

Large-Diameter Carbon Steel Flanges

**(Nominal Pipe Sizes 26 Through 60;
Classes 75, 150, 300, 400, 600, and 900)**

Refining Department

API STANDARD 605
THIRD EDITION, FEBRUARY 1980

OFFICIAL PUBLICATION



REG. U.S. PATENT OFFICE

API specifications (standards) are published as an aid to procurement of standardized equipment and materials. These specifications are not intended to inhibit the purchase or production of products made to specifications other than those of API.

Nothing contained in any API specification is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use in connection with any method, apparatus, or product covered by letters patent nor as insuring anyone against liability for infringement of letters patent.

API specifications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with the publication of API specifications. The Institute hereby expressly disclaims any liability or responsibility for loss or damage resulting from their use; for the violation of any federal, state, or municipal regulation with which an API specification may conflict; or for the infringement of any patent resulting from the use of an API specification.

INTRODUCTION

This standard is a purchase specification for the procurement of carbon steel flanges, NPS 26 through 60. It establishes an economical series of standard flanges in six nominal classes for use with pipe, fittings, valves, and as pressure vessel shell flanges and nozzle flanges.

Flange dimensions are verified for bolt, gasket, and hydrostatic pressure loadings in accordance with the rules in Appendix II of the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, Pressure Vessels (referred to throughout as the "ASME Code"). Gaskets used in this analysis are in accordance with API Standard 601 and ANSI B16.21. Allowable stresses for design analysis are from the ASME Code and ANSI B31.3, *Chemical Plant and Petroleum Refinery Piping*. An allowable stress of 25 kips per square inch (172 megapascals) was used for the ASTM A 694 material in Tables 1-B and A-2 based upon MSS SP-44.

The pressure-temperature ratings established by the above-described design analysis are those of ANSI B16.5 (1977) for Classes 150, 300, 400, 600, and 900. The ratings for Class 75 are one-half of those for Class 150, with a maximum temperature limit of 650 F (344 C).

The pressure-temperature ratings for Classes 300, 400, 600, and 900 flanges mating with high-strength line pipe comply with ANSI B31.4 and B31.8. Flange dimensions for Classes 400, 600, and 900, NPS 38 and larger, are identical with those in MSS SP-44. Flanges NPS 26 through 36 are designed with the same philosophy as used for flanges NPS 38 and larger.

CONTENTS

	PAGE
Notes to Purchaser	vii
SECTION 1 — GENERAL	
1.1 Scope	1
1.2 Size	1
1.3 Details	1
1.4 Referenced Publications	1
SECTION 2 — DIMENSIONS	
2.1 General	2
2.2 Excess Thickness and Back Facing or Spot Facing	2
2.3 Bolt Holes	2
2.4 Facing Finish	2
2.5 Welding End	2
SECTION 3 — TOLERANCES	
3.1 General	2
3.2 Welding End	2
SECTION 4 — MATERIALS	
4.1 Welding Neck Flanges	3
4.2 Integral Flanges	3
SECTION 5 — PRESSURE-TEMPERATURE RATINGS	
5.1 General	3
5.2 Bolting and Gasket Required	3
SECTION 6 — BOLTING AND GASKETS	
6.1 Bolting	5
6.2 Gaskets	5
SECTION 7 — MARKING	
7.1 Welding Neck Flange	5
7.2 Valves and Fittings	5
7.3 Marking Method	5
APPENDIX A — PRESSURE-TEMPERATURE RATINGS IN SI UNITS	
	15
APPENDIX B — DIMENSIONAL TABLES IN SI UNITS	
	19
LIST OF ILLUSTRATIONS	
Tables	
1-A — Pressure-Temperature Ratings for Plant Piping and Pressure Vessel Flanges	4
1-B — Pressure-Temperature Ratings for Pipe Line Flanges	4

