CSA Z245.12:21

Steel flanges

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Preface

This is the ninth edition of CSA Z245.12, *Steel flanges*. It supersedes the previous editions published in 2017, 2013, 2009, 2005, 2001, 1996, 1991, and 1985.

This Standard covers the requirements for steel flanges intended to be used for transporting fluids as specified in CSA Z662.

Changes to this edition include the following:

a) revised optional ordering requirements (Clause 4.1.2);
b) revised quality management system requirements (Clause 4.4);
c) revised chemical test requirements, including new records requirements (Clause 7);
d) revised heat treatment procedures and records requirements (Clause 8);
e) revised mechanical test requirements (Clause 9);
f) addition of new elevated temperature service requirements (Clause 14); and
g) revised certification requirements (Clause 16).

This Standard was prepared by the Subcommittee on Materials, under the jurisdiction of the Technical Committee on Petroleum and Natural Gas Industry Pipeline Systems and Materials and the Strategic Steering Committee on Petroleum and Natural Gas Industry Systems, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*
4) *To submit a request for interpretation of this Standard, please send the following information to inquiries@csagroup.org and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
   b) *provide an explanation of circumstances surrounding the actual field condition; and*
   c) *where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.*

   Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at standardsactivities.csa.ca.*
5) *This Standard is subject to review within five years from the date of publication. Suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to inquiries@csagroup.org and include "Proposal for change" in the subject line:*
   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

CSA Z245.12:21
Steel flanges

1 Scope

1.1 General

This Standard covers wrought steel welding neck and blind flanges primarily intended for use in oil or gas pipeline systems.

1.2 Size, grade, nominal pressure class, and category

1.2.1 Size

This Standard covers flanges in sizes from NPS 1/2 to NPS 60. (See Table A.1.)

1.2.2 Grade

For other than sour service, this Standard covers flanges from Grade 248 to Grade 690. For sour service, this Standard covers flanges from Grade 248 to Grade 483.

Note: *The standard grades are Grades 248, 290, 317, 359, 386, 414, 448, 483, 550, 620, and 690 (see Table 4); however, intermediate grades may also be used.*

1.2.3 Nominal pressure class

This Standard covers flanges having cold working-pressure ratings designated by nominal pressure classes from PN 20 to PN 420. The standard nominal pressure classes are shown in Table 1. (ASME class designations are shown in Table B.1.)

1.2.4 Category

This Standard covers flanges in the following categories:

a) Category I: flanges without requirements for proven notch-toughness properties; and
b) Category II: flanges with requirements for proven notch-toughness properties.

1.3 Assemblies

This Standard does not cover assemblies.

Note: *An assembly is a grouping of fittings or flanges, or both, joined by one or more circumferential welds.*

1.4 Terminology

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, unless the user finds it more appropriate to use newer or amended editions of such publications.

CSA Group

CSA Z662:19
Oil and gas pipeline systems

ASME (The American Society of Mechanical Engineers)

Boiler and Pressure Vessel Code,
Section II — Materials, Part D, Properties, 2019
Section VIII — Pressure Vessels, Division 1, 2019
Section IX — Welding and Brazing Qualifications, 2019

B16.5-2017
Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

B46.1-2019
Surface Texture (Surface Roughness, Waviness, and Lay)

ASTM International (American Society for Testing and Materials)

A370-20
Standard Test Methods and Definitions for Mechanical Testing of Steel Products

A751-20
Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A991/A991M-17
Standard Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products

E18-20
Standard Test Methods for Rockwell Hardness of Metallic Materials

E21-20
Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials

E29-13 (R2019)
Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E140-12BE1 (R2019)
Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness.

EN (European Standard)
10204:2004
Metallic products — Types of inspection documents

ISO (International Organization for Standardization)
15156-2:2020
Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low alloy steels, and the use of cast irons

NACE International/ISO (International Organization for Standardization)
NACE MR0175/ISO 15156-2:2015
Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low alloy steels, and the use of cast irons

3 Definitions

The following definitions shall apply in this Standard:

Defect — an imperfection of sufficient magnitude to warrant rejection based on the requirements of this Standard.

Demonstrate — verify, or describe and explain, by the use of records, measurements, tests, comparison of specimens, experiments, or analysis by a competent person, supported by documentation.

Grade — a product designation based on strength.
Note: *A grade designation is nondimensional; however, it is numerically equivalent to the specified minimum yield strength in megapascals.*

Heat-affected zone — that portion of the base metal that has not been melted but whose mechanical properties or microstructure has been altered by the heat of welding.

Heat analysis — the chemical analysis reported by the steel producer as being representative of the heat of steel.

Imperfection — a material discontinuity or irregularity that is detectable by inspection in accordance with the requirements of this Standard.

Material test report (MTR) — a document that presents all Clause 16 applicable or quantitative results obtained by applying one or more given test methods in accordance with EN10204 Type 3.1.

Notch toughness — the resistance of the steel to fracture under suddenly applied loads at a notch.

Product analysis — the chemical analysis made on a sample taken from the finished flange or from material representative of the finished flange.

Tensile strength — the stress obtained by dividing the maximum load applied in a conventional tensile test by the original cross-sectional area of the test sample.

Yield strength — the stress at which the steel exhibits either 0.2% offset deviation from the proportionality of stress to strain or 0.5% total elongation under load in a tensile test.

4 General requirements

4.1 Product ordering requirements

4.1.1 Standard requirements

The following information shall be included in the purchase order for flanges:

a) CSA Standard designation and year of publication (Z245.12:21);
b) quantity, size, and description;
c) nominal pressure class (see Clause 1.2.3);
d) for buttwelding flanges, matching pipe grade (if higher than Grade 241) and specified wall thickness (see Clause 5.2.3);
e) category (see Clause 1.2.4);
f) test temperature for Category II (see Clause 9.3.1.2);
g) packaging and shipping instructions; and
h) required delivery date.

4.1.2 Optional requirements

Where applicable, the purchase order shall include information concerning the following items, which are optional for the purchaser:

a) mechanical testing per heat treat charge [see Clause 9.1.3.3 a)];
b) increased absorbed energy values (see Clause 9.3.4.1);
c) alternative flange facings (see Clause 10.4 and Table 2);
d) plant inspection by the purchaser (see Clause 11.2);
e) sour service (see Clause 13);
f) report of hardness tests or specific sour service items (see Clause 16.2); and
g) elevated temperature (see Clause 14.1); and
h) other special requirements.

4.1.3 Additional requirements

Where applicable, the purchase order shall include information concerning the following items, which are subject to agreement between the purchaser and the manufacturer:

a) manufacturing procedure specification (see Clause 6.4);
b) inspection test plan (see Clause 6.5);
c) test frequency for hardness tests (see Clause 9.4.2);
d) dimensions and tolerances of non-standard flanges (see Clause 10.2);
e) ultrasonic inspection of repair welds (see Clause 12.2); and
f) alternate or additional requirements for markings (see Clause 15.1).

4.2 Weldability

Buttwelding flanges shall be capable of being welded in accordance with CAN/CSA-Z662 when using welding procedure specifications that comply with that Standard.

4.3 Rounding procedure

Except as otherwise required by this Standard, to determine conformance with the specified requirements, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in compliance with the rounding method of ASTM E29.

4.4 Quality management system

The manufacturer shall comply with the requirements of a nationally or internationally recognized quality management system standard. The quality management system shall specify controls for the manufacturing process, heat treat process, testing, inspection, material traceability from starting material to final product, and documentation requirements necessary to ensure compliance with this Standard. The control and verification of sub-supplier activities (e.g., steelmaking, forming, heat treatment, inspection) shall be the responsibility of the manufacturer.

To ensure material traceability, the manufacturer shall follow documented procedures for maintaining the heat and lot identity throughout the entire supply chain and production process. Such procedures shall provide means for tracing any flange to the appropriate heat and lot, and the chemical and mechanical test results, back to and including the starting raw material used for production.

5 Design

5.1 Flange ring design

NPS 38 and larger welding neck flanges that have a nominal pressure class of PN 50 or higher shall be Grade 290 or higher.

