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Steel Pipeline Flanges

Standard Practice
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This MSS Standard Practice was developed under the consensus of the MSS Technical Committee 110, *Steel Flanges & Flanged Fittings*, and the MSS Coordinating Committee. In addition, this Standard Practice was approved by an MSS-sponsored Consensus Committee and recognized by ANSI as an American National Standard. The content of this Standard Practice is the resulting efforts of knowledgeable and experienced industry volunteers to provide an effective, clear, and non-exclusive standard that will benefit the industry as a whole. This MSS Standard Practice describes minimal requirements and is intended as a basis for common practice by the manufacturer, the user, and the industry at large. It is the responsibility of the user of this Standard Practice to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use. The existence of an MSS Standard Practice does not in itself preclude the manufacture, sale, or use of products not conforming to the Standard Practice. Mandatory conformance to this Standard Practice is established only by reference in other documents such as a code, specification, sales contract, or public law, as applicable. MSS has no power, nor does it undertake, to enforce or certify compliance with this document. Any certification or other statement of compliance with the requirements of this Standard Practice shall not be attributable to MSS and is solely the responsibility of the certifier or maker of the statement.

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The SI (metric) units and U.S. customary units in this Standard Practice are regarded separately as the standard and may not be technically equivalent; each should be used independently of the other. Combining or converting values or tolerances between the two systems may result in non-conformance with this Standard Practice.

> **This Standard Practice has been substantially revised from the previous 2016 (2017 REISSUE) edition. It is suggested that if the user is interested in knowing what changes have been made, that direct page by page comparison should be made of this document and that of the previous edition.**

Non-toleranced dimensions in this Standard Practice are nominal unless otherwise specified.

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FOREWORD

The Manufacturers Standardization Society originally developed this Standard Practice in response to the continued requests for steel pipe flanges for pipeline use, particularly in sizes larger than those covered by ANSI Standard B16.5 on Steel Pipe Flanges and Flanged Fittings. The line pipe is uniquely characterized by high-strength, cold worked, thin-wall of the carbon steel grade, which necessitates special considerations for the welding end of the flanges.

The size and pressure class range were originally NPS 26 through NPS 36 in pressure classes customarily designated in ANSI Standard B16.5 as 300, 400, 600, and 900 lb. The 1970 edition deleted the slip-on flanges for lack of demand, and then added a 150 lb. Class and coverage for NPS 12 through NPS 24. Additional coverage was also necessitated by the advent of the use of line pipe of grades having minimum specified yield strength higher than the 52 000 psi maximum contemplated at the time of initial development, and therefore still thinner walls.

In some instances, this advent widened the differential between the tensile properties of the flange steel versus that of the mating pipe steel. This, in turn necessitated greater flexibility in the selection of hub dimensions, so that various combinations of material-strength and flange-dimensions could be utilized to supply the flanges. Section 5 on Flange Design was introduced at this point and is one of the key features of this Standard Practice. The 1972 edition included the coverage of blind flanges in all pressure classes and clarification of text requirements for better understanding and usage under the more diverse conditions.

The 1975 edition expanded the size range above NPS 36. The drilling templates for the Class 150 flanges of the NPS 38 and larger sizes continued the previous philosophy of adopting the drilling template of the Class 125 of ANSI/ASME Standard B16.1. However, the drilling templates of the Class 300 flanges of the NPS 38 and larger sizes did not continue the adoption of the Class 250 of ANSI/ASME Standard B16.1 drilling templates, nor did the NPS 38 and larger sizes of Classes 400, 600, and 900 continue the extrapolation of ANSI/ASME B16.5 drilling templates; instead, these drilling templates were necessarily designed more compactly because of the increased loads. While these flanges are designated by the customary ANSI Standard Class 150, 300, 400, 600, and 900, their use is almost entirely confined to cross country transmission pipelines at atmospheric temperatures. The flanges have been designed primarily for use at their cold ratings which conform to the ANSI/ASME Standard B16.5 ratings of 100 °F, and are intended primarily for attachment to relatively thin-wall, high-strength cold worked pipe, and high-strength butt-welding fittings in pipeline service at temperatures of 450 °F and lower. However, flanges forged of other materials are capable of pressure temperature ratings as specified in Section 2.1.