2 — Dimensions for Class 75 Welding Neck and Integral Flanges	6
3 — Dimensions for Class 150 Welding Neck and Integral Flanges	8
4 — Dimensions for Class 300 Welding Neck and Integral Flanges	10
5 — Dimensions for Class 400 Welding Neck Flanges	12
6 — Dimensions for Class 600 Welding Neck Flanges	13
7 — Dimensions for Class 900 Welding Neck Flanges	14
A-1 — Pressure-Temperature Ratings (SI) for Plant Piping and Pressure Vessel Flanges	17
A-2 — Pressure-Temperature Ratings (SI) for Pipe Line Flanges	17
B-1 — Dimensions for Class 75 Welding Neck and Integral Flanges (SI)	20
B-2 — Dimensions for Class 150 Welding Neck and Integral Flanges (SI) ...	22
B-3 — Dimensions for Class 300 Welding Neck and Integral Flanges (SI) ...	24
B-4 — Dimensions for Class 400 Welding Neck Flanges (SI)	26
B-5 — Dimensions for Class 600 Welding Neck Flanges (SI)	27
B-6 — Dimensions for Class 900 Welding Neck Flanges (SI)	28

NOTES TO PURCHASER

1. In addition to referencing API Standard 605, purchase orders for welding neck flanges or flanged piping components shall specify the following, where applicable:
 - a. Flange size (Tables 2 through 7).
 - b. Nominal class (Tables 1-A and 1-B) for plant piping and pipe line flanges.
 - c. Bore diameter for welding neck flanges (Tables 2 through 7).
 - d. For a valve, fitting, or nozzle neck, include the requirements for the component as well as for the flange.
 - e. Grade of high-yield-strength mating pipe, where applicable.
2. For gasket-bolting combinations other than those specified in this standard, the purchaser must verify that allowable stresses are not exceeded.
3. The need for impact testing should be considered.

Large-Diameter Carbon Steel Flanges

(Nominal Pipe Sizes 26 Through 60; Classes 75, 150, 300, 400, 600, and 900)

SECTION 1 — GENERAL

1.1 Scope

This standard covers raised-face carbon steel welding neck flanges in NPS 26 through 60 with pressure ratings of Classes 75, 150, 300, 400, and 600 and in NPS 26 through 48 with a pressure rating of Class 900. It also covers integral flanges for Classes 75, 150, and 300, cast or forged as the integral ends of flanged valves, fittings, or nozzle necks.

1.2 Size

The nominal size of the flange corresponds to the nominal pipe size of the pipe with which the flange is intended to be used. Flange sizes included vary by 2-inch increments from NPS 26 through 60 for Classes 75 through 600 and from NPS 26 through 48 for Class 900.

1.3 Details

Flange details covered by this standard include:

1. Dimensions (including facing and welding end)
2. Tolerances
3. Materials
4. Pressure-temperature ratings
5. Bolting and gaskets
6. Marking

1.4 Referenced Publications

The latest edition or revision of the following standards and specifications shall, to the extent specified, form a part of this standard:

ANSI¹

- B16.5 (1977) *Steel Pipe Flanges and Flanged Fittings*
B16.21 *Nonmetallic Gaskets for Pipe Flanges*

B16.25 *Butt welding Ends*

B31.3 *Chemical Plant and Petroleum Refinery Piping*

B31.4 *Liquid Petroleum Transportation Piping Systems*

B31.8 *Gas Transmission and Distribution Piping Systems*

API

6D² *Specification for Pipeline Valves*

601 *Metallic Gaskets for Piping, Double-Jacketed Corrugated and Spiral Wound*

ASME³

Boiler and Pressure Vessel Code: Section VIII, Division 1, Pressure Vessels

ASTM⁴

A 105 *Forgings, Carbon Steel, for Piping Components*

A 193 *Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service*

A 194 *Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service*

A 216 *Carbon Steel Castings Suitable for Fusion Welding for High-Temperature Service*

A 694 *Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves and Parts for High-Pressure Transmission Service*

MSS⁵

SP-9 *Spot Facing for Bronze, Iron and Steel Flanges*

SP-44 *Steel Pipe Line Flanges*

¹ American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018.