5.2 Flange hub design

5.2.1

NPS 24 and smaller flanges shall have a single-slope hub or a double-slope hub, as shown in Figures 1A to 1F.

5.2.2

NPS 26 and larger flanges shall have a single-slope hub, as shown in Figures 1B, 1D, and 1F.

5.2.3

Where the specified minimum yield strength of the hub portion is less than that of the matching pipe, the nominal thickness of the hub at the welding end shall be such that the product of its nominal thickness and its specified minimum yield strength is equal to or greater than the product of the specified wall thickness and the specified minimum yield strength of the matching pipe; however, the ratio of the specified minimum yield strength of the pipe to that of the hub portion shall not exceed 1.5. The design of the weld bevel shall be in accordance with Figures 1A to 1F.

5.3 Design of flanges with non-standard dimensions

5.3.1

Flanges with non-standard dimensions shall be designed as specified in the ASME *Boiler and Pressure Vessel Code,* Section VIII, Division 1, using the stresses specified in Clause 5.3.2.

5.3.2

The allowable stresses shall not exceed the values listed below:

a) Welding neck flanges:

	Flange material	
	Lower than Grade 290	**Grade 290 and higher**
Longitudinal hub stress	207 MPa	207 MPa
Radial flange stress	138 MPa	172 MPa
Tangential flange stress	138 MPa	172 MPa
Average stress	138 MPa	172 MPa

b) Blind flanges:

	Flange material
	Grade 248 and higher
Blind flange stress	179 MPa

c) The bolting stress shall not exceed the values specified in the ASME *Boiler and Pressure Vessel Code,* Section II, Part D.

6 Materials and manufacture

6.1 Steelmaking process

Flanges shall be made from open hearth, electric furnace, or basic oxygen-process steel.

6.2 Deoxidation practice

The steel shall be killed.

6.3 Manufacturing practice

6.3.1

Forged flanges shall be forged as close as practicable to the specified final flange shape and size.

6.3.2

Hot-formed flanges shall be cooled below the lower critical temperature prior to heat treatment.

6.3.3

Flanges that are PN 68 or higher, Grade 290 or higher, or both, shall be heat treated using one or more of the procedures specified in Clauses 8.2 to 8.4.

6.3.4

Weld neck flanges shall not be made from plate.

6.3.5

Flanges shall not be machined from bars.

6.4 Manufacturing procedure specification (MPS)

When specified by the purchaser, flanges shall be manufactured in accordance with a documented manufacturing procedure specification. If specified by the purchaser, manufacturing shall not proceed until the MPS has been accepted by the purchaser.

The MPS shall specify the following items, as applicable:

a) for the starting material used in the manufacturing process:
   i) plant name and location producing the starting material used in production of the flanges;
   ii) product form (ingot, billet, bar and dimensions); and
   iii) NDE procedures and results; and
b) for the flange manufacturer:
   i) forging method and temperature;
   ii) heat treatment procedure including thermal cycles;
   iii) machining requirements;
   iv) inspection, dimensions and test requirements;
   v) traceability; and
   vi) any additional requirements such as special facing, coatings, markings, etc.

6.5 Inspection and test plan

When specified by the purchaser, the manufacturer shall supply the purchaser with summary information or identification of the control documents, as applicable, on the main characteristics of the inspection and test plan. The plan shall include at least the following:

a) inspection activity;
b) organization or individuals responsible for performing the inspection activity (including manufacturer, subcontractor, purchaser or third party representation);
c) inspection/test and calibration practices, as applicable;
d) frequency of inspection;
e) acceptance criteria;
f) actions to non-conformances;
g) result recording, as applicable;
h) identification of processes requiring validation; and
i) witness and hold points.

7 Chemical test requirements

7.1 General

Except as otherwise required by this Standard, the methods, practices, and definitions pertaining to chemical analysis shall be as specified in ASTM A751.

7.2 Heat analysis

For grades lower than Grade 290, the requirements for heat analysis (i.e., ladle analysis) shall be as specified in Table 3.

7.3 Product analysis

For Grade 290 and higher, at a frequency of one test per heat, a product analysis shall be determined by the flange manufacturer or the steel manufacturer. The requirements for product analysis shall be as specified in Table 3.

7.4 Records

The heat analysis or product analysis values for the elements listed in Table 3, and the carbon equivalent calculated in accordance with Table 3, shall be reported on the material test report (MTR) as required by Clause 16.1 b).

The steel manufacturer may supply the product analysis, provided the flange manufacturer has assured by one or more quality assurance methods that the results are representative of the delivered material.

Note: *Quality assurance methods include periodic supplier quality audits, periodic over-check testing of incoming material, records of supplier's non-conformance and effective supplier corrective actions, and records that demonstrate a supplier's consistent conformance to chemical and mechanical properties.*

8 Heat treatment procedures

8.1 General

Where specified by Clause 6.3.3 or 11.5.2 e), the flanges shall be heat treated in furnaces surveyed at least annually, controlled within ± 15 °C from the set point temperature, and equipped with recording sensors that are calibrated at least quarterly using one or more of the procedures specified in Clauses 8.2 to 8.5. To ensure uniform temperature throughout the flange during heat treatment, the effective thickness shall include the total flange thickness shown in Figure 3 and account for the flange being in contact with other objects (e.g., other flanges, supports). Annex C shall be used for the calibration and survey of heat treating equipment unless some other practice is demonstrated to be equivalent.

8.2 Normalizing

Flanges shall be

a) uniformly heated above the transformation range;
b) held at this temperature for a minimum of 0.5 h per 25 mm of effective thickness, but not less than 0.5 h; and
c) cooled in air.

8.3 Normalizing and tempering

Flanges shall be

a) normalized as specified in Clause 8.2;
b) tempered by reheating to a temperature below the transformation range, but not less than 540 °C;
c) held at this temperature for a minimum of 1 h per 25 mm of effective thickness, but not less than 0.5 h; and
d) cooled in the furnace or in air.

8.4 Quenching and tempering

Flanges shall be

a) uniformly heated above the transformation range;
b) held at this temperature for a minimum of 0.5 h per 25 mm of effective thickness, but not less than 0.5 h;
c) immediately immersion-quenched in a suitable liquid medium such that the required microstructure is achieved;
d) quenched in facilities of sufficient size and equipped to ensure proper cooling; and
e) tempered as specified in Clause 8.3.

8.5 Post-weld stress relieving

Flanges shall be

a) heated to a suitable temperature below the transformation range, but not less than 540 °C;
b) held at this temperature for not less than 1 h per 25 mm of thickness of the repaired area, but not less than 0.5 h; and
c) cooled in the furnace or in air.

8.6 Procedures and records

8.6.1

Heat treating shall be done by trained operators.

8.6.2

Heat treat and loading procedures shall be available for review at the facility and shall include requirements for furnace temperatures and soak times at temperature. For quench treatments, cooling medium temperature before and after quench shall be controlled along with time to the quench tank. Cooling medium temperature and agitation should be considered to ensure proper cooling rate based on maximum mass being heat treated. Furnaces shall be visually inspected at least every three months for scale build-up, burner malfunction, loss of refractory material, or hot spots on the shell of the furnace.

8.6.3

A record of each heat treat load shall be recorded and reviewed for consistency to previous loads of the same lot. Records shall, at a minimum, include furnace number, date, heat codes of all pieces in the load, procedure used, heat treatment charts, order number and part descriptions. Manufacturers using third party services shall maintain copies of heat treat records from their sub-supplier.

9 Mechanical test requirements

9.1 General

9.1.1 Selection of test specimens

9.1.1.1

Test specimens shall be obtained from either a sacrificial forging, forged test bar, or prolongation. Test specimens for mechanical tests shall be representative of the finished flange. When a sacrificial forging is used, the locations specified in Figure 3 shall be used. When a forged test bar is used, the test bar shall reflect the heat treatment properties of the hub of the flange at Figure 3 location 1 or 2.

