ASME B16.5-2003
(Revision of ASME B16.5-1996)

Pipe Flanges and Flanged Fittings

NPS 1/2 Through NPS 24 Metric/Inch Standard

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The next edition of this Standard is scheduled for publication in 2007. There will be no addenda or written interpretations to the requirements of this Standard issued to this edition.

The American Society of Mechanical Engineers
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FOREWORD

In 1920, the American Engineering Standards Committee[later the American Standards Associations (ASA)] organized Sectional Committee B16 to unify and further develop standards for pipe flanges and fittings (and later for valves and gaskets). Co-sponsors of the B16 Committee were the American Society of Mechanical Engineers (ASME), the Heating and Piping Contractors National Association [now Mechanical Contractors Association of America (MCAA)], and the Manufacturers Standardization Society of the Valves and Fittings Industry (MSS). Co-sponsors were later designated as co-secretariat organizations.

The Committee soon recognized the need for standardization of steel pipe flanges. In May, 1923, Subcommittee 3 was organized to develop such standards for pressures in the 250 psi to 3200 psi range and for elevated temperatures. Active work began in October, including steel flanged fittings. The first proposed standard was submitted to the Committee in April, 1926 and approved by letter ballot in December. After favorable review by the three sponsor organizations, the Standard was approved as American Tentative Standard B16e in June 1927.

Experience in using the Standard showed the need for hub dimensions of companion flanges and for other changes, including rerating of 250 lb and 1350 lb flanges and development of flanged fittings with integral bases. An investigation was made into the factors determining stiffness of flanges and flange hubs. The revised edition was approved as ASA B16E-1932.

A revision was initiated in 1936, stimulated by suggestions from Committee members and industrial users. The resulting 1939 edition contained standards for welding neck flanges (completed in March 1937), 1500 lb flanges in the 14 in. through 24 in. range 2500 lb flanges and flanged fittings in the ½ in. through 12-in. range, and dimensions for a full line of ring joint flanges developed by the American Petroleum Institute. Pressure-temperature ratings for alloy steel flanges and fittings, developed by Subcommittee 4, were included for the first time.

In August 1942, the War Production Board requested a review of measures to conserve vital materials in piping components. A special War Committee of B16 was appointed and, operating under War Standard Procedure, developed revised pressure-temperature ratings for all materials and all pressure classes. The ratings were published as American War Standard B16e5-1943. In 1945, under normal procedures, Subcommittees 3 and 4 reviewed the 1939 standard and the 1943 ratings, and recommended adoption of the wartime ratings. Their report was approved as Supplement No. 1 to B16e-1939 and published as ASA B16e6-1949. In addition to ratings, the supplement updated material specification references and added a table of metal wall thickness for welding-end valves.

Subcommittee 3 then began a revision of the entire standard. Technically, the 1949 Supplement was absorbed, new materials were recognized, a general rating method was developed and added as an appendix, and welding end preparations were expanded. Editorially, a new style of presentation was worked out, including tables rearranged for easier use. Approval by Sectional Committee, co-sponsors, and ASA resulted in publication of ASA B16.5-1953 (designation changed from B16e).

Work soon began on further revisions. Class B ratings were deleted and Class A ratings were clarified as the standard. An appendix defined qualifications for gaskets, other than ring joint, which would merit the ratings. Another appendix defined the method for calculating bolt lengths (including measurement of the length of stud bolts between thread ends instead of between points). Pressure-temperature ratings for several new materials were added, the table of welding end dimensions was expanded, and the temperatures used in determining ratings were redefined. The resulting new edition, after approval, was published as ASA B16.5-1957.

The more modest revision approved as ASA B16.5-1961 changed the text to clarify the intent or to make requirements easier to administer. The next revision began in 1963 with nearly 100 comments and suggestions. No fundamental changes were made, but the text was further clarified and wall thicknesses less then ¼ in. for flanged fittings were recognized in the 1968 edition.