² American Petroleum Institute, Production Department, 211 N. Ervay, Suite 1700, Dallas, Tx. 75201.

³ American Society of Mechanical Engineers, 345 East 47th Street, New York, N.Y. 10017.

⁴ American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

⁵ Manufacturers Standardization Society of the Valve and Fittings Industry, 1815 N. Fort Meyer Drive, Arlington, Va. 22209.

SECTION 2 — DIMENSIONS

2.1 General

Flange dimensions shall conform with Tables 2 through 7 and B-1 through B-6.

Flange dimensions may require adjustment for flange material with yield strength in the welding section differing from that of the mating pipe.

The maximum inside diameters are calculated for full pressure rating at 100 F (38 C) using gaskets as specified in 6.2. These inside diameters can be increased when using flanges with lower pressures or adjusted gasket dimensions. Flange and bolt stresses should be verified by calculation considering both gasket seating stresses and operating stresses.

2.2 Excess Thickness and Back Facing or Spot Facing

The flange shall be either back faced or spot faced at the bolt holes on the flange back if: (1) the nut-bearing surface at the back of the flange is not parallel with the flange face within the tolerances listed in 3.1, (2) the fillet at the hub interferes with the nut-bearing surface, or (3) the flange thickness exceeds the minimum required thickness (Tables 2 through 7, C dimensions) by more than 0.19 inch (4.8 millimeters). The nut-bearing surface is the spot-facing diameter at the bolt holes as given in MSS SP-9. Spot facing shall be in accordance with MSS SP-9.

2.3 Bolt Holes

Bolt holes shall be drilled perpendicular to the flange face and shall be equally spaced. Bolt holes in an integral

flange of a flanged valve or fitting shall straddle the centerline.

2.4 Facing Finish

The flange facing finish shall be in accordance with ANSI B16.5 (1977) and the following additional requirements:

1. For Class 300 and smaller, the gasket surface shall have a roughness in the range of 125-500 microinches AARH.
2. For Class 400 and larger, the gasket surface finish shall have a roughness in the range of 125-250 microinches AARH.

2.5 Welding End

1. The welding end of a welding neck flange shall conform with ANSI B16.25.
2. When the specified minimum yield strength of the hub portion of any flange is less than that of the pipe to be matched, the minimum thickness of the hub at the welding end shall be such that the product of its thickness times its yield strength (at welding end) is at least equal to the product of the specified nominal wall thickness and the specified minimum yield strength of the pipe.
3. When the hub thickness at the welding end is greater than that of the mating pipe, the joint design shall be in accordance with ANSI B16.5 (1977), Figures 12, 13, or 14.

SECTION 3 — TOLERANCES

3.1 General

Tolerances shall be as follows:

Dimension	Tolerance	
	(inches)	(millimeters)
OD of raised face, <i>R</i>	± 0.03	± 0.8
Flange thickness, <i>C</i>	+ 0.19,* - 0	+ 4.8,* - 0
Hub length, overall, <i>Y</i>	± 0.12	± 3.2
OD of hub, <i>A</i>	+ 0.16, - 0.03	+ 4.0, - 0.8
Bolt circle diameter	± 0.06	± 1.6
Center-to-center of adjacent bolt holes	± 0.03	± 0.8
ID, welding neck flange, <i>B</i>	+ 0.12, - 0.06	+ 3.2, - 1.6
Parallelism, back-to-face of flange	a	

* Flanges shall have bearing surfaces for bolting that are parallel to the flange face within 1 degree. Any back facing or spot facing required to

accomplish parallelism between the flange face and nut-bearing surface on the back of the flange shall not reduce the flange thickness, *C*, below the dimension given in Tables 2 through 7.

3.2 Welding End

Tolerances for the welding end of a welding neck flange shall conform to the specifications in ANSI B16.25.