When Figure 3 location 2 or 3 or a forged test bar are used, test specimens shall be taken

a) for T ≤ 50 mm and material grades < 359: 1/2T x T;
b) for T > 50 mm and material grades < 359: 1/4T x T; and
c) for material grades ≥ 359, the specimens shall be taken from the mid-wall of the test bar, a maximum of 19 mm from the surface.

9.1.1.2
Except where specified by Clause 9.1.1.3, test specimens shall be in the same heat-treated condition as the flanges they represent.

9.1.1.3
Flanges stress relieved at or below a previous stress-relieving or tempering temperature need not be retested.

9.1.2 Defective test specimens
For any of the mechanical tests specified in Clause 9, specimens showing defective preparation or material imperfections unrelated to the intent of the particular mechanical test, whether observed before or after testing, may be discarded, and replacements shall be considered as original specimens.

9.1.3 Test frequency

9.1.3.1
Tests shall be performed at a frequency of one set of tests per lot. For Category I flanges, a set shall consist of a tension test. For Category II flanges, a set shall consist of a tension test and a notch-toughness test.

9.1.3.2
For flanges of Grade 290 and higher, the mechanical test specimens specified in Clause 9.1.1.1 shall be selected from the same lot as the production flanges and the mechanical properties of the test specimen shall be representative of the final finished flanges.

9.1.3.3
A test lot shall consist of all flanges from one heat of material and the same method of manufacture whose maximum thicknesses do not exceed the thickness of the test flange or forged test bar by more than 6 mm and that are

a) heat treated in the same charge as the test specimens; or
b) heat treated in the same furnace and in accordance with Clause 8.1. Lot testing results may apply for a period of one year or until any major furnace modifications occur as defined by ASTM A991/A991M, whichever is sooner, providing the furnace is routinely checked to ensure it is functional, reliable, and operates within defined parameters.

9.2 Tension tests

9.2.1 General
Except for additional requirements specified in Clause 14, test specimens shall be at room temperature and testing procedures shall be in accordance with ASTM A370. Yield strength and tensile strength results shall be rounded to the nearest megapascal. Round cross-section specimens shall be used unless otherwise agreed by manufacturer and purchaser.

9.2.2 Requirements
The room temperature tensile properties of the flange shall be as specified in Table 4.

9.3 Notch-toughness tests — Category II flanges

9.3.1 General

9.3.1.1
Charpy V-notch impact tests shall be conducted and evaluated as specified in ASTM A370. An impact test shall consist of testing three adjacent specimens taken from a single test coupon. The result shall be the average of the results of the three test specimens.

9.3.1.2
The test temperature shall be as specified in the purchase order, except that a lower test temperature may be used if the specified absorbed energy requirements are met.

9.3.2 Test specimen orientation
The test specimen orientation and location shall be the same as that of the tensile specimen shown in Figure 3 with the notch perpendicular to the surface.

9.3.3 Test specimen size
The test specimens shall be full size unless the flange dimensions or the testing machine capacity dictate the use of subsize specimens. In such cases, the largest obtainable subsize test specimen from those specified in Clause 9.3.4.2 shall be used.

9.3.4 Requirements

9.3.4.1
The absorbed energy (based on full-size test specimens) for each Charpy V-notch impact test shall be 27 J minimum average for all sizes of flanges or a higher value, if specified in the purchase order.

9.3.4.2
Where subsize test specimens are used, the minimum energy absorption value requirement shall be that specified for full-size test specimens multiplied by the applicable reduction ratio, as follows:

Specimen size	Dimensions, mm	Reduction ratio
2/3	10 × 6.7	0.67
1/2	10 × 5.0	0.50

9.4 Macrohardness tests

9.4.1
The macrohardness at any location shall not exceed 30 HRC, as specified in ASTM E18 or as converted from another scale as specified in ASTM E140.

9.4.2
Where a frequency for hardness tests is specified in the purchase order, flanges shall be tested at the specified frequency.

9.5 Retesting

If the tension test or, the Charpy test specimen from any lot fails to conform to the requirements for the particular lot ordered, at the manufacturer's option the lot may be rejected or retested using test specimens from two additional samples from the same lot. Where both retests conform to the requirements specified in Table 4 for tensile properties or Clause 9.3.4 for impacts the lot shall be accepted including the initial test specimen provided two additional tests of that same piece both pass. If one or both of the retests fail to conform to the requirements, the lot fails. The manufacturer may elect to test each of the remaining pieces in the lot. All failed tests shall be reason to reject that flange. Retests shall only be required for the particular test which the specimen did not comply with originally.

10 Dimensions and tolerances

10.1 Standard dimensions and tolerances

Flanges as specified in Tables 5 to 11 are considered to be standard. The tolerances of standard flanges shall be as specified in Table 12.

10.2 Non-standard dimensions and tolerances

Flanges not specified in Tables 5 to 12 are considered to be non-standard. Non-standard dimensions and tolerances shall be as agreed upon by the purchaser and the manufacturer.

10.3 End preparations

The land shall be machined flat within 0.8 mm.

Note: *The end preparations specified in Figures 2A and 2B are recommended.*

10.4 Contact face finish

Unless otherwise specified in the purchase order, flanges shall be furnished with contact face finishes as specified in Table 2. The finish of contact faces of flanges shall be judged by visual comparison with arithmetical average roughness height (AARH) standards (see ASME B46.1). The size and separation of any imperfections in flange facing finish for raised-face flanges shall be as specified in Table 13.

Imperfections less than half the depth of the serrations shall not be considered cause for rejection.

11 Inspection, work quality, and repair of flanges containing defects

11.1 Plant inspection

The finished flange shall be free, both internally and externally, of loose mill scale, foreign matter, oil, and grease, and shall be clean and dry for final inspection. Each flange shall be visually inspected to detect defects and to determine compliance with the dimensional and work quality requirements.

11.2 Inspection notice

Where it is specified in the purchase order that the inspector representing the purchaser intends to inspect the flanges or witness the tests at the manufacturer's plant, the manufacturer shall give the purchaser reasonable notice of the production schedule.

11.3 Plant access

While work on the purchaser's order is being performed, the inspector representing the purchaser shall have unrestricted entry at all times to all parts of the manufacturer's plant concerned with the manufacture of the ordered flanges. The manufacturer shall afford the inspector all reasonable facilities to allow the inspector to verify that the flanges are being manufactured, sampled, tested, and inspected as specified in this Standard and the purchase order. Inspections shall be conducted without unnecessary interference with normal plant operation.

11.4 Work quality

11.4.1

Flanges shall be free of defects and shall have a competently produced finish. Representative imperfections may be explored for acceptability. If defects are not encountered, the remaining imperfections need not be explored.

11.4.2

Defects shall be defined as

a) cracks;
b) sharp notches;
c) mechanical marks, abrasions, and pits that
   i) are deeper than 1.5 mm; or
   ii) result in the thickness of the remaining metal being less than that specified in Clause 10; and
d) seams, laps, tears, scabs, slivers, and other imperfections that
   i) are deeper than 1.5 mm;
   ii) are deeper than 5% of the thickness at the point of the imperfection; or
   iii) result in the thickness of the remaining metal being less than that specified in Clause 10.

11.5 Repair of flanges containing defects

11.5.1

Flanges containing defects shall be addressed in one or more of the following ways:

a) the defect shall be mechanically removed, provided that the depth of material removed does not exceed the limits specified in Clause 11.4.2;
b) when approved by the purchaser, the defect may be removed by grinding and the flange repaired by welding; or
c) the flange shall be rejected.

