | 1 1/8 | 1 5/16 | 1 1/2 | 1 3/4 | 2 | 2 3/8 | 3 | 3 3/8 |
| | 6000 # | A | 1 5/16 | 1 1/2 | 1 3/4 | 2 | 2 3/8 | 2 1/2 | 3 1/4 | 3 3/4 |
|  | 3000 # 45°ELL | B | 7/8 | 1 | 1 1/8 | 1 5/16 | 1 7/16 | 1 11/16 | 2 1/16 | 2 1/2 |
| | 6000 # | B | 1 | 1 1/8 | 1 5/16 | 1 11/32 | 1 11/16 | 1 23/32 | 2 1/16 | 2 1/2 |
|  | 3000 # COUPLING | C | 1 7/8 | 2 | 2 3/8 | 2 5/8 | 3 1/8 | 3 3/8 | 3 5/8 | 4 1/4 |
| | 6000 # | C | 1 7/8 | 2 | 2 3/8 | 2 5/8 | 3 1/8 | 3 3/8 | 3 5/8 | 4 1/4 |
|  | 3000 # UNION | E | 1 15/16 | 2 1/4 | 2 1/2 | 2 13/16 | 3 1/16 | 3 7/16 | 4 | 4 5/16 |
| | 6000 # | E | 2 5/16 | 2 1/2 | 2 13/16 | 2 3/4 | 2 7/8 | 3 11/16 | 3 15/16 | 4 5/8 |
| SOCKET DEPTH | 3000 # | D | 1/2 | 9/16 | 5/8 | 11/16 | 3/4 | 7/8 | 1 3/8 | 1 1/8 |
| | 6000 # | D | 11/16 | 3/4 | 7/8 | 15/16 | 1 1/8 | 1 | 1 1/2 | 1 5/8 |

FIGURE 3.55 Socket-weld fittings dimensioning chart.

# Pipe Fittings – Screwed & socket-weld fittings

Most screwed fittings are manufactured with internal, or female, threads as defined by the American Standard and API thread guidelines. As shown in Figure 3.56, of particular concern to the pipe designer is the amount of pipe length lost during the assembly.

The assembly length:

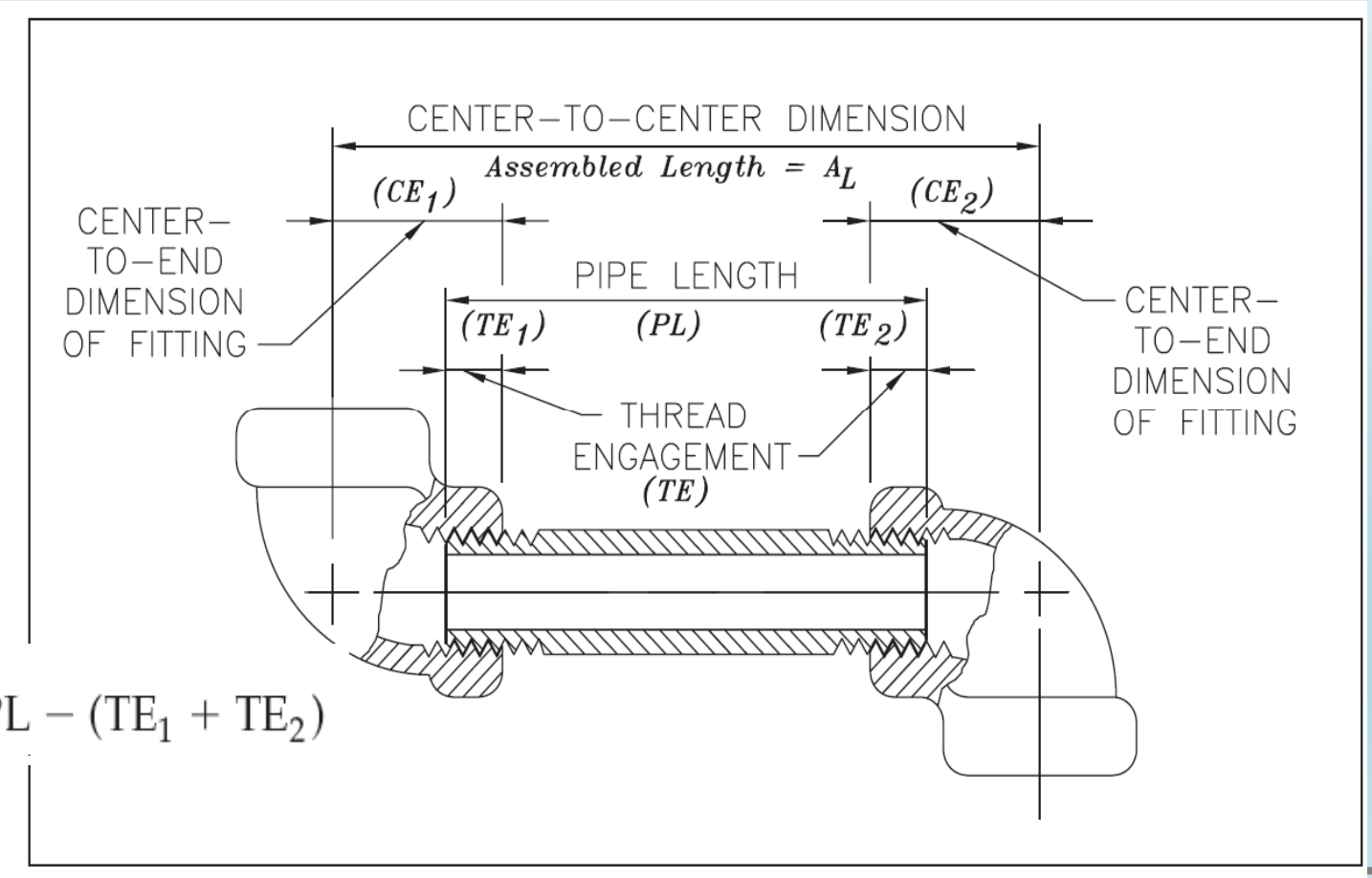



FIGURE 3.56 Internal and external thread engagements.

$$A_L = CE_1 + CE_2 + PL - (TE_1 + TE_2)$$

# Pipe Fittings – Screwed & socket-weld fittings

Some fittings, such as plugs and swages, however, are manufactured with external threads and their assembled lengths are treated differently, as will be explained later.


Socket-weld fittings with greater strength can be easily fitted and welded without the need of special clamps or tack-welds. Like screwed fitting configurations, during the assembly of socket-weld configurations, there is pipe length loss. This lost length is equal to the depth of the socket. However, there is a slight difference from screwed pipe assemblies. On socket-weld connections, a gap is factored into each socket-weld connection.

# Pipe Fittings – Screwed & socket-weld fittings

Figure 3.57 provides a sectional view of two socket-weld elbows and the connecting pipe. Notice two socket depths must be subtracted from the total unassembled length of the two elbows and the piece of pipe, then 1⁄8" is added back to account for the two gaps, before an assembled configuration length can be determined.

The assembled length:

$$A_L = CE_1 + CE_2 + PL - (SD_1 + SD_2) + \tfrac{1}{8}''$$

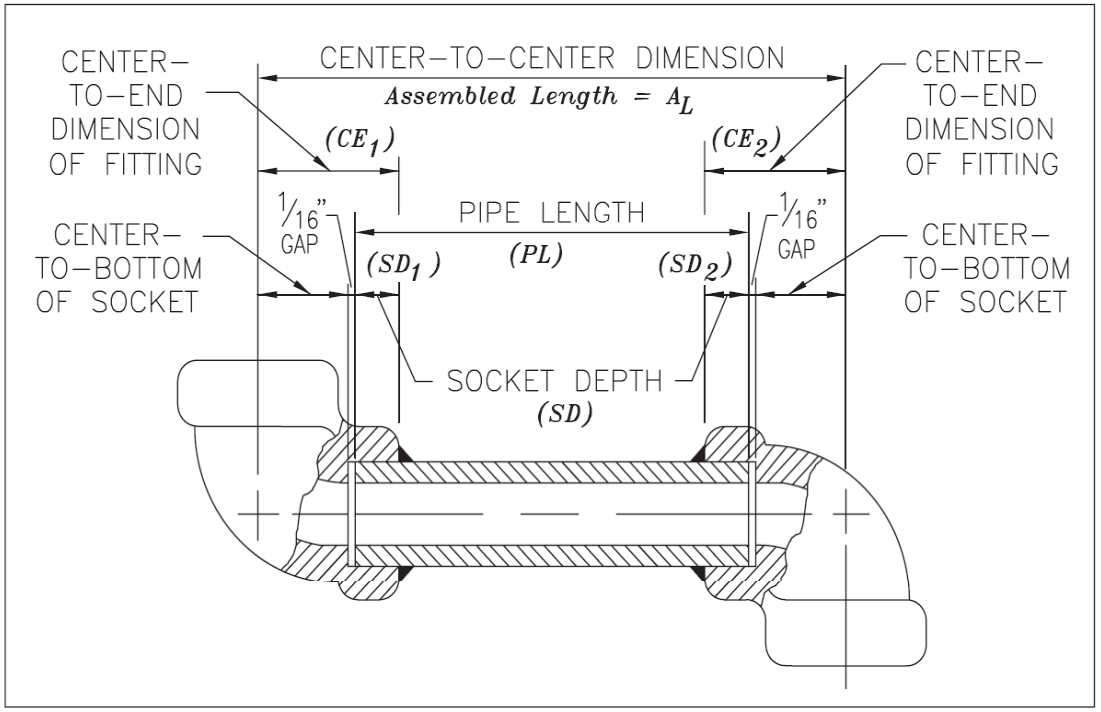



FIGURE 3.57 Socket-weld fitting connections.

# Pipe Fittings – Screwed & socket-weld fittings

## Fittings

Like butt-weld fittings, screwed and socket-weld fittings are used to make similar routings in the piping system, but only in smaller pipe sizes. Screwed and socket-weld fittings differ in size and shape, but they achieve the same purpose as butt-weld fittings. However, there are some differences. Their center-to-end dimension must be found on a dimensioning chart, as no formula is available for calculating their radius length.

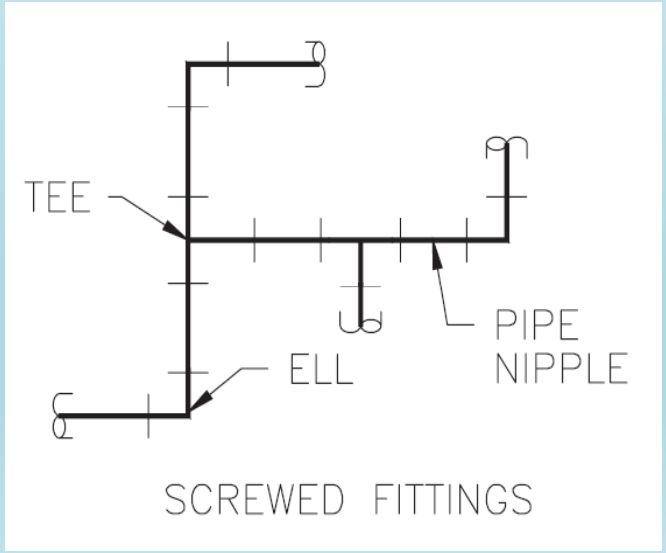
Figure 3.58 provides examples of some screwed and socket-weld fittings.

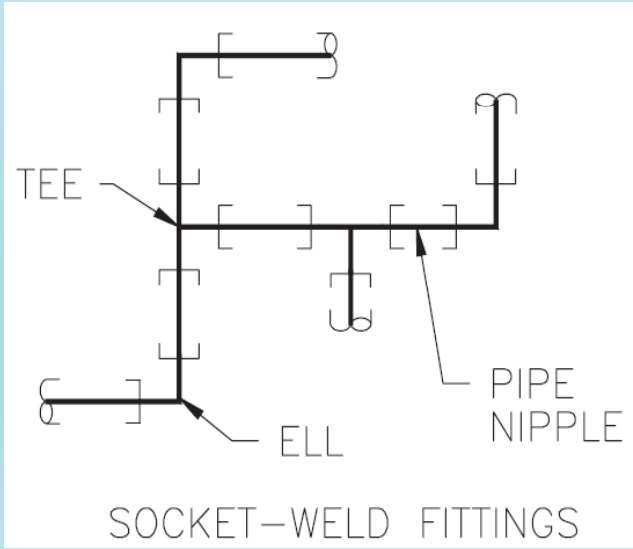
FIGURE 3.58 Screwed and socket-weld fittings.

# Pipe Fittings – Screwed & socket-weld fittings

## Fittings

Screwed and socket-weld fittings are represented differently on drawings than their butt-weld counter-parts. For example, screwed and socket-weld elbows are drawn with square corners, using short hash marks to represent the connection points of the fitting and its mating pipe. Some engineering companies even draw short ears on the hash marks to indicate a difference between screwed and socket-weld symbols (see Figure 3.59).



# Pipe Fittings – Screwed & socket-weld fittings

## Unions

The union, shown in Figure 3.60, is a fitting placed within a piping configuration that will allow the assembly to be disassembled for inspection, repair, or replacement.