SECTION 4 — MATERIALS

4.1 Welding Neck Flanges

4.1.1 Welding neck flanges for Classes 75 through 600 with design stresses conforming to the ASME Code and for Classes 75 through 900 with design stresses conforming to ANSI B31.3 shall be carbon steel ASTM A105, normalized or quenched and tempered.

4.1.2 The hub thickness of the welding ends of Classes 75, 150, and 300 welding neck flanges will mate to pipe having a specified minimum yield strength of 52 kips per square inch (359 megapascals) with a 0.72 design factor.

4.1.3 Class 300 welding neck flanges mating with pipe having a specified minimum yield strength greater than 52 kips per square inch (359 megapascals) and Classes 400 through 900 mating with pipe having a specified minimum yield strength of 36 kips per square inch (248 megapascals) shall be ASTM A694, with flanges having a

specified minimum yield strength of 42 kips per square inch (290 megapascals) in the ring section and a minimum yield strength at the welding end at least equal to that specified for the mating pipe. When the yield strength of the welding end is less than that specified for the mating pipe, compensation in accordance with 2.5 shall be made.

4.1.4 When the specified minimum yield strengths of the sections to be joined are unequal, the deposited weld metal joining the two sections shall have mechanical properties at least equal to those of the section having the higher strength.

4.2 Integral Flanges

Flanges integral with nozzle necks, valve bodies, or fittings shall be cast carbon steel ASTM A216 Grade WCB or forged carbon steel ASTM A105.

SECTION 5 — PRESSURE-TEMPERATURE RATINGS

5.1 General

Flanges covered by this standard shall be designated as one of the following: Class 75, 150, 300, 400, 600, or 900. Ratings are the maximum allowable nonshock working pressures, expressed as gage pressure, at the temperature shown, for the applicable material. Ratings in Tables 1-A and 1-B are in U.S. customary units. Tables in Appendix A list ratings in metric units. For immediate temperatures, linear interpolation is permitted.

5.2 Bolting and Gasket Required

The ratings in this standard are based on the use of the bolting and gaskets described in 6.1 and 6.2. If other types of bolting, gasket material, or other dimensions are used, the user is responsible for such selections with respect to their suitability with the flange for the specific service conditions and for the ability of the gasket to withstand the required bolt load without injurious crushing.

(Tables and text continue on next page.)

Table 1-A — Pressure-Temperature Ratings for Plant Piping and Pressure Vessel Flanges^a

Metal Temperature (degrees Fahrenheit)	Pressure ^b (pounds per square inch gage)					
	Class					
	75	150	300	400	600	900
100	140	285	740	990	1480	2220
200	130	260	675	900	1350	2025
300	115	230	655	875	1315	1970
400	100	200	635	845	1270	1900
500	85	170	600	800	1200	1795
600	70	140	550	730	1095	1640
650	60	125	535	715	1075	1610
700	—	110	535	710	1065	1600
750	—	95	505	670	1010	1510
800	—	80	410	550	825	1235
850	—	65	270	355	535	805
900	—	50	170	230	345	515
950	—	35	105	140	205	310
1000 ^c	—	20	50	70	105	155

^a Based on the pressure-temperature ratings in ANSI B16.5 (1977), for use with flanges designed in accordance with the ASME Code or ANSI B31.3.

^b Pressure-temperature ratings are based on material specifications ASTM A105 and A216 Grade WCB. Limitations on the use of these materials shall be in accordance with the applicable code.

^c Maximum service temperature for Classes 150 through 900.

Table 1-B — Pressure-Temperature Ratings for Pipe Line Flanges^a

Metal Temperature (degrees Fahrenheit)	Pressure (pounds per square inch gage)			
	Class			
	300	400	600	900
100	740	990	1480	2220
250	740	990	1480	2220
300	715	955	1430	2145
350	690	925	1380	2070
400	665	890	1330	2000
450	640	860	1285	1925

^a Pressure-temperature ratings meet the requirements set forth in ANSI B31.4 and B31.8