White Paper:

In Search of a Simpler Solution - Identifying and Defining the Pressure Rating Standards for Flanged Valves in Water Works Service

Mueller Co.

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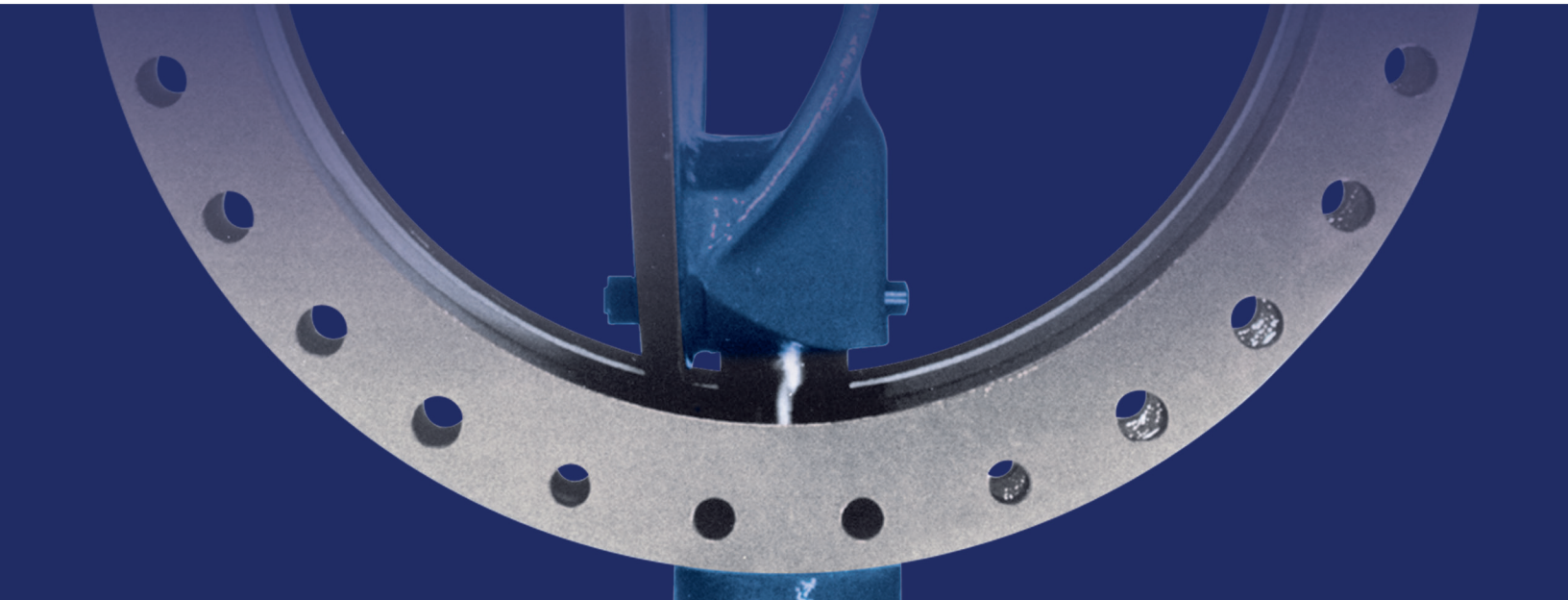

Overview

In any industry, one of the most challenging tasks is often keeping up-to-date and compliant with a complicated and changing set of performance standards. In an ideal world, performance standards serve a vital purpose by guiding employees and end users to the most efficient application of their equipment. Unfortunately, good intentions can often turn into overzealousness, creating a situation in which performance standards create as many problems as they solve. To make matters worse, many industries feature multiple agencies and advocacy groups that publish competing sets of standards, making it even more difficult to understand and employ their suggestions. An ideal set of performance standards should be unambiguous and easy to interpret, leading industry stakeholders to proper decision making.

