



An Introduction to Pipe Flanges

This white paper is provided as a general overview in understanding the most commonly used pipe flanges in North America. There are many types of pipe flanges, some covered by official standards like ANSI, ASME and AWWA, and those that are “industry standard” type flanges that are not covered by a published specification but are used in certain applications. Around the world there are other significant pipe flange standards, including DIN, BS, JIS and SABS. Those flanges are not addressed here.

Pipe flanges are used primarily to connect two sections of pipe together using bolts. In some cases pipe flanges may be used on pressure vessels to provide viewing or manway access points.

A summary of major flange specifications for the North American market and what they cover is below:

ANSI/ASME B16.5 (American National Standards Institute/American Society of Mechanical Engineering)
Covering pressure classes 150, 300,400,600, 1500 and 2500 in slip-on, weldneck, blind, threaded, socket weld and lap joint flange styles.

AWWA C207 (American Waterworks Association) – covering carbon steel slip on and blind flanges; covering pressure ratings from 86psi to 300psi

AWWA C228 (American Waterworks Association) – covering stainless steel slip on and blind flanges; covering pressure classes from 50psi to 300psi

ANSI/ASME B16.47 covering previous MSS SP44 and API 605 specifications for 26” through 48” weldneck and blind flanges – covering pressure classes 75, 150,300,400,600 and 900

Another specification that is occasionally used in oilfield service applications is the API (American Petroleum Institute) 6A wellhead flange specification. This specification is not covered in this introduction.

Some other types of flanges you may hear about that may not have official specifications are API type flanges Industrial Standard Pressure Vessel Flanges, Class 125 Lightweight Flanges, Metal Hose Flanges, Ductile Iron Backup Flanges, and TubeTurns Slip Ons. This white paper will focus on the most commonly used flanges in the most commonly used flanges styles – slip ons, weld necks and blinds. Other styles in ANSI specifications, less commonly encountered, may include threaded, orifice, lap joint, reducing or socket weld flanges.

If you are looking for more information on more specialized flanges please send us a message from our website www.cabinc.com and we’ll be happy to provide you more background on your flange of interest. We have more than 150 years of combined flange experience on our team... and that’s before counting our manufacturing team!

What is a Slip On Flange?

A slip on flange slips over the outside of a pipe and then is welded on both the outside and the inside. This is the most commonly used pipe flange across both waterworks and industrial applications.



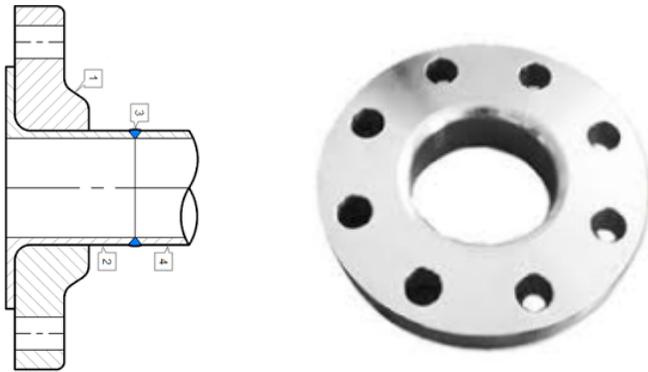
What is a Weldneck Flange?

A weldneck flange tapers to the thickness of the pipe wall and then is welded directly to the end of the pipe in a single weld. This is the most commonly used flange for pipeline and higher pressure applications.



What is a Lap Joint or Backup Flange?

These flanges are loose and are mounted behind a pipe stub end fitting or angle faced ring. No welding to the flange is done. These are frequently used on stainless steel pipe and high density polyethylene pipe.



What is a Blind Flange?

A blind flange is used to close off the end of a pipe. It is a solid piece that is bolted to another flange welded on the pipe. The blind flange is removable and is not welded.



What Information Do You Need When Selecting a Flange?