The 1981 edition brought the document into closer editorial alignment with ANSI/ASME B16.5. However, out of recognition of the successful experience of the pipeline industry, room temperature ratings were extended to 250 °F. Users are cautioned that when these flanges are bolted to valves and used at temperatures between 100 °F and 450 °F, the rating of the valve may not be as high as the flange.

The 1990 revision of this Standard Practice was required to update the referenced standards list and delete the SI (metric) equivalents.

The 1991 revision of this Standard Practice was required to add blind flange machining guidance, flat face requirements and precautionary notes as well as updating of the referenced standards.

The 1996 revision adds a table with permissible imperfections in flange facing finish and clarifies Annex A design criteria. There were several errata, or corrections made to references to other standards. Dimensional tolerances have been changed where necessary to conform to ASME B16.5 and ASME B16.47.

The 2006 revision was required to add SI (metric) equivalent units, notch toughness requirement, new bolting materials and update of reference standards list.

The 2010 revision recognized the existence of ASME B16.47 Series A flanges, which adopted MSS SP-44 dimensions but does not cover the SP-44 high strength materials used in the pipeline industry to match API line pipe of equivalent grades.

In 2014, this Standard Practice (2010 Edition) was ANSI-approved as an American National Standard. This process involved an ANSI/MSS Consensus Committee that was composed of a diverse volunteer group of industry stakeholders with a material interest in the topic of this Standard Practice. This American

National Standard edition, ANSI-approved and published in 2015, is substantively consistent with the 2010 MSS-only edition and will utilize this 2010 year in its nomenclature.

In 2016, this Standard Practice was substantially revised and reformatted to include: Defined chemistry limits (added a Table 1 and also removed external references), clarified the “lot” definition, made impact testing at -50 °F mandatory for grades over F42, added requirement for hardness testing, clarified allowable heat treatment methods, changed marking requirements, added tolerances for raised face height and bolt hole diameter, added requirements for Manufacturing Procedure Specification and Inspection and Test Plans, added Figure 4 to illustrate test locations and orientation, removed ring gasket dimensions and referenced ASME B16.20, added Supplementary Requirements SR-1 through SR-16, updated and renumbered the reference annex, among other substantive and editorial revisions. Moreover, the 2016 edition was ANSI-approved as a Revised American National Standard. Note that the original 2016 edition was replaced by the 2017 Reissue of the 2016 Edition to correct publication processing related errata. A separate Errata Sheet was also issued (Sept 2017) for insertion into the original 2016 Edition.

In 2019, this Standard Practice was substantially revised and reformatted. MSS members worked with a task group commissioned by API Committee on Standardization of Oilfield Equipment and Materials (CSOEM) Subcommittee 21 (Materials) to completely review and improve the Standard Practice. In addition to the introduction of a "PSL2" option and the corresponding Appendix D.1, the main body was revised to have the carbon equivalent (CE) calculated the same way as MSS SP-75, to clarify material is to be fully killed, strengthen the intent that results from test coupons should be representative of the finished flanges, prohibit weld repair without customer approval, clarify the conditions under which dual slope hubs may be certified to this Standard Practice, added requirements for the manufacturer's quality control program including traceability and retention of records, established cosmetic requirements, and detailed information to be contained on the Certified Material Test Report. References to “DN” have been removed (except in Section 2.2) within the body and Tables and replaced with NPS, to align with external standards; however, system units remain as before, e.g., “mm (in.)”, except for some corrections to align with the rest of this Standard Practice. In addition, various editorial changes and the incorporation of the 2017 Errata were also completed before being ANSI-approved as a Revised American National Standard and published in 2020.

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STEEL PIPELINE FLANGES

1. SCOPE

1.1 ***General*** This Standard Practice covers pressure-temperature ratings, materials, dimensions, tolerances, marking, and testing for steel pipeline flanges. The welding neck type flanges shall be forged steel, and the blind flanges may be made from either forged steel or from steel plate.

1.1.1 Dimensional and tolerance requirements for NPS 10 and smaller are provided by reference to ASME B16.5. When such flanges are produced from materials meeting Table 2 requirements, and meet all other stipulations of this Standard Practice, then they shall be considered as complying therewith.