A new joint study of ratings between Subcommittees 3 and 4 was initiated before the next revision. Based on Subcommittee 4 report, the rating procedure was revised and a rating basis for Class 150 (150 lb) flanges was developed. New product forms, bar and plate, were added for special applications, including fabricated flanged valves and fittings. Reference to welding-end valves was not included because a separate standard for them was. Bolt length calculations based on worst case tolerances led to a revision of tabulated lengths. Testing of valve subsequently published by SC 15 closure members was added to the test requirements. Following final approval on October 23, the Standard was published as ANSI B16.5-1973.

Subcommittee N (formerly 15) was assigned responsibility for all valve standards in late 1973. Subcommittee C (formerly 3) continues to have responsibility for flange standards. A revision was accordingly initiated to remove all references to valves. At the same time, comments from users and changes in the ASME Boiler and Pressure Vessel Code led to significant revisions in the Class 150 rating basis, and, in the ratings of stainless steel and certain alloy steel flanges and flanged fittings in all rating classes. Extensive public review comments led to addition of considerations for flanged joints, for bolting and gaskets, and of marking requirements. To avoid frequent and confusing changes in ratings as further changes in Code allowable stresses are made, it was agreed with Subcommittee N to leave ratings alone unless the relevant Code stress values are changed by more than 10%. After final approval by Standards Committee co-sponsors and ANSI, ANSI B16.5-1977, Steel Pipe Flanges and Flanged Fittings, was published on June 16, 1977.

In 1979, work began on another new edition. Materials coverage was expanded by the addition of nickel and nickel alloys. Bolting rules were revised to cover nickel alloy bolts. Bolt hole and bolting were changed to provide interchangeability between inch and metric dimensions. Metric dimensional tables were made informational rather than alternative requirements of the Standard. Final approval was granted for ANSI B16.5-1984, Pipe Flanges and Flanged Fittings on August 14.

In 1982, American National Standards Committee B16 was reorganized as an ASME Committee operating under procedures accredited by ANSI. The 1988 edition of the Standard extended nickel alloy ratings to higher temperatures, clarifying flat face flange requirements, and included other minor revisions. The Committee determined that any metric standard for flanges will stand alone, with metric bolting and gaskets; hence metric equivalents have been deleted. Following approval by the Standard Committee and ASME, approval as American National Standard was given by ANSI on April 7, 1988, with the new designation ASME/ANSI B16.5-1988.

The 1996 Edition allowed flanges marked with more than one material grade or specification, revised flange facing finish requirements, revised pressure-temperature ratings for several material groups, added a nonmandatory quality system annex, and included several other revisions. The 1996 Edition was approved by ANSI on October 3, 1996, with the new designation of ASME B16.5-1996.

The 2003 Edition includes metric units as the primary reference units while maintaining U.S. Customary units in either parenthetical or separate forms. The goal is to delete the U.S. customary units when the standard is next issued. New materials have been added while some materials have been shifted from one group to another and new material groups have been established.

All pressure-temperature ratings have been recalculated using data from the latest edition of the ASME Boiler and Pressure Vessel Code, Section II, Part D. Annex F has been added to cover pressure-temperature ratings and dimensional data for Class 150 through 2500 flanges and Class 150 and 300 flanged fittings in U.S. Customary units. Table and figure numbers in Annex F are prefixed by the letter F and correspond to table and figure numbers in the main text for metric version with the exception of some table and figure numbers that have not been used in Annex F. Of note, the flange thickness designations for Class 150 and 300 have been revised with reference to their raised faces. For these classes, the flange thickness dimensional reference planes have been altered, however, required flange thickness remains unchanged. The minimum flange thickness designation has been changed from C to t_f and it does not include 2.0 mm (0.06 in.) raised face for Class 150 and 300 raised face flanges and flanged fittings. Because of diminished interest, flanged end fittings conforming to ASME Class 400 and higher are listed only with U.S. Customary units in Annex G. In addition, straight hub welding flanges have been incorporated as a new set of flanges in Classes 150 through 2500. Also, there are numerous requirement clarifications and editorial revisions.