- At what pressure will your application be operating?
- At what temperature range will your application be operating?
- What is your application? Water service? Air Piping? Chemical Piping? Process Piping? High Pressure Oil or Gas? These questions will likely drive whether you have a pressure requirement.
- What material is required for your application? ANSI and AWWA flanges are most commonly supplied in a common carbon steel like A105, however the ANSI B16.5 specification covers a wide variety of materials including high yield carbon materials, stainless materials and alloys. The AWWA C207 and C228 specifications cover carbon and stainless materials.
- Does your application require the welded slip on, a weldneck flange or a loose backup type lap joint flange?
- If you require a weldneck flange, what is the inside diameter/bore size of the pipe you will be welding to?
- Are there any specialized gasket requirements? Each flange specification designates the allowable options for gaskets.
- Are there any specialized bolt requirements? Each flange specification designates the allowable options for bolting
- Other considerations: coating, oil, paint, epoxy, galvanizing
- What is your flange mating up with? If your flange mates up to the same type of flange then there are no issues, but if your flange mates up to something else, then understanding the bolt pattern of the existing flange is critical. There are a wide variety of flange specifications, and it will be critical to know what the existing flange spec is so you can assure that the bolt pattern will mate.

Flange Face and Gasket Surface Options

ANSI B16.5 flanges are most commonly supplied with a raised face, however are available with flat faces. AWWA flanges are mostly commonly provided as flat face, and may be supplied with raised face by special request.

Other less commonly used face options include RTJ (Ring Type Joint) Small tongue and groove and large tongue and groove and large and small male and female flanges.

The gasket surface area on flanges (either the raised face area or the flat face area) is customarily machined to a spiral phonographic surface that has an RA (roughness average) of 125-250 RA on ANSI flanges and typically a 125-500 RA on AWWA flanges. Other finishes are available by special request.

Pressure Class Options

Below is a summary of pressure and temperature options for carbon steel flanges from the ANSI/ASME B16.5 specification and the AWWA C207 specifications at "atmospheric" temperatures (-20 to 100 degrees F).

There is a more detailed pressure temperature chart available in ANSI/ASME B16.5 which shows changes in pressure ratings at higher temperatures. Please contact CAB if you need more information on this.

There are additional pressure/temperature charts available in the ANSI/ASME B16.5 specification which cover other types of stainless and alloy materials.

AWWA also has a second specification, C228, which covers stainless steel flanges.

There are certain instances where no pressure rating required, for example when using flanges that are bolting together pipe that has no pressure or vacuum, such as air piping.

Heat Treatment

ANSI flanges with pressure classes of 150 and 300 are not required to be heated treated. Pressure classes of 400 and higher require normalizing and then air cooling. Flanges produced from higher strength carbon, or stainless or alloy materials may require normalizing, annealing or quench and tempering, depending on material specified and design requirements.

Test pressures

You should always review your specific flange specification, but typically hydrostatic pressure testing on ANSI and AWWA flanges is conducted at a maximum of 1.5 times the working pressure.

ANSI/ASME B16.5 Group 1.1 Materials (A105 and similar carbon steels)

Pressure Ratings at -20 – 100 degrees F

Pressure Class	Pressure Rating at -20 – 100 deg F
150	285 psi
300	740 psi
400	985 psi
600	1480 psi
900	2220 psi
1500	3705 psi
2500	6170 psi

Excerpted from ASME/ANSI B16.5-13 specification

Notes:

Commonly used bolts used with carbon steel ANSI flanges are per ASTM A193 B7. There are a variety of other low, intermediate and high strength bolt options specified in the ASME/ANSI B 16.5 specification.

A wide variety of gaskets are used on ANSI/ASME B16.5 flanges. They are specified by design engineers based on the application. Further information on gaskets can be found in the ASME/ANSI B16.5 specification.