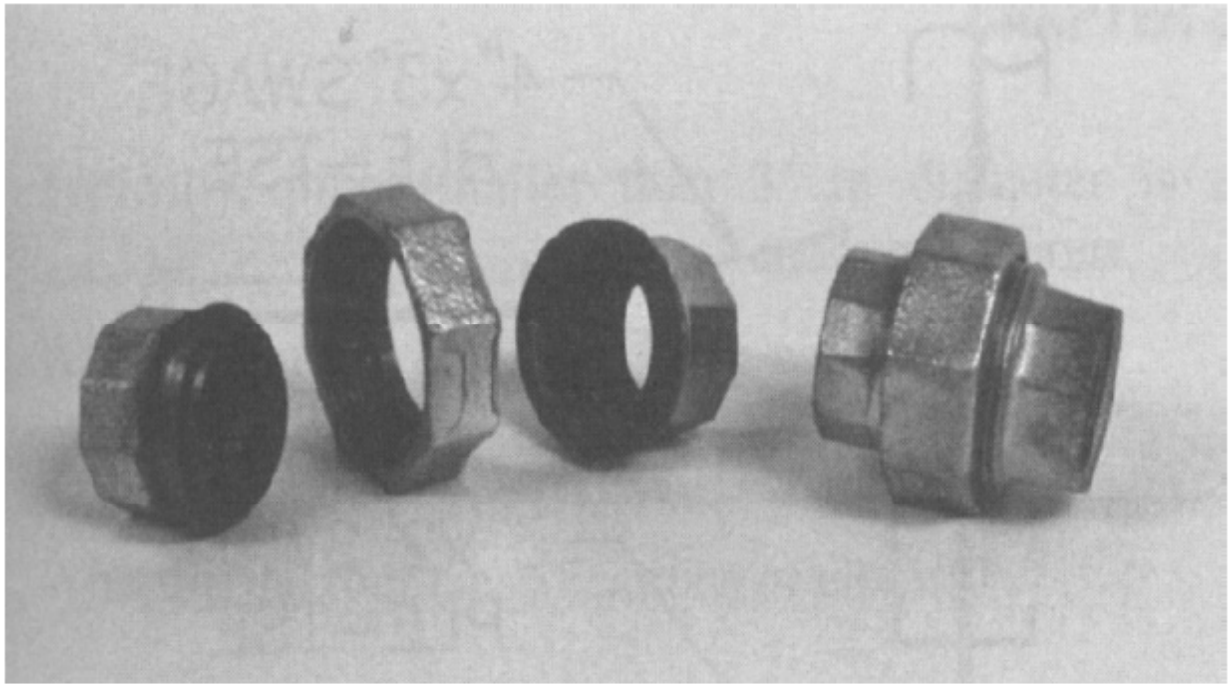


FIGURE 3.60 Union.

# Pipe Fittings – Screwed & socket-weld fittings

## Unions

Manufactured for screwed and socket-weld applications, the union is represented on drawings as shown in Figure 3.61. Unions should be positioned in locations that will facilitate the easy removal of critical pieces of equipment. Figure 3.62 shows how unions are placed in a configuration to allow easy removal of a valve.

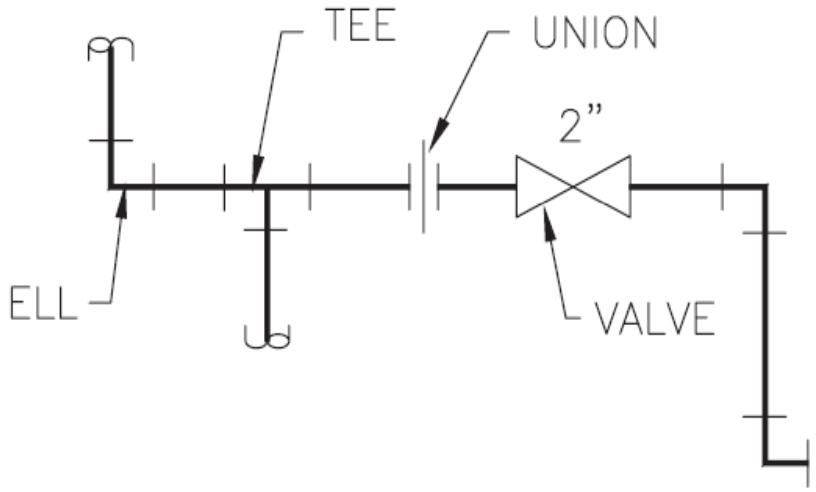
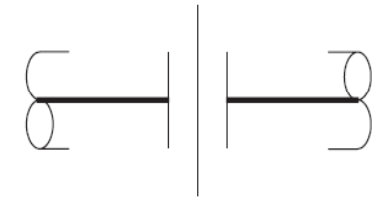



FIGURE 3.62 Positioning of unions.