11.5.2

When approved by the purchaser, the repair of flanges by welding shall comply with the following requirements:

a) the defect shall be removed and the resultant cavity shall be thoroughly cleaned and suitably prepared for inspection by magnetic particle or liquid penetrant inspection, which shall be used to verify the complete removal of the defect;

   Note: *Surface preparation can affect the adequacy of the inspection.*
b) the depth of the cavity shall not exceed one-third of the actual thickness at the area to be repaired, or 10 mm, whichever is less;
c) the total area to be repaired shall not exceed 10% of the surface area of the flange;

d) the repair shall be made by submerged arc welding, gas tungsten arc welding, gas metal arc welding, or shielded metal arc welding using low-hydrogen electrodes;
e) the repaired area shall be heat treated in accordance with one or more of the procedures specified in Clause 8;
f) the repair shall be ground flush with the surface;
g) the welders, welding operators, and welding procedure specifications shall be qualified in accordance with the ASME *Boiler and Pressure Vessel Code,* Section IX;
h) for Category II flanges,
   i) the welding procedure qualification tests shall include Charpy V-notch impact tests of both the weld metal and the heat-affected zone;
   ii) specimen location and orientation shall be as specified in Paragraph UG 84 of the ASME *Boiler and Pressure Vessel Code,* Section VIII, Division 1; and
   iii) the required absorbed energy value (see Clause 9.3.4.1) shall be met; and
i) all repairs made by welding shall be non-destructively inspected as specified in Clause 12.

12 Non-destructive inspection

12.1

Except as allowed by Clause 12.2, all repair welds shall be radiographically inspected and shall comply with Paragraph UW 51 of the ASME *Boiler and Pressure Vessel Code,* Section VIII, Division 1.

12.2

Where approved by the purchaser, ultrasonic inspection may be used for the inspection of repair welds. Ultrasonic inspection shall be used for the inspection of repair welds where it is not practicable to use radiographic inspection. Welds so inspected shall comply with Appendix 12 of the ASME *Boiler and Pressure Vessel Code,* Section VIII, Division 1.

13 Sour service

13.1

Where sour service is specified in the purchase order, the requirements of Clauses 1 to 12, 15, and 16 shall apply, except as such requirements are modified by Clause 13.2.

Note: *Materials, including welding consumables, and manufacturing procedures should be selected in order to avoid microstructures in the weld metal, heat-affected zones, and parent metal that are detrimental to sour service.*

13.2

Flanges shall comply with the requirements specified in ISO 15156-2:2015 Clause A.2 or NACE MR0175/ISO 15156-2:2015 Clause A.2.

Note: *Material selected using NACE MR0175/ISO 15156-2 are resistant to cracking in defined H_2S containing environments in oil and gas production, but not necessarily immune to cracking under all service conditions. It is the equipment user's responsibility to select the material suitable for the intended service.*

14 Elevated temperature service

14.1

Where a flange for elevated temperature service is specified in the purchase order, the requirements of Clauses 1 to 12 shall apply, except where modified by the requirements of Clause 14. The requirements of Clause 13 shall also apply when sour service is applicable.

Note: *Materials and manufacturing procedures should be selected so that specified elevated temperature properties are maintained at the elevated test temperature.*

14.2

In addition to the standard requirements specified in Clause 4.1.1, the purchase order shall include the following:

a) elevated test temperature(s);
b) elevated temperature tension test
   i) frequency;
   ii) specimen type, size, location, and orientation;
   iii) required properties for flange body and weld seam (if present); and
   iv) retesting procedures; and
c) supplementary toughness test requirements (if applicable)
   i) test frequency;
   ii) test temperature(s); and
   iii) energy and shear area, as applicable.

Note: *Elevated tension test requirements and impact property requirements at the minimum design temperature may be derived from the CSA Z662, Clause 14 and Annex I.*

14.3

In addition to the requirements specified in Clause 9.2.1, elevated temperature tension tests shall be conducted in accordance with the requirements of ASTM E21 at the specified elevated test temperature. Round cross-section specimens shall be used unless otherwise agreed by manufacturer and purchaser.

Note: *The relationship between tensile properties and test temperatures might not be linear.*

15 Markings

15.1 General

Unless otherwise specified in the purchase order, the manufacturer shall stamp the flanges as specified in Clause 15.2 on the rim of the flange. Additional markings desired by the manufacturer or requested by the purchaser may be used.

15.2 Required markings

The required markings shall be separated by dashes or adequate spaces and shall generally be in the following sequence:

a) the CSA designation: Z245.12:21;
b) “NONSTD”: for flanges with non-standard dimensions;
c) nominal pressure class: the numerical portion of the nominal pressure class;
d) manufacturer's name or mark;
e) size: the numerical portion of the NPS designation;

f) grade: the numerical portion of the flange grade designation;
g) test temperature for Category II: the notch-toughness test temperature shall be marked using the designation "MXC" or "PXC", where "M" and "P" signify minus and plus, respectively, and "X" signifies the numerical value of the test temperature in degrees Celsius (e.g., "M45C" for –45 °C);
h) "W" for flanges that contain weld repairs to the parent metal;
i) "SS" for sour service, if applicable;
j) elevated temperature service flanges, the symbol "ET";
k) for buttwelding flanges, matching pipe wall thickness;
l) for buttwelding flanges, matching pipe grade, if higher than Grade 241; and
m) identification designation: a manufacturer's identification designation shall be used on flanges and shall be traceable to pertinent material certificates, test reports, and inspection reports.

Note: *Where Items k) and l) are both marked on the flange, the two numbers shall be separated by an oblique (slash).*

15.3 Examples

Examples of the markings specified in Clause 15.2 are as follows:

a) NPS 48 PN 100 Category I flange, manufactured by XYZ Company, Grade 448, sour service, to match 12.7 mm thick Grade 448 pipe, with an identification designation of H328, and with a weld repair to the parent metal, shall be marked as follows: Z245.12:21 100 XYZ 48 448 W SS 12.7/448 H328.
b) NPS 30 PN 68 Category II flange with non-standard dimensions, Grade 359, tested at –45 °C, manufactured by KNJ Company, whose mark is K, to match 9.8 mm thick Grade 414 pipe, with an identification designation of 80013, shall be marked as follows: Z245.12:21 NONSTD 68 K 30 359 M45C 9.8/414 80013.

16 Certification

16.1

The manufacturer shall furnish a material test report (MTR) listing the following:

a) statement that the product was manufactured, sampled, tested, and inspected as specified in this Standard and the purchase order, and was found to have met such requirements;
b) actual results of chemical composition heat or product analysis, including carbon equivalency, see Clause 7;
c) mechanical properties of each lot of steel, test orientation, and test specimen size, see Clause 9.2, and when tested in accordance with Clause 9.1.3.3 b), all test results shall be reported;
d) for Category II flanges, notch toughness properties to include size, orientation, temperature, and actual results for each specimen, Clause 9.3;
e) notification of number of retests and reason for retesting (e.g., two heat lot retests for low body yield strength);
f) heat treatment used, including temperatures and tempering hold times, see Clause 8;
g) non-destructive examination results as applicable, see Clause 12;
h) part description that agrees with the marking on the flanges, see Clause 15.2;
i) CSA designation and effective year date (i.e., CSA Z245.12:21);
j) any other special or supplemental test required by the purchaser;
k) name and location of the starting raw material manufacturer with heat number; and
l) name and location of all entities used to perform forging, heat treatment, or machining.

16.2

Where specified in the purchase order the manufacturer shall provide the following:

a) results of hardness tests shall include the test method used and test results, see Clause 9.4;
b) results of any sour service items specified by the purchaser, see Clause 13;
c) heat treatment charts; and
d) mechanical properties ascertained from testing on final finished flanges; and
e) starting raw material test certificate from the steel mill.

16.3

Where elevated temperature service is specified in the purchase order, elevated test temperature and the elevated temperature tension test properties (i.e., yield strength, tensile strength, and elongation) [see Clauses 15.2 a), b), and c)] shall be reported, as applicable.