Following the approval of the Standards Committee and ASME, approval for the new edition was granted by the American National Standards Institute on July 9, 2003.

Requests for Interpretations or suggestion for revision should be sent to the secretary, B16 Committee, Three Park Avenue, New York, NY 10016-5990.

ASME B16 COMMITTEE
Standardization of Valves, Flanges, Fittings, and Gaskets

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B16 Standards Committee
The American Society of Mechanical Engineers
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the B16 Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B16 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings, which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B16 Standards Committee regularly holds meetings, which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the B16 Standards Committee.

PIPE FLANGES AND FLANGED FITTINGS

NPS ½ THROUGH NPS 24 METRIC/INCH STANDARD

1 SCOPE

1.1 General

(a) This Standard covers pressure–temperature ratings, materials, dimensions, tolerances, marking, testing, and methods of designating openings for pipe flanges and flanged fittings. Included are

(1) flanges with rating class designations 150, 300, 400, 600, 900, 1500, and 2500 in sizes NPS ½ through NPS 24, with requirements given in both metric and U.S. Customary units with diameter of bolts and flange bolt holes expressed in inch units

(2) flanged fittings with rating class designation 150 and 300 in sizes NPS ½ through NPS 24, with requirements given in both metric and U.S. Customary units with diameter of bolts and flange bolt holes expressed in inch units

(3) flanged fittings with rating class designation 400, 600, 900, 1500, and 2500 in sizes NPS ½ through NPS 24 that are acknowledged in Annex G in which only U.S. Customary units are provided

(b) This Standard is limited to

(1) flanges and flanged fittings made from cast or forged materials

(2) blind flanges and certain reducing flanges made from cast, forged, or plate materials

Also included in this Standard are requirements and recommendations regarding flange bolting, flange gaskets, and flange joints.

1.2 References

Codes, standards, and specifications, containing provisions to the extent referenced herein, constitute requirements of this Standard. These reference documents are listed in Annex H.

1.3 Time of Purchase, Manufacture, or Installation

The pressure–temperature ratings in this Standard are applicable upon its publication to all flanges and flanged fittings within its scope which otherwise meet its requirements. For unused flanges or flanged fittings maintained in inventory, the manufacturer of the flange or flanged fittings may certify conformance to this Edition provided that it can be demonstrated that all requirements of this Edition have been met. Where such components were installed in accordance with the pressure-temperature ratings of an earlier edition of this Standard, those ratings are applicable except as may be governed by the applicable code or regulation.

1.4 User Accountability

This Standard cites duties and responsibilities that are to be assumed by the flange or flanged fitting user in the areas of, for example, application, installation, system hydrostatic testing, operation, and material selection.

1.5 Quality Systems

Requirements relating to the product manufacturer's Quality System Program are described in Annex E.

1.6 Relevant Units

This Standard states values in both metric and U.S. Customary units. As an exception, diameter of bolts and flange bolt holes are expressed in inch units only. These systems of units are to be regarded separately as standard. Within the text, the U.S. Customary units are shown in parentheses or in separate tables. The values stated in each system are not exact equivalents; therefore, it is required that each system of units be used independently of the other. Except for diameter of bolts and flange bolt holes, combining values from the two systems constitutes nonconformance with the Standard.

1.7 Service Conditions

Criteria for selection of materials suitable for particular fluid service are not within the scope of this Standard.

1.8 Convention

For the purpose of determining conformance with this Standard, the convention for fixing significant digits where limits, maximum and minimum values are specified, shall be rounded as defined in ASTM Practice E 29. This requires that an observed or calculated value shall be rounded off to the nearest unit in the last right hand digit used for expressing the limit. Decimal values and tolerances do not imply a particular method of measurement.