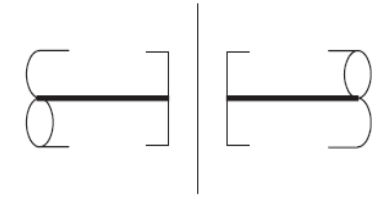




FIGURE 3.61 Union drawing symbols.

# Pipe Fittings – Screwed & socket-weld fittings

## Plug

The plug, like a cap, is designed to seal the end of a run of pipe. Plugs are manufactured for screwed fit-tings with male threads and are screwed into the end of a pipe to create a seal. Figure 3.63 shows the drawing symbols for the plug.

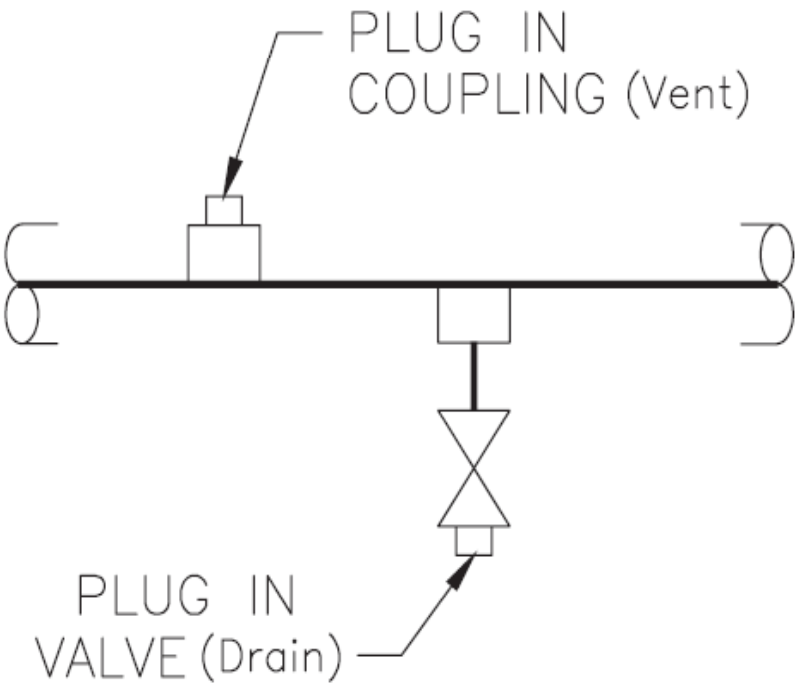



FIGURE 3.63 Plug drawing symbols.

# Pipe Fittings – Screwed & socket-weld fittings

## Coupling

Although this fitting is used in butt-welding applications as a branch connection, its primary use is to connect lengths of screwed and socket-weld pipe together. Some clients may stipulate, however, that all socket-weld pipe must be connected with a butt-weld rather than a coupling.


# Pipe Fittings – Pipe Nipples

By design, there must be pipe in between screwed and socket-weld fittings. As mentioned previously, screwed fittings are manufactured with threads on the inside of the fitting and socket-weld fittings have an internal socket that prevents fitting make-up assembly like butt-weld fittings. To facilitate the assembly of screwed and socket-weld fittings, short lengths of pipe called pipe nipples are placed between the fittings.

Pipe nipples can vary in length. A close nipple is one that allows for the minimum assembly length between two pipe fittings.

Many companies will use 3”, as the standard minimum length of pipe nipples.

# Pipe Fittings – Pipe Nipples

## Swage

Swages are functionally similar to reducers, but they are specifically designed for screwed and socket-weld pipe. Screwed swages have external (male) threads and are connected directly to other screwed fittings without the need of a pipe nipple. Like reducers, they are available in either a concentric or eccentric shape and are always drawn double-line on a drawing.

Figure 3.64 shows varying lengths and sizes of screwed pipe and swage nipples.