In water works service, pressure rating standards are used to define the acceptable use of flanged valves. However, because of the multiple sets of variables involved in the use of flanges, including material of construction and temperature, pressure rating standards can be complicated and difficult to interpret. Compounding the issue is the fact that workers in the water service industry must contend with standards issued by multiple organizations, the American Society of Mechanical Engineers (ASME), whose work has been accredited by the American National Standards Institute (ANSI), and the American Water Works Association (AWWA). If you are already confused, you are not alone; the complex and often contradictory standards issued by these two organizations, in addition to manufacturer literature that can muddy the waters further, can lead to misunderstandings or improper application.

High Stakes

For a piping system to perform reliably and successfully, each of its component parts must function properly. Any weakness or improper application at any point in the piping system could result in higher construction and maintenance costs as well as decreased efficiency. Those responsible for the construction, maintenance and performance of pressurized systems must have a complete grasp on the pressure ratings of every component in their system.

Deciphering the Standards

In considering pressure rating standards for valve flanges, it is essential to understand the various factors involved. Each of these factors (material, size, and temperature) impacts the resultant pressure rating. Pressure ratings are measured in pounds per square inch gauge (psig).

Valve flanges are constructed of different materials, including steel, stainless steel, gray iron and ductile iron. As each of these materials offers a different strength, they each correspond with a different pressure rating. Ductile iron is stronger than gray iron, while steel is considerably stronger than either iron alloy.

Flange sizes are measured by the size of the pipe and are expressed as Nominal Pipe Size (NPS). This measurement does not correspond precisely to the size of the pipe in inches; rather, it is a dimensionless reference to the nominal diameter (DN) in inches used in international standards. DN standards are also dimensionless. The relationship of NPS to DN can roughly be calculated as DN = NPS x 25. As NPS increases, the pressure rating of the flange decreases.

In addition to flange sizes as measured in NPS, flange thickness can also vary and must be taken into account. Flange gaskets are also variable and can be found in one of three variations: smooth gasket, flange tyte gaskets, and triple seal gaskets. For a comprehensive report on these factors, one should consult AWWA C111, "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings."

Temperature is the final key to determining the pressure rating of valve flange. Because metals are weaker at higher temperatures, high pressure ratings correspond with lower temperatures. The noticeable disparity in pressure ratings between high temperature situations and low temperature situations is what prompted the American Water Works Association to issue its own set of standards specific to cold water service.

ASME/ANSI Standards

The American Society of Mechanical Engineers recognized the importance of reliable standards and were the first to create a set of performance standards for valves, flanges, and fittings in 1920. There are three relevant sets of ASME/ANSI standards for flanged valves and fittings, each of which corresponds to construction material. Gray iron flanges and fittings correspond to ASME B16.1. Ductile iron flanges and fittings correspond to ASME B16.42. Steel flanges and fittings correspond to ASME B16.5.

AWWA Standards

The American Water Works Association issued its own set of standards specifically for cold water service. AWWA C110 applies to ductile iron and gray iron flanges and fittings. AWWA C207 was developed more recently and applies to steel flanges and fittings. As these standards are designed for cold water service, their pressure ratings are higher than ASME/ANSI ratings for a fitting of similar size and material; this is because ASME/ANSI fittings are expected to deal with more hazardous service situations.

Table 1: **Applicable Flange and Fitting Standards**

Flange and Fitting Standard	Construction Material
ASME B16.1	Gray and Ductile Iron
ASME B16.42	Ductile Iron
ASME B16.5	Steel and Stainless Steel
AWWA C110	Gray and Ductile Iron
AWWA C207	Steel

Classes

Perhaps the most outwardly confusing aspect of pressure rating standards is the inclusion of classes. These classes are designations based on a specific pressure and temperature for saturated steam. Pressure classes are not, as is often misconceived, based on pressure ratings from the flange. The determination of pressure classes was clearly described in a November 2014 Valve Magazine article, "Understanding and Selecting Valve Flanges, Pt. I: Design and Standards."

In all sets of standards, as the class rating increases, the pressure rating increases. As can be observed in the ASME/ANSI Standards found in Table 2, class rating never corresponds exactly to pressure rating at temperatures of 100°F, 200°F, or 300°F.