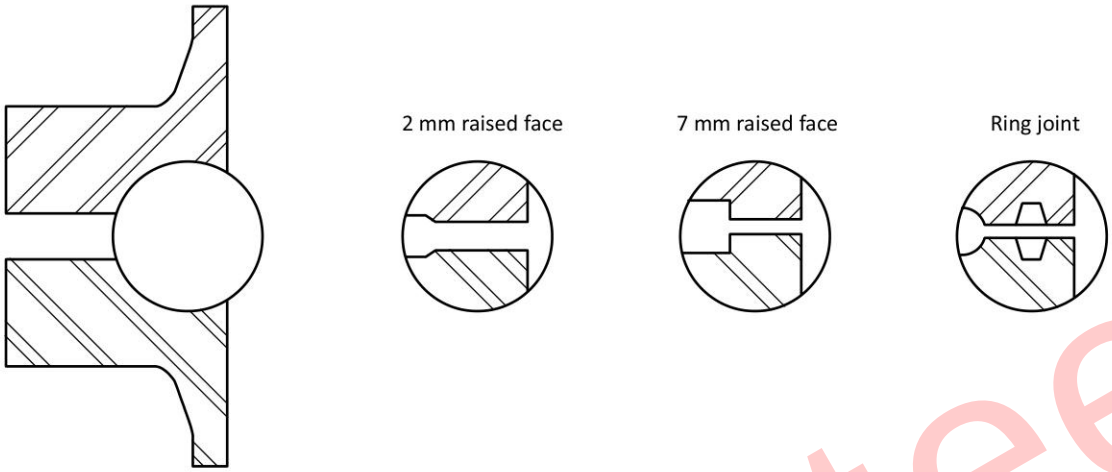
Table 1
Maximum cold working-pressure ratings
(See Clause 1.2.3.)

Nominal pressure class	Maximum cold working–pressure rating, kPa
PN 20	1 900
PN 50	4 960
PN 68	6 620
PN 100	9 930
PN 150	14 890
PN 250	24 820
PN 420	41 370

Notes:

1) *"PN" = means "pression nominale" (nominal pressure). The PN system of nominal pressure class designation is contained in standards prepared by the International Organization for Standardization (ISO). The numerical part of the designation approximates the maximum cold working-pressure rating in bars (100 kPa). (See also Table B.1.)*
2) *Pressure ratings are for temperatures lower than or equal to 120 °C.*

Table 2
Types of contact faces and contact face finish
(See Clauses 4.1.2 c) and 10.4.)



Type of contact face	Required finish
2 mm and 7 mm raised face	General finish: serrated Type of serration: spiral or concentric Number of serrations: 18 to 22 per 10 mm Roughness: 3.2 µm to 6.4 µm AARH
Ring joint — side walls of groove	Smooth: 1.5 µm AARH maximum

Notes:

1) *Unless otherwise specified in the purchase order, the manufacturer may supply either spiral or concentric grooves for serrations. The spiral or concentric machining operation should be done with a cutting tool having a tip radius approximately 1.5 mm or larger.*
2) *AARH = arithmetical average roughness height.*
3) *Other facings, as specified in ASME B16.5, shall be provided where specified in the purchase order.*

Table 3
Chemical composition limits for heat and product analyses
(See Clauses 7.2, 7.3, and 7.4.)

Grades	Maximum carbon equivalent†	
Grade 290 and higher	0.50	
	Maximum permitted, %	
Element	Lower than Grade 290, by heat analysis	Grade 290 and higher, by product analysis
Carbon	0.35	0.30
Manganese	1.35	1.60
Phosphorus	0.05	0.05
Sulphur	0.06	0.06
Silicon	0.35	0.50
Copper	0.40*	1.50
Nickel	0.40*	1.00
Chromium	0.30*	0.30
Molybdenum	0.12*	0.25
Vanadium	0.10	0.13
Niobium	0.05	0.10
Boron	—	0.001

** The sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00%. The sum of chromium and molybdenum shall not exceed 0.32%.*
† The carbon equivalent shall be determined from the product analysis using the following formula:

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

where

F = *a compliance factor that is dependent on carbon content and is as specified in the following table:*

Carbon content, %	F	Carbon content, %	F	Carbon content, %	F
< 0.06	0.53	0.11	0.70	0.17	0.94
0.06	0.54	0.12	0.75	0.18	0.96
0.07	0.56	0.13	0.80	0.19	0.97
0.08	0.58	0.14	0.85	0.20	0.98
0.09	0.62	0.15	0.88	0.21	0.99
0.10	0.66	0.16	0.92	> 0.21	1.00

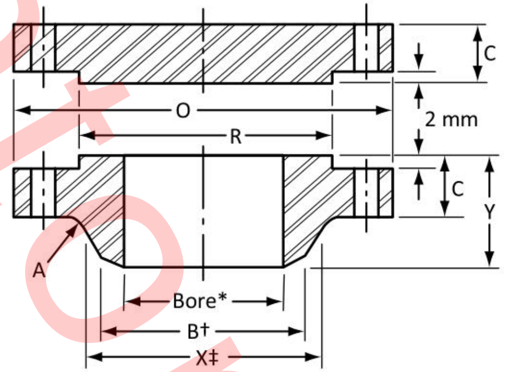
Notes:
1) *The chemical requirements specified in this Table are not intended to represent the composition of any heat of steel but to record the maximum permissible amounts of individual elements.*
2) *Niobium is also known as columbium.*

Table 4
Tensile requirements
(See Clauses 1.2.2, 9.2.2, and 9.5.)

Grade	Minimum yield strength, MPa	Minimum tensile strength, MPa	Minimum elongation in 50 mm, %
248	248	414	20
290	290	414	20
317	317	434	20
359	359	455	20
386	386	490	20
414	414	517	20
448	448	531	18
483	483	565	16
550	550	620	16
620	620	690	16
690	690	760	16

Note: *The tensile requirements for intermediate grades shall be obtained by interpolation between those specified for standard grades.*

Table 5
Dimensions of PN 20 standard flanges, raised face
(See Clause 10.1.)



Nominal flange size	Flange dimensions, mm: Flange OD, O	Flange thickness, C	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Raised face diameter, R	Min. fillet radius, A	Drilling: Number of bolt holes	Diameter, mm: Bolt holes	Bolt circle
NPS 1/2	90	11.6	48	30	21.3	34.9	—	4	16	60.3
NPS 3/4	100	13.2	53	38	26.7	42.9	—	4	16	69.9
NPS 1	110	14.7	56	49	33.4	50.8	—	4	16	79.4
NPS 1-1/4	115	16.3	58	59	42.2	63.5	—	4	16	88.9
NPS 1-1/2	125	17.9	62	65	48.3	73.0	—	4	16	98.4
NPS 2	150	19.5	64	78	60.3	92.1	—	4	19	120.7
NPS 2-1/2	180	22.7	70	90	73.0	104.8	—	4	19	139.7
NPS 3	190	24.3	70	108	88.9	127.0	—	4	19	152.4
NPS 3-1/2	215	24.3	72	122	101.6	139.7	—	8	19	177.8
NPS 4	230	24.3	77	135	114.3	157.2	—	8	19	190.5
NPS 5	255	24.3	89	164	141.3	185.7	—	8	22	215.9
NPS 6	280	25.9	89	192	168.3	215.9	—	8	22	241.3
NPS 8	345	29.0	102	246	219.1	269.9	—	8	22	298.5
NPS 10	405	30.6	102	305	273.0	323.8	—	12	25	362
NPS 12	485	32.2	115	365	323.8	381.0	10	12	25	431.8

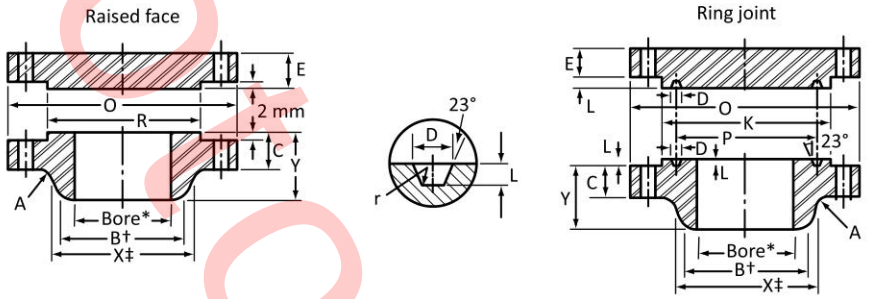
(Continued)