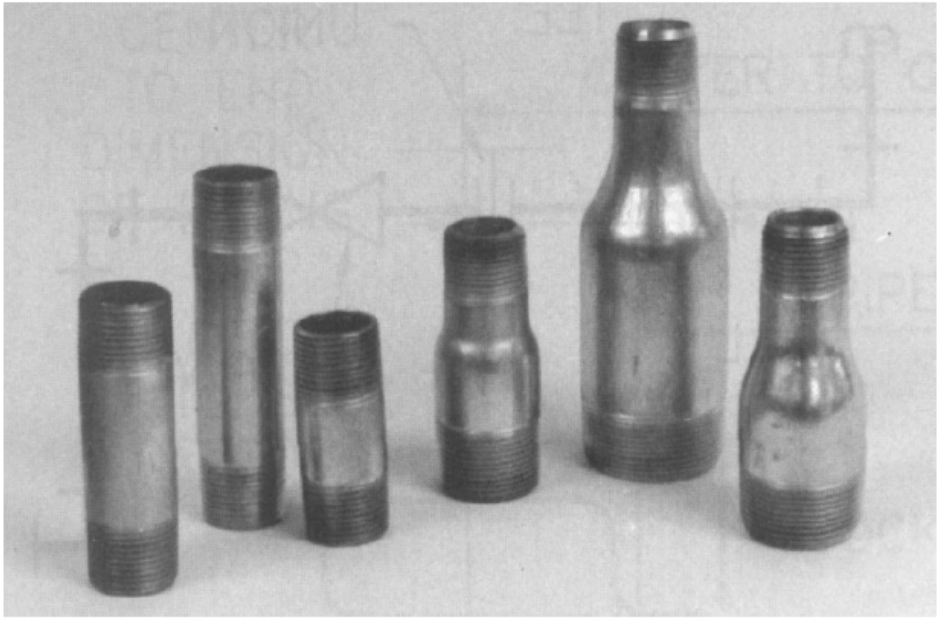


FIGURE 3.64 Pipe and swage nipples.

# Pipe Fittings – Pipe Nipples

## Swage

Swages will have a variety of different end preparations. These end preparation combinations use in a number of different attachment applications—screwed to socket-weld, butt-weld to screwed, or butt-weld to socket-weld.

Screwed swages will have threaded ends (TE), socket-weld swages will have plain ends (PE), and butt-weld swages will have beveled ends (BE).

# Pipe Fittings – Pipe Nipples

## Swage

Swages are also manufactured with different preparations on their opposing ends. When specifying a swage, use the following abbreviations:

BBE—bevel both ends;

TBE—thread both ends;

PBE—plain both ends;

BLE/TSE—bevel large end/thread small end;

PLE/TSE—plain large end/thread small end.

# Pipe Fittings – Pipe Nipples

## Swage

Figure 3.66 shows the drawing symbols for various swages.

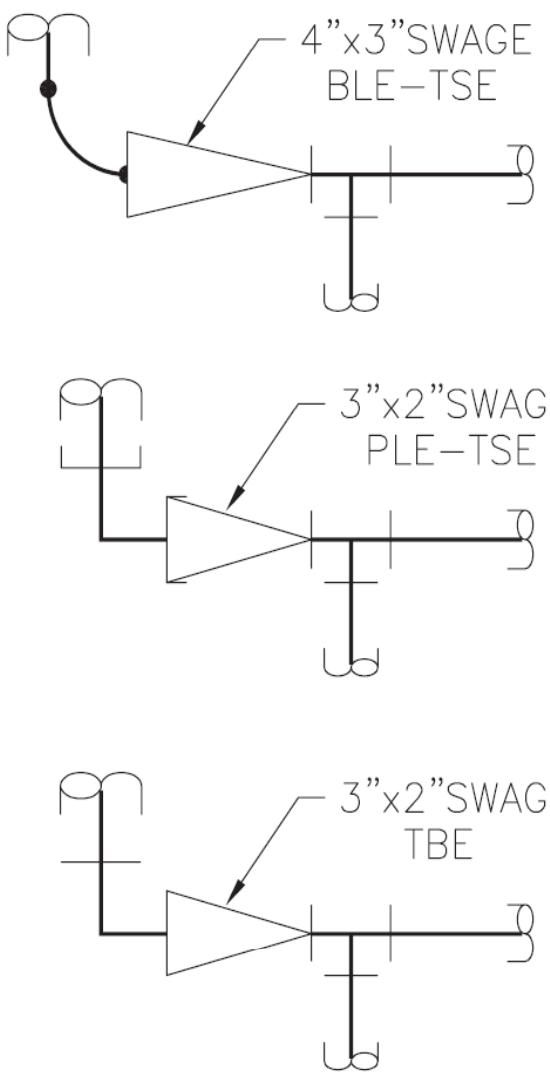
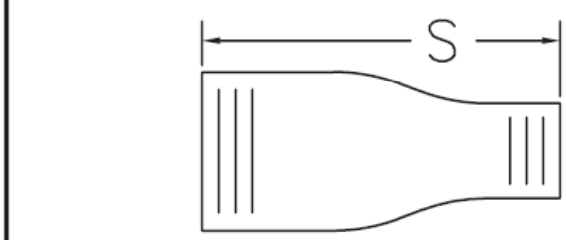



FIGURE 3.66 Swage drawing symbols.