It is important to note that Class 125 and Class 150 flanges use the same bolting pattern and can be bolted together, despite the fact that they have different pressure ratings. The same principle holds true for Class 250 and Class 300 flanges. Gray iron flanges are "flat-faced," ductile iron flanges are typically flat-faced, and steel flanges can have either raised or flat faces. Because of this potential incongruity, gray iron flanges can only be bolted to ductile iron or steel flanges if

the raised face of the mating flange is removed or if the mating flange is also flat-faced. This precaution prevents the breaking of the gray iron flange when tightening the bolts.

The issue of valve pressure ratings is even more complicated than that of flanges due to the significantly increased number of variables involved. The prescribed standards of the

Table 2: **Flange Pressure Ratings According to ASME/ANSI Standards (psig)**

	Gray Iron ASME B16.1				Ductile Iron ASME B16.42			
	Class 125		Class 250		Class 150		Class 300	
Max Temp.	NPS 1-12	NPS 14-24	NPS 1-12	NPS 14-24	NPS 1-12	NPS 14-24	NPS 1-12	NPS 14-24
100° F	200	150	500	300	250	250	640	640
200° F	190	135	460	280	235	235	600	600
300° F	165	110	375	240	215	215	565	565

Table 3: **Flange Pressure Ratings According to AWWA Standards (psig)**

	Gray Iron AWWA C110		Ductile Iron AWWA C110		Steel AWWA C207				
	Class 125		Class 125		Class D		Class E		Class F
Max Temp.	NPS 3-12	NPS 14-24	NPS 3-12	NPS 14-24	NPS 3-12	NPS >12	NPS 3-12	NPS >12	NPS 4-48
100° F	250	250	350	350	175	150	275	275	300

Tables 2 and 3 provide a clear reference for the various pressure rating standards assigned by the ASME/ANSI and AWWA. ASME B16.5 prescribes several tables for different materials and temperatures, the details of which are beyond the scope of this paper. To ensure compliance, consult the tables found in the published standard. It is important to note that the AWWA Standards are only listed with a maximum temperature of 100°F because of their exclusive design for cold water service.

Complicating Matters Further: Valve Pressure Ratings

Even after developing a clear understanding of the ASME/ANSI and AWWA pressure rating standards for flanges, it must be acknowledged that the flange is not the only part of the piping system. Just as crucial is the valve itself, and unfortunately, valve pressure ratings can differ entirely from the pressure ratings of a flange in the same class.

ASME/ANSI and AWWA for flanges are based on standardized dimensions. But waterworks valves differ considerably in size, shape and design depending on the manufacturer, making it impossible to come to such a relatively concise set of standards.

The American Water Works Association has issued standards for many of the valves used in water service, but users must take caution when using these standards in combination with AWWA pressure rating standards for flanges. The pressure ratings often differ within a given class, and a responsible service provider must understand these differences to prevent accidents. The key tenet to recognize is that a piping system is only as strong as its weakest component; therefore, all decisions related to pressure should be built around the pressure rating of the system's weakest link.

Table 6: **Flange Compatibility**

Class of Flange	Flange Material	Pressure Rating	Compatibility
ANSI B16.1 Cl. 125	ASTM A 126 Cl. B Iron	1"-12" 175 psi; 14"-48 150 psi	AWWA* Cl. B, D, E; ANSI B16.5 Cl.150, ANSI B16.42 CL. 150
ANSI B16.1 Cl. 250	Same as above	1"-12" 400 psi; 14"-48" 300 psi	AWWA Cl. F, ANSI B16.42 Cl. 300
ANSI B16.5 Cl. 150	Carbon or Stainless Steel	275 psi @ 100 deg. F	AWWA Cl. B, D, E; ANSI B16.1 Cl.125, ANSI B16.42 CL. 150
AWWA Cl. B	Carbon Steel	86 psi	AWWA Cl. D, E; ANSI B16.1 Cl.125 B16.5 Cl. 150, ANSI B16.42 CL. 150
AWWA Cl. D	Carbon Steel	1"-12" 175 psi; 14"-144 150 psi	AWWA Cl. B, E; ANSI B16.1 Cl.125 B16.5 Cl. 150, ANSI B16.42 CL. 150
AWWA Cl. E	Carbon Steel	275 psi	AWWA Cl. D; ANSI B16.1 Cl.125, ANSI B16.42 CL. 150
AWWA Cl. F	Carbon Steel	300 psi	ANSI B16.1 Cl.250 , ANSI B16.42 Cl. 300