Table 5 (Concluded)

Nominal flange size	Flange dimensions, mm							Drilling		
	Flange OD, O	Flange thickness, C	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Raised face diameter, R	Min. fillet radius, A	Number of bolt holes	Diameter, mm	
									Bolt holes	Bolt circle
NPS 14	535	35.4	127	400	355.6	412.8	10	12	29	476.3
NPS 16	595	37.0	127	457	406.4	469.9	10	16	29	539.8
NPS 18	635	40.1	140	505	457	533.4	10	16	32	577.9
NPS 20	700	43.3	145	559	508	584.2	10	20	32	635
NPS 22	750	46.0	149	616	559	641.2	10	20	35	692
NPS 24	815	48.1	153	663	610	692.2	10	20	35	749.3
NPS 26	870	68.5	121	675	660	749	10	24	35	806
NPS 28	925	71.5	125	725	711	800	11	28	35	863
NPS 30	985	74.5	137	780	762	857	11	28	35	914
NPS 32	1060	81.0	144	830	813	914	11	28	41	978
NPS 34	1110	82.5	149	880	864	965	13	32	41	1029
NPS 36	1170	90.5	157	935	914	1022	13	32	41	1086
NPS 38	1240	87.5	157	990	965	1073	13	32	41	1150
NPS 40	1290	90.5	164	1040	1016	1124	13	36	41	1200
NPS 42	1345	97.0	171	1090	1067	1194	13	36	41	1257
NPS 44	1405	102.0	178	1145	1118	1245	13	40	41	1314
NPS 46	1455	103.0	186	1195	1168	1295	13	40	41	1365
NPS 48	1510	108.0	192	1250	1219	1359	13	44	41	1422
NPS 50	1570	111.0	203	1300	1270	1410	13	44	48	1480
NPS 52	1625	116.0	210	1355	1321	1460	13	44	48	1537
NPS 54	1685	121.0	216	1405	1372	1511	13	44	48	1594
NPS 56	1745	124.0	229	1455	1422	1575	13	48	48	1651
NPS 58	1805	129.0	235	1510	1473	1626	13	48	48	1708
NPS 60	1855	132.0	240	1560	1524	1676	13	52	48	1759

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Table 6
Dimensions of PN 50 standard flanges, raised face and ring joint
(See Clause 10.1.)



Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	95	14.7	14.7	53	38	21.3	—	34.9	51.0	34.14	7.14	5.54	0.8	4	16	66.7	R11
NPS 3/4	115	16.3	16.3	58	48	26.7	—	42.9	63.5	42.88	8.74	6.35	0.8	4	19	82.6	R13
NPS 1	125	17.9	17.9	62	54	33.4	—	50.8	70.0	50.80	8.74	6.35	0.8	4	19	88.9	R16
NPS 1-1/4	135	19.5	19.5	66	64	42.2	—	63.5	79.5	60.33	8.74	6.35	0.8	4	19	98.4	R18
NPS 1-1/2	155	21.1	21.1	69	70	48.3	—	73.0	90.5	68.27	8.74	6.35	0.8	4	22	114.3	R20
NPS 2	165	22.7	22.7	70	84	60.3	—	92.1	108	82.55	11.91	7.92	0.8	8	19	127.0	R23
NPS 2-1/2	190	25.9	25.9	77	100	73.0	—	104.8	127	101.60	11.91	7.92	0.8	8	22	149.2	R26
NPS 3	210	29.0	29.0	80	117	88.9	—	127.0	146	123.83	11.91	7.92	0.8	8	22	168.3	R31
NPS 3-1/2	230	30.6	30.6	81	133	101.6	—	139.7	159	131.78	11.91	7.92	0.8	8	22	184.2	R34
NPS 4	255	32.2	32.2	86	146	114.3	—	157.2	175	149.23	11.91	7.92	0.8	8	22	200.0	R37

(Continued)

Table 6 (Continued)

Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 5	280	35.4	35.4	99	178	141.3	—	185.7	210	180.98	11.91	7.92	0.8	8	22	235.0	R41
NPS 6	320	37.0	37.0	99	206	168.3	—	215.9	241	211.12	11.91	7.92	0.8	12	22	269.9	R45
NPS 8	380	41.7	41.7	112	260	219.1	—	269.9	302	269.88	11.91	7.92	0.8	12	25	330.2	R49
NPS 10	445	48.1	48.1	118	321	273.0	—	323.8	356	323.85	11.91	7.92	0.8	16	29	387.4	R53
NPS 12	520	51.3	51.3	131	375	323.8	10	381.0	413	381.00	11.91	7.92	0.8	16	32	450.8	R57
NPS 14	585	54.4	54.4	143	425	355.6	10	412.8	457	419.10	11.91	7.92	0.8	20	32	514.4	R61
NPS 16	650	57.6	57.6	146	483	406.4	10	469.9	508	469.90	11.91	7.92	0.8	20	35	571.5	R65
NPS 18	710	60.8	60.8	159	533	457	10	533.4	575	533.40	11.91	7.92	0.8	24	35	628.6	R69
NPS 20	775	64.0	64.0	162	587	508	10	582.2	635	584.20	13.49	9.53	1.5	24	35	685.8	R73
NPS 22	838	66.7	66.7	165	640	559	10	641.2	686	635.00	15.10	11.13	1.5	24	41	743.0	R81
NPS 24	915	70.3	70.3	169	702	610	10	692.2	749	692.15	16.66	11.13	1.5	24	41	812.8	R77
NPS 26	970	79.5	84.0	184	720	660	10	749	810	749.30	19.85	12.70	2	28	44	876	R93
NPS 28	1035	85.5	90.5	197	775	711	11	800	860	800.10	19.85	12.70	2	28	44	940	R94
NPS 30	1090	92.0	95.0	210	825	762	11	857	918	857.25	19.85	12.70	2	28	48	997	R95
NPS 32	1150	98.5	100	222	880	813	11	914	984	914.40	23.00	14.30	2	28	51	1054	R96

(Continued)

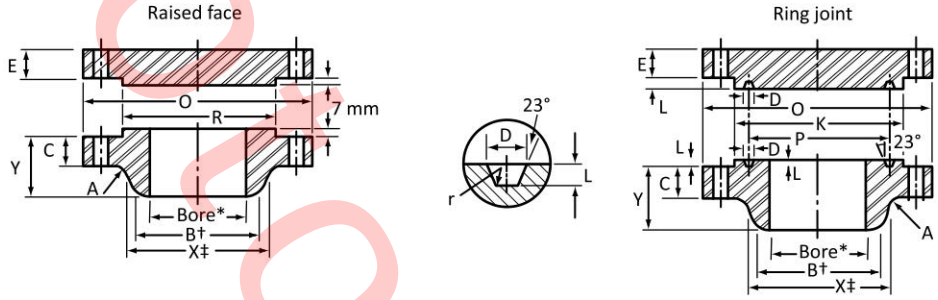
Table 6 (Concluded)

Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
	Flange OD, O	Flange thickness		Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Ring joint					Number of bolt holes	Diameter, mm		
		Weld neck, C	Blind, E						Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r		Bolt holes	Bolt circle	Ring number
NPS 34	1205	102	105	232	935	864	13	965	1035	965.20	23.00	14.30	2	28	51	1105	R97
NPS 36	1270	105	111	241	990	914	13	1022	1092	1022.3-5	23.00	14.30	2	32	54	1168	R98
NPS 38	1170	108	108	181	995	965	13	1029	—	—	—	—	—	32	41	1092	—
NPS 40	1240	114	114	194	1050	1016	13	1086	—	—	—	—	—	32	44	1156	—
NPS 42	1290	119	119	200	1100	1067	13	1137	—	—	—	—	—	32	44	1206	—
NPS 44	1355	124	124	206	1150	1118	13	1194	—	—	—	—	—	32	48	1264	—
NPS 46	1415	129	129	216	1205	1168	13	1245	—	—	—	—	—	28	51	1321	—
NPS 48	1465	133	133	224	1255	1219	13	1302	—	—	—	—	—	32	51	1372	—
NPS 50	1530	140	140	232	1305	1270	13	1359	—	—	—	—	—	32	54	1429	—
NPS 52	1580	144	144	238	1355	1321	13	1410	—	—	—	—	—	32	54	1480	—
NPS 54	1660	152	152	252	1410	1372	13	1467	—	—	—	—	—	28	60	1549	—
NPS 56	1710	154	154	260	1465	1422	13	1518	—	—	—	—	—	28	60	1600	—
NPS 58	1760	159	159	267	1515	1473	13	1575	—	—	—	—	—	32	60	1651	—
NPS 60	1810	164	164	273	1565	1524	13	1626	—	—	—	—	—	32	60	1702	—

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Note: *The ring number shall be used when ordering gasket rings.*

Table 7
Dimensions of PN 68 standard flanges, raised face and ring joint
(See Clause 10.1.)



Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness		Hub					Ring joint							Diameter, mm		
	Flange OD, O	Weld neck, C	Blind, E	length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	95	14.3	14.3	52	38	21.3	—	34.9	51.0	34.14	7.14	5.54	0.8	4	16	66.7	R11
NPS 3/4	115	15.9	15.9	57	48	26.7	—	42.9	63.5	42.88	8.74	6.35	0.8	4	19	82.6	R13
NPS 1	125	17.5	17.5	62	54	33.4	—	50.8	70.0	50.80	8.74	6.35	0.8	4	19	88.9	R16
NPS 1-1/4	135	20.7	20.7	67	64	42.2	—	63.5	79.5	60.33	8.74	6.35	0.8	4	19	98.4	R18
NPS 1-1/2	155	22.3	22.3	70	70	48.3	—	73.0	90.5	68.27	8.74	6.35	0.8	4	22	114.3	R20
NPS 2	165	25.4	25.4	73	84	60.3	—	92.1	108	82.55	11.91	7.92	0.8	8	19	127.0	R23
NPS 2-1/2	190	28.6	28.6	79	100	73.0	—	104.8	127	101.60	11.91	7.92	0.8	8	22	149.2	R26
NPS 3	210	31.8	31.8	83	117	88.9	—	127.0	146	123.83	11.91	7.92	0.8	8	22	168.3	R31
NPS 3-1/2	230	35.0	35.0	86	133	101.6	—	139.7	159	131.78	11.91	7.92	0.8	8	25	184.2	R34
NPS 4	255	35.0	35.0	89	146	114.3	—	157.2	175	149.23	11.91	7.92	0.8	8	25	200.0	R37
NPS 5	280	38.1	38.1	102	178	141.3	—	185.7	210	180.98	11.91	7.92	0.8	8	25	235.0	R41
NPS 6	320	41.3	41.3	103	206	168.3	—	215.9	241	211.12	11.91	7.92	0.8	12	25	269.9	R45
NPS 8	380	47.7	47.7	117	260	219.1	—	269.9	302	269.88	11.91	7.92	0.8	12	29	330.0	R49
NPS 10	445	54.0	54.0	124	321	273.0	—	323.8	356	323.85	11.91	7.92	0.8	16	32	387.4	R53
NPS 12	520	57.2	57.2	137	375	323.8	11	381.0	413	381.00	11.91	7.92	0.8	16	35	450.8	R57

(Continued)

Table 7 (Concluded)

Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
	Flange OD, O	Flange thickness		Hub length,	Hub OD,	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Ring joint					Number of bolt holes	Diameter, mm		
		Weld neck, C	Blind, E	Y	X‡				Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r		Bolt holes	Bolt circle	Ring number
NPS 14	585	60.4	60.4	149	425	355.6	11	412.8	457	419.10	11.91	7.92	0.8	20	35	514.4	R61
NPS 16	650	63.5	63.5	152	483	406.4	11	469.9	508	469.90	11.91	7.92	0.8	20	38	571.5	R65
NPS 18	710	66.7	66.7	165	533	457	11	533.4	575	533.40	11.91	7.92	0.8	24	38	628.6	R69
NPS 20	775	69.9	69.9	168	587	508	11	584.2	635	584.20	13.49	9.53	1.5	24	41	685.8	R73
NPS 22	838	73.0	73.0	171	641	559	11	641.2	686	635.00	15.10	11.13	1.5	24	44	743.0	R81
NPS 24	915	76.2	76.2	175	702	610	11	692.2	749	692.15	16.66	11.13	1.5	24	48	812.8	R77
NPS 26	970	89.0	98.5	194	725	660	11	749	810	749.30	19.85	12.70	2	28	48	876	R93
NPS 28	1035	95.0	105	206	785	711	13	800	860	800.10	19.85	12.70	2	28	51	940	R94
NPS 30	1090	102	111	219	835	762	13	857	918	857.25	19.85	12.70	2	28	54	997	R95
NPS 32	1150	108	116	232	890	813	13	914	984	914.40	23.0	14.30	2	28	54	1054	R96
NPS 34	1205	111	122	241	945	864	14	965	1035	965.20	23.0	14.30	2	28	54	1105	R97
NPS 36	1270	114	129	251	1000	914	14	1022	1092	1022.35	23.0	14.30	2	32	54	1168	R98
NPS 38	1205	124	124	206	1005	965	14	1035	—	—	—	—	—	32	48	1118	—
NPS 40	1270	130	130	216	1055	1016	14	1092	—	—	—	—	—	32	51	1175	—
NPS 42	1320	133	133	224	1110	1067	14	1143	—	—	—	—	—	32	51	1226	—
NPS 44	1385	140	140	233	1160	1118	14	1200	—	—	—	—	—	32	54	1283	—
NPS 46	1440	146	146	244	1215	1168	14	1257	—	—	—	—	—	36	54	1340	—
NPS 48	1510	152	152	257	1265	1219	14	1308	—	—	—	—	—	28	60	1403	—
NPS 50	1570	157	159	268	1320	1270	14	1362	—	—	—	—	—	32	60	1460	—
NPS 52	1620	162	164	276	1370	1321	14	1413	—	—	—	—	—	32	60	1511	—
NPS 54	1700	170	171	289	1425	1372	14	1470	—	—	—	—	—	28	67	1581	—
NPS 56	1755	175	176	298	1480	1422	14	1527	—	—	—	—	—	32	67	1632	—
NPS 58	1805	178	181	306	1530	1473	14	1578	—	—	—	—	—	32	68	1683	—
NPS 60	1886	186	189	319	1585	1524	14	1635	—	—	—	—	—	32	73	1753	—

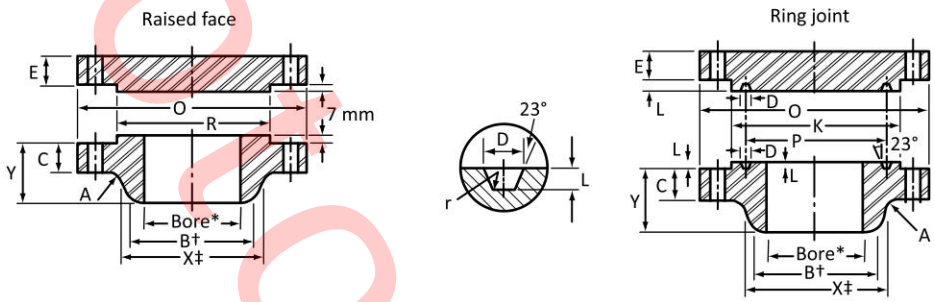
* *Bore — see purchase order.*

† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*

‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°*

Note: *The ring number shall be used when ordering gasket rings.*

Table 8
Dimensions of PN 100 standard flanges, raised face and ring joint
(See Clause 10.1.)