# Pipe Fittings – Pipe Nipples

## Swage

The swage section of the Screwed Fittings dimensioning chart, shown in Figure 3.67, provides the length or, S dimension, of swage fittings. Like reducers, one must always use the large end pipe size to find the length of the swage on the dimensioning chart. Notice the Outlet section of the chart. This section simply indicates the range in which the small end pipe size can reduce to.

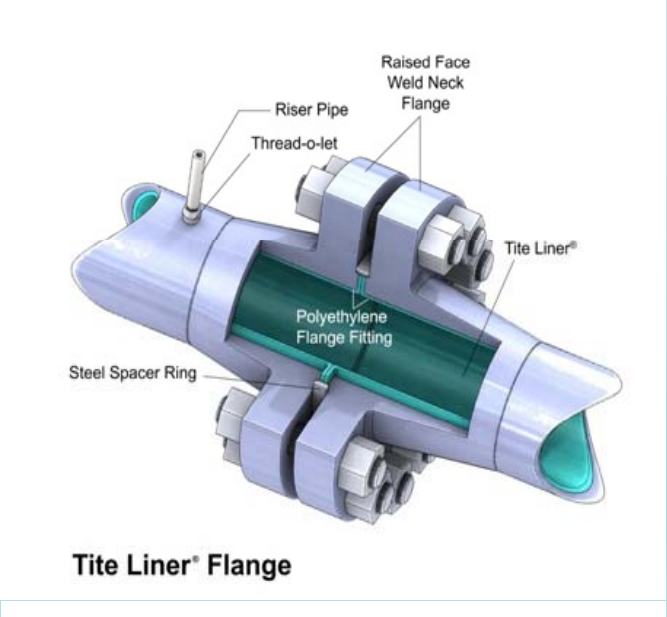



| NOMINAL PIPE SIZE – (INCHES) | | $\frac{1}{2}$" | $\frac{3}{4}$" | 1" | $1\frac{1}{4}$" | $1\frac{1}{2}$" | 2" | $2\frac{1}{2}$" | 3" |
|---|---|---|---|---|---|---|---|---|---|
| SWAGE | OUTLET | 1/4 to 3/8 | 1/4 to 1/2 | 1/4 to 3/4 | 1/4 to 1 | 1/4 to 1 1/4 | 1/4 to 1 1/2 | 1/4 to 2 1/4 | 1/4 to 2 1/2 |
| | S | 2 3/4 | 3 | 3 1/2 | 4 | 4 1/2 | 6 1/2 | 7 | 8 |

FIGURE 3.67 Swage dimensioning chart.

# Pipe Fittings – Flanged Fittings

Flanged fittings perform functions similar to other fittings of the same type. The major difference is their method of connection. The connection joint for flanged fittings is made by bolting two specially designed metal surfaces together. Sandwiched between the two surfaces is a gasket that prevents leaks.

# Pipe Fittings – Cast Iron Fittings

Cast iron fittings are typically designed for use in gravity-flow installations using low-pressure water services.

Because molten cast iron can be easily manufactured into many unique shapes that cannot be attained with steel, pipe routings that have many varying turns, bends, and branches are quite common.

# Pipe Fittings – Plastic Fittings

Plastic fittings are also manufactured in many diverse and unique shapes. Therefore, they have become the material of choice for many low-pressure and low-temperature applications, replacing cast iron. All the standard fitting shapes are available: elbows, tees, reducers, couplings, unions, etc. Plastic fittings are manufactured for either screwed, socket, or butted assembly. Plastic screwed and socket fittings are avail-able in sizes through 4" in diameter. Butt fittings are manufactured for sizes 6-10".

# Pipe Fittings – Fitting Exercise Instructions

The fittings in Figure 3.68 will be used to complete exercises in Chapters 3, 4, 5, and 10. To complete those exercises, draw the symbols below using the following instructions:

- Draw all fitting symbols full size using dimensions found on the Welded Fittings and Flanges Dimensioning Charts.
- Double-line symbols are drawn with a “default” lineweight. Single-line symbols are drawn with a 0.53 mm lineweight.
- Draw all weld dots with the DONUT command. The DONUT will have an inside diameter of 0" & outside diameter of 1.75".
- Create a BLOCK of each symbol. Use a block name that appropriately describes the fitting and its size. (DO NOT include text with the blocked symbol.)
- BLOCK the symbol with the base point placed at an appropriate location using an ENDpoint, MIDpoint, or CENter OSNAP. SAVE the file as Fitting Symbols.