1.9 Denotation

1.9.1 Pressure Rating Designation. Class, followed by a dimensionless number, is the designation for pressure–temperature ratings as follows:

Class	150	300	400	600	900	1500	2500

1.9.2 Size. NPS, followed by a dimensionless number, is the designation for nominal flange or flange fitting size. NPS is related to the reference *nominal diameter*, DN, used in international standards. The relationship is, typically, as follows:

NPS	DN
1/2	15
3/4	20
1	25
1 1/4	32
1 1/2	40
2	50
2 1/2	65
3	80
4	100

GENERAL NOTE: For NPS ≥ 4, the related DN is DN = 25 (NPS).

2 PRESSURE-TEMPERATURE RATINGS

2.1 General

Pressure-temperature ratings are maximum allowable working gage pressures in bar units at the temperatures in degrees Celsius shown in Tables 2-1.1 through 2-3.17 for the applicable material and class designation. Tables F2-1.1 through F2-3.17 of Annex F list pressure-temperature ratings using psi units for pressure at the temperature in degrees Fahrenheit. For intermediate temperatures, linear interpolation is permitted. Interpolation between class designations is not permitted.

2.2 Flanged Joints

A flanged joint is composed of separate and independent, although inter-related components: the flanges, the gasket, and the bolting, which are assembled by another influence, the assembler. Proper controls must be exercised in the selection and application for all these elements to attain a joint that has acceptable leak tightness. Special techniques, such as controlled bolt tightening are described in ASME PCC-1.

2.3 Ratings of Flanged Joints

2.3.1 Basis. Pressure-temperature ratings apply to flanged joints that conform to the limitations on bolting in para. 5.3 and on gaskets in para. 5.4, which are made up in accordance with good practice for alignment and assembly (see para. 2.2). Use of these ratings for flanged joints not conforming to these limitations is the responsibility of the user.

2.3.2 Mixed Flanged Joints. If the two flanges in a flanged joint do not have the same pressure–temperature rating, the rating of the joint at any temperature is the lower of the two flange ratings at that temperature.

2.4 Rating Temperature

The temperature shown for a corresponding pressure rating is the temperature of the pressure-containing shell of the component. In general, this temperature is the same as that of the contained fluid. Use of a pressure rating corresponding to a temperature other than that of the contained fluid is the responsibility of the user, subject to the requirements of applicable codes and regulations. For any temperature below −29°C (−20°F), the rating shall be no greater than the rating shown for −29°C (−20°F). See also paras. 2.5.3 and 5.1.2.

2.5 Temperature Considerations

2.5.1 General. Use of flanged joints at either high or low temperatures shall take into consideration the risk of joint leakage due to forces and moments developed in the connected piping or equipment. Provisions in paras. 2.5.2 and 2.5.3 are included as advisory with the aim of lessening these risks.

2.5.2 High Temperature. Application at temperatures in the creep range will result in decreasing bolt loads as relaxation of flanges, bolts, and gaskets takes place. Flanged joints subjected to thermal gradients may likewise be subject to decreasing bolt loads. Decreased bolt loads diminish the capacity of the flanged joint to sustain loads effectively without leakage. At temperatures above 200°C (400°F) for Class 150 and above 400°C (750°F) for other class designations, flanged joints may develop leakage problems unless care is taken to avoid imposing severe external loads, severe thermal gradients, or both.

2.5.3 Low Temperature. Some of the materials listed in Tables 1A and 1B, notably some carbon steels, may undergo a decrease in ductility when used at low temperatures to such an extent as to be unable to safely resist shock loading, sudden changes of stress, or high stress concentration. Some codes or regulations may require impact testing for applications even where temperatures are higher than −29°C (−20°F). When such requirements apply, it is the responsibility of the user to ensure these requirements are communicated to the manufacturer prior to the time of purchase.

2.6 System Hydrostatic Testing

Flanged joints and flanged fittings may be subjected to system hydrostatic tests at a pressure of 1.5 times the 38°C (100°F) rating rounded off to the next higher 1 bar (25 psi) increment. Testing at any higher pressure is the responsibility of the user, taking into account the requirements of the applicable code or regulation.