Also of Significance: Minimum Wall Thickness Standards

In addition to ASME/ANSI and AWWA standards applicable to pressure ratings, one other set of standards to remain aware of are those relating to the minimum wall thickness of resilient gate valves. AWWA Standard C509 was created to cover resilient seated gate valves made of gray cast iron, the most common metal used at the time of publishing in 1985. As manufacturers turned to ductile iron, Standard C515 was issued to compensate for the higher strength of the new material. The following table defines the applicable wall thickness standards.

Table 4: **Minimum Wall Thickness Standards According to AWWA**

Size (in.)	AWWA C509 - Gray Iron	AWWA C515 - Ductile Iron
	Minimum Wall Thickness (in.)	Minimum Wall Thickness (in.)
3	0.37	0.30
4	0.40	0.31
6	0.43	0.32
8	0.50	0.34
10	0.63	0.36
12	0.68	0.38

Table 5: **Mueller Flanged Valves and Their Corresponding Standards**

Mueller Product	Applicable Standards/Flange Compatibility
4"-12" A-2361 Resilient Wedge Gate Valve with Aqua-Grip x Fl. Ends	ANSI/AWWA C515; ANSI B16.1, Class 125
2"-12" A-2360 Resilient Wedge Gate Valve - Fl. x Fl.	ANSI/AWWA C509; ANSI B16.1, Class 125
4"-12" A-2360 Resilient Wedge Gate Valve - M.J. x Fl.	ANSI/AWWA C509; ANSI B16.1, Class 125
4"-12" A-2360 Resilient Wedge Gate Valve - Sl. x Fl.	ANSI/AWWA C509; ANSI B16.1, Class 125
14"-48" A-2361 D.I. Resilient Wedge Gate Valve - Fl. x Fl.	ANSI/AWWA C515; ANSI B16.1, Class 125
14"-48" A-2361 D.I. Resilient Wedge Gate Valve - M.J. x Fl.	ANSI/AWWA C515; ANSI B16.1, Class 125
14", 16" A-2361 D.I. Resilient Wedge Gate Valve - Sl. x Fl.	ANSI/AWWA C515; ANSI B16.1, Class 125
14"-36" Double-Disc NRS Gate Valves - Fl. x Fl.	ANSI B16.1, Class 125
30" & 36" Double-Disc NRS Gate Valves - Standard Fl. x M.J.	ANSI B16.1, Class 125
Swing Check Valves	ANSI B16.1, Class 125
LINESEAL III Butterfly Valve	ANSI B16.1, Class 125
LINESEAL XP Butterfly Valve	ANSI B16.1, Class 250
LINESEAL XPII Butterfly Valve	ANSI B16.1, Class 125
LINESEAL 350 Butterfly Valve	ANSI B16.1, Class 250

The Standards As They Apply to You

While this paper serves to clearly identify and define the ASME/ANSI and AWWA standards germane to the use of flanged valves in water works service, the simplest way to determine which standards are applicable to your equipment is to consult the following table. Containing all flanged valves offered by Mueller Co., this table can be cross-referenced with preceding Tables 1, 2, and 4 to determine the figures relevant to your equipment.

Do you have questions about the various pressure rating standards for flanged valves? Would you like to learn more about the products impacted by these standards? Visit muellercompany.com or contact us directly at 800-423-1323 or moreinfo@muellercompany.com

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AWWA C509-515, 2015. "Resilient Seated Gate Valves for Water Supply Service"

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