NOTE: When drawing the symbol of the back of the elbow, break the arc so that it creates an opening approximately 45° to the pipe.

# Pipe Fittings – Fitting Exercise Instructions

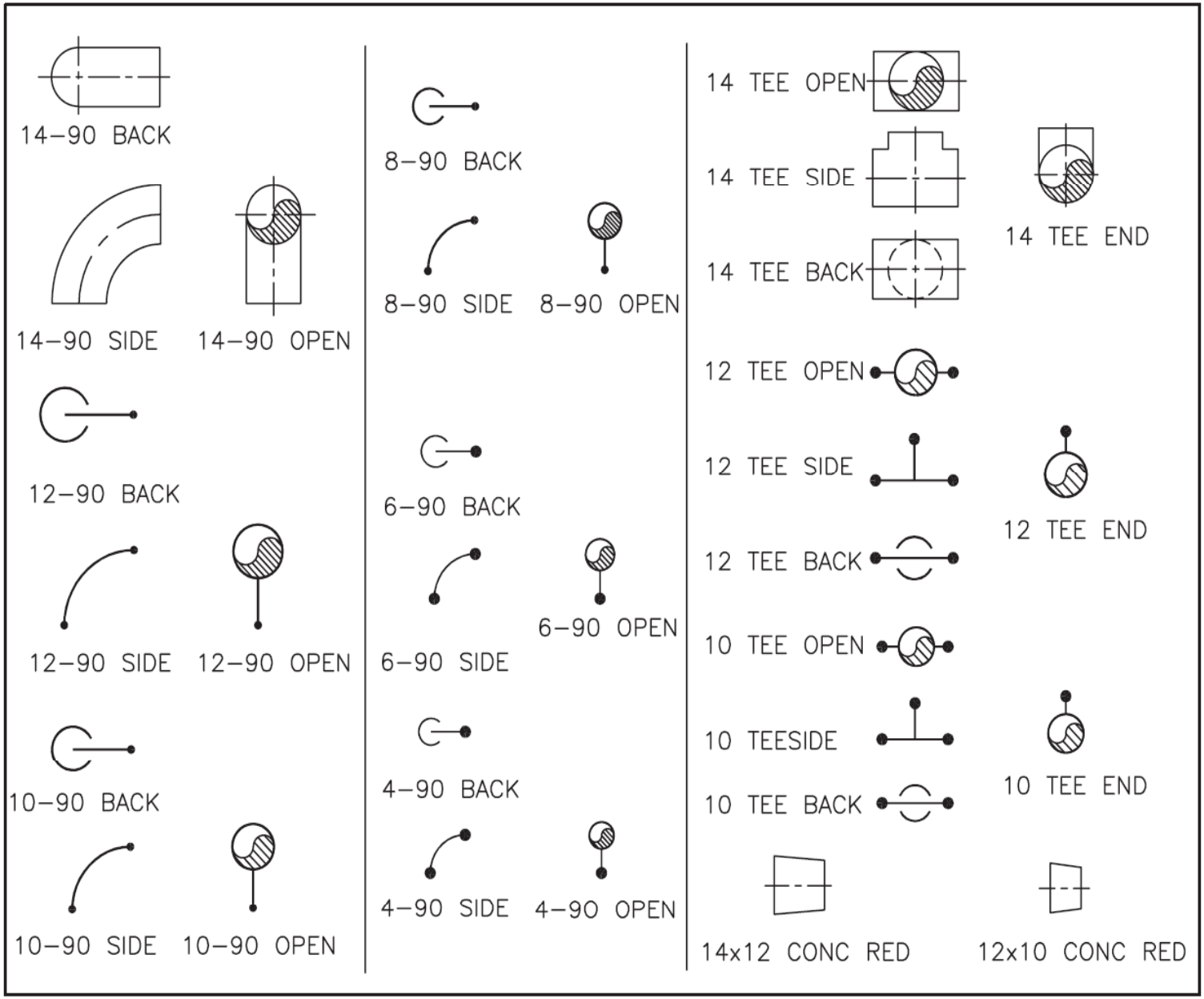



FIGURE 3.68 Fitting drawing symbols with file names.

# Summary

This chapter covers different fittings and drafting. Fittings are fabricated pipe components that are used to perform specific functions throughout the routing of a pipeline.

Fittings can make directional changes (elbow), create a branch from a main pipe (tee, stub-in, coupling), or make a reduction in the diameter of the pipe (reducer) . Others: weld cap; pipe nipples; swage; flanged fittings.

Screwed and socket-weld fittings (not like butt-weld fittings) are normally reserved for installations where the nominal pipe size is 3" and smaller.