Markings required: Size, Pressure Class, Material Grade, Heat #, Manufacturer’s Trademark

AWWA C207 Pressure Ratings at Atmospheric Temp Based on Gasket Type

Pressure Class	Size Range	Pressure Rating at -20 – 100 deg F	Gasket Material
B	4" – 24"	86 psi	Rubber, CFG, PTFE (Full Face or Ring - 1/16")
B	26" - 144"	86 pis	Rubber, CFG, PTFE (Ring – 1/8")
D	4" – 12"	175 psi	Rubber, CFB, PTFE (Full Face or Ring – 1/16")
D	14" – 144"	150 psi	Rubber, CFG, PTFE (Full Face or Ring – 1/8")
E	4" – 12"	175 psi	Rubber, CFB, PTFE (Ring – 1/16")
E	14" – 24"	150 psi	Rubber, CFB, PTFE (Ring – 1/16")
E	4" – 24"	275 psi	CFG, PTFE (Ring – 1/16")
E	26" – 144"	275 psi	CFG, PTFE (Ring – 1/8")
F	4" – 24"	300 psi	CFG, PTFE (Ring – 1/16")
F	26" – 48"	300 psi	CFG, PTFE (Ring – 1/8")

Excerpted from AWWA C207-13 specification

Notes:

CFG = Compressed Fiber Gasket

PTFE = Polytetrafluoroethylene Gasket

Bolts specified in AWWA C207 are ASTM A193 grade B7.

See spec for further information.

Markings: Required by AWWA - AWWA Class, Size, Manufacturer's Trademark

What is a 150# flange?

And finally, a brief discussion on "150# flanges".

It is very common to hear the term "150# flanges". Confusion abounds when this type of flange is requested. The most significant area of confusion is when a 150# slip on flange is requested. There are two types of slip on flanges – ring type flanges, as covered in AWWA specifications (and also commonly referred to as plate flanges though they are frequently manufactured from forged steel) and hub type flanges as covered in ANSI/ASME B16.5, ANSI/ASME B16.1 and Tube Turns 150# Slip On designs.

When referring to a 150# flange, it could refer to any of the following:

Pressure Class:

Flanges with 150# pressure class include ANSI B16.5, ASME B16.47 Series A and Series B, Tube Turns 150# Slip On

Pressure Rating:

Flanges with 150# (150psi) pressure rating include AWWA C 207 Class D and AWWA C228 Class SD

Drilling Pattern and Outside Diameter:

Flanges with 150# Drilling Pattern and Outside Diameter include:
AWWA C207 Class B and Class D and AWWA C228 Class SB and SD
ANSI/ASME B 16.5 Class 150
ASME B16.47 Series A and Series B (which covers 26" and larger weldnecks and blinds only)
TubeTurns 150# Slip On
ASME/ANSI B16.1 Class 125 (which covers 26" and larger flanges; Class 125 matches the "Class 150" drill pattern of larger size AWWA, ANSI/ASME B16.47 and Tubeturns drill patterns, so sometimes is referred to as Class 150 drill pattern.

If it is the "pressure class", it would very likely be an ANSI B16.5 Class 150 type flange, which has a pressure rating at atmospheric temps of 285psi.

If it is the "pressure rating", it could refer to a flange with a pressure rating of 150 psi. An example of this would be an AWWA C207 Class D flange with a pressure rating of 150psi at atmospheric temps in water, sewer or air type applications. If someone has a low pressure application an AWWA flange can provide the lowest cost alternative for a mating flange because in its ring flange slip on style it is a lighter weight alternative to an ANSI "hub" type slip on flange.

A drilling pattern may also be described as "150#" drill pattern. This could cover either ANSI or AWWA flanges. Additionally, valves frequently have Class 125 drill patterns, which match up to the 150# drill patten of ANSI and AWWA flanges.

Flanges that would have 150# Outside Diameter and Drilling include:
AWWA C207 Class B and SB Ring Flanges
AWWA C207 Class D and SD Ring Flanges
AWWA C207 Class E and SE Ring Flanges
Class 125 Lightweight Flanges (also previously known as AWWA Class D Hub flanges before dropped from AWWA spec)
ANSI/ASME B16.1 Class 125 (which covers grey iron flanges usually mating to a valve; steel flanges are also produced to the dimensions in this specification in order to mate up to cast iron valves).

For additional information about the mysteries of 150# flanges, please contact CAB.