1.1.2 This Standard Practice covers two Product Specification Levels (PSL). If no PSL is specified, material shall be supplied as PSL1 with the standard requirements as are contained in the body of this Standard Practice. If PSL2 is specified, the material shall meet the additional requirements specified in Supplementary Requirement SR-18 (see Annex D/D.1).

1.2 ***References***

1.2.1 ***Referenced Standards*** The standards and specifications incorporated by reference in this Standard Practice are shown in Annex E, for convenience of identifying edition number, date, and source of supply.

A flange made in conformance with a prior edition of referenced standards or specifications and is in all other respects conforming to this Standard Practice, will be considered to be in conformance even though the edition referenced may have changed in a subsequent revision of this Standard Practice.

1.2.2 ***Codes and Regulations*** A flange used under the jurisdiction of the ASME Boiler and Pressure Vessel Code (BPVC), the ANSI-approved ASME Code for Pressure Piping, or Governmental Regulations, is subject to any limitation of that code or regulation. This includes any maximum temperature limitation for a material, or rule governing the use of a material at a low temperature.

1.3 ***Relevant Units*** This Standard Practice states values in both SI (metric) and U.S. Customary units. As an exception, diameters of bolts and flange bolt holes in all tables are expressed in inch units (U.S. Customary) only. Each of these systems of units are to be regarded separately as the standard and cannot be combined. Within the text, the SI (metric) units are listed first and included in main tables with U.S. Customary units shown in parentheses, combined tables, or in separate annex tables; however, this does not imply primacy of SI (metric) units. The values and tolerances 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 non-conformance with the Standard Practice.

2. DENOTATIONS

2.1 ***Pressure-Temperature Ratings*** Flanges covered by this Standard Practice shall be designated as one of the following: Class 150, 300, 400, 600, or 900. The pressure-temperature ratings in Table 4 are in SI (metric) and U.S. Customary.

2.2 ***Size*** The term “NPS”, followed by a dimensionless number, is the designation for a corresponding nominal pipe size. NPS is a separate designation system; however, it has a relation to the reference Nominal Diameter, “DN”, which is used in international standards.

The specific relationship between NPS and DN sizing, for flanges in this Standard Practice, are as follows:

NPS	12	14	16	18	20	22	24	26	28	30	32	34	36
DN	300	350	400	450	500	550	600	650	700	750	800	850	900

NPS	38	40	42	44	46	48	50	52	54	56	58	60	–
DN	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	–

3. MATERIALS

3.1 The steel used in the manufacture of these flanges shall be selected by the manufacturer to meet the following requirements.

3.1.1 All materials used for flanges shall be fully killed steel made to fine grain practice as defined in ASTM A941. Welding neck flanges shall be made from forgings. Blind flanges may be made from either forged steel or from steel plate.

The selected material shall meet the specified chemistry limits in Table 1, grade requirements of Table 2, and other provisions of Section 3.

A ladle and product analysis shall be performed in accordance with ASTM A961/A961M and the results shall be reported on the Certified Material Test Report (CMTR). The product analysis is subject to over/under tolerances as specified in ASTM A961/A961M.

3.1.2 The steel used shall be suitable for field welding to other flanges, fittings, or pipe manufactured according to ASTM A105/A105M, ASTM A53/A537M, ASTM A106/A106M, ASTM A350/A350M, ASTM A381, ASTM A516/A516M, ASTM A537/A537M, ASTM A694/A694M, ASTM A707/A707M, or API Specification 5L.

3.1.3 The steel used shall have a maximum carbon content of 0.30%. The Carbon Equivalent (CE) shall be computed by one of the following equations (based upon the ladle analysis):

For: $C > 0.17\%$

1)

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

For: $C \leq 0.17\%$

2)

$$CE = C + F\left(\frac{Mn}{6} + \frac{Si}{24} + \frac{Cu}{15} + \frac{Ni}{20} + \frac{Cr + Mo + V + Nb}{5} + 5B\right)$$

Where:

F is a compliance factor dependent upon carbon content defined as follows:

Carbon Content, %	*F*
<0.06	0.53
0.06	0.54
0.07	0.56
0.08	0.58
0.09	0.62
0.10	0.66
0.11	0.70

Carbon Content, %	*F*
0.12	0.75
0.13	0.80
0.14	0.85
0.15	0.88
0.16	0.92
0.17	0.94