	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	95	14.3	14.3	52	38	21.3	—	34.9	51.0	34.14	7.14	5.54	0.8	4	16	66.7	R11
NPS 3/4	115	15.9	15.9	57	48	26.7	—	42.9	63.5	42.88	8.74	6.35	0.8	4	19	82.6	R13
NPS 1	125	17.5	17.5	62	54	33.4	—	50.8	70.0	50.80	8.74	6.35	0.8	4	19	88.9	R16
NPS 1-1/4	135	20.7	20.7	67	64	42.2	—	63.5	79.5	60.33	8.74	6.35	0.8	4	19	98.4	R18
NPS 1-1/2	155	22.3	22.3	70	70	48.3	—	73.0	90.5	68.27	8.74	6.35	0.8	4	22	114.3	R20
NPS 2	165	25.4	25.4	73	84	60.3	—	92.1	108	82.55	11.91	7.92	0.8	8	19	127.0	R23
NPS 2-1/2	190	28.6	28.6	79	100	73.0	—	104.8	127	101.60	11.91	7.92	0.8	8	22	149.2	R26
NPS 3	210	31.8	31.8	83	117	88.9	—	127.0	146	123.83	11.91	7.92	0.8	8	22	168.3	R31
NPS 3-1/2	230	35.0	35.0	86	133	101.6	—	139.7	159	131.78	11.91	7.92	0.8	8	25	184.2	R34
NPS 4	275	38.1	38.1	102	152	114.3	—	157.2	175	149.23	11.91	7.92	0.8	8	25	215.9	R37
NPS 5	330	44.5	44.5	114	189	141.3	—	185.7	210	180.98	11.91	7.92	0.8	8	29	266.7	R41
NPS 6	355	47.7	47.7	117	222	168.3	—	215.9	241	211.12	11.91	7.92	0.8	12	29	292.1	R45
NPS 8	420	55.6	55.6	133	273	219.1	—	269.9	302	269.88	11.91	7.92	0.8	12	32	349.2	R49
NPS 10	510	63.5	63.5	152	343	273.0	—	323.8	356	323.85	11.91	7.92	0.8	16	35	431.8	R53
NPS 12	560	66.7	66.7	156	400	323.8	11	381.0	413	381.00	11.91	7.92	0.8	20	35	489.0	R57

(Continued)

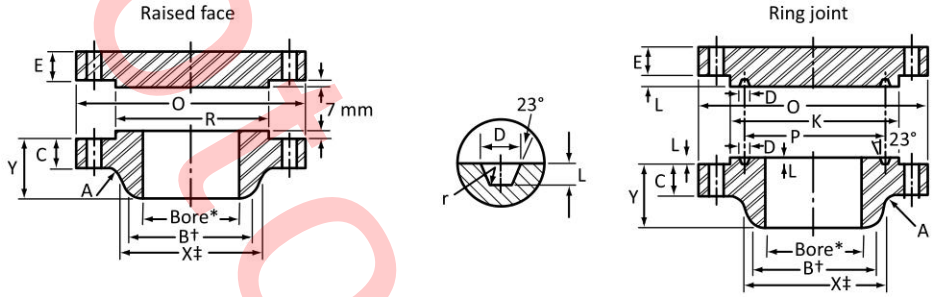
Table 8 (Concluded)

Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 14	605	69.9	69.9	165	432	355.6	11	412.8	457	419.10	11.91	7.92	0.8	20	38	527.0	R61
NPS 16	685	76.2	76.2	178	495	406.4	11	469.9	508	469.90	11.91	7.92	0.8	20	41	603.2	R65
NPS 18	745	82.6	82.6	184	546	457	11	533.4	575	533.40	11.91	7.92	0.8	20	44	654.0	R69
NPS 20	815	88.9	88.9	190	610	508	11	584.2	635	584.20	13.49	9.53	1.5	24	44	723.9	R73
NPS 22	870	95.2	95.2	197	667	559	11	641.2	686	635.00	15.10	11.13	1.5	24	47	777.9	R81
NPS 24	940	101.6	101.6	203	718	610	11	692.2	749	692.15	16.66	11.13	1.5	24	51	838.2	R77
NPS 26	1015	108	125	222	750	660	11	749	810	749.30	19.85	12.70	2	28	51	914	R93
NPS 28	1075	111	132	235	805	711	13	800	860	800.10	19.85	12.70	2	28	54	965	R94
NPS 30	1130	114	140	248	860	762	13	857	918	857.25	19.85	12.70	2	28	54	1022	R95
NPS 32	1195	117	148	260	920	813	13	914	984	914.40	23.00	14.30	2	28	60	1080	R96
NPS 34	1245	121	154	270	975	864	14	965	1035	965.20	23.00	14.30	2	28	60	1130	R97
NPS 36	1315	124	162	283	1030	914	14	1022	1092	1022.35	23.00	14.30	2	28	67	1194	R98
NPS 38	1270	152	156	254	1020	965	14	1054	—	—	—	—	—	28	60	1162	—
NPS 40	1320	159	162	264	1075	1016	14	1111	—	—	—	—	—	32	60	1213	—
NPS 42	1405	168	171	279	1125	1067	14	1168	—	—	—	—	—	28	67	1283	—
NPS 44	1455	173	178	289	1180	1118	14	1226	—	—	—	—	—	32	67	1334	—
NPS 46	1510	179	186	300	1235	1168	14	1276	—	—	—	—	—	32	67	1391	—
NPS 48	1595	189	195	316	1290	1219	14	1334	—	—	—	—	—	32	73	1460	—
NPS 50	1670	197	203	329	1345	1270	14	1384	—	—	—	—	—	28	79	1524	—
NPS 52	1720	203	210	337	1395	1321	14	1435	—	—	—	—	—	32	79	1575	—
NPS 54	1780	210	217	349	1450	1372	14	1492	—	—	—	—	—	32	79	1632	—
NPS 56	1855	217	225	362	1500	1422	16	1543	—	—	—	—	—	32	86	1695	—
NPS 58	1905	222	232	370	1555	1473	16	1600	—	—	—	—	—	32	86	1746	—
NPS 60	1995	233	243	389	1610	1524	17	1657	—	—	—	—	—	28	92	1822	—

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Note: *The ring number shall be used when ordering gasket rings.*

Table 9
Dimensions of PN 150 standard flanges, raised face and ring joint
(See Clause 10.1.)



	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness						Ring joint							Diameter, mm		
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub lengt-h, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radi-us, A	Raise-d face dia., R	Facing dia., K	Pitch dia., P	Groov-e width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	120	22.3	22.3	60	38	21.3	—	34.9	60.5	39.67	8.74	6.35	0.8	4	22	82.6	R12
NPS 3/4	130	25.4	25.4	70	44	26.7	—	42.9	66.5	44.45	8.74	6.35	0.8	4	22	88.9	R14
NPS 1	150	28.6	28.6	73	52	33.4	—	50.8	71.5	50.80	8.74	6.35	0.8	4	25	101.6	R16
NPS 1-1/4	160	28.6	28.6	73	64	42.2	—	63.5	81.0	60.33	8.74	6.35	0.8	4	25	111.1	R18
NPS 1-1/2	180	31.8	31.8	83	70	48.3	—	73.0	92.0	68.27	8.74	6.35	0.8	4	29	123.8	R20
NPS 2	215	38.1	38.1	102	105	60.3	—	92.1	124	95.25	11.91	7.92	0.8	8	25	165.1	R24
NPS 2-1/2	245	41.3	41.3	105	124	73.0	—	104.8	137	107.95	11.91	7.92	0.8	8	29	190.5	R27
NPS 3	240	38.1	38.1	102	127	88.9	—	127.0	156	123.83	11.91	7.92	0.8	8	25	190.5	R31
NPS 4	290	44.5	44.5	114	159	114.3	—	157.2	181	149.23	11.91	7.92	0.8	8	32	235.0	R37

(Continued)

Table 9 (Continued)

Nominal flange size	Flange dimensions, mm							Facing dimensions, mm							Drilling			
		Flange thickness						Ring joint								Diameter, mm		
	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 5	350	50.8	50.8	127	190	141.3	—	185.7	216	180.98	11.91	7.92	0.8	8	35	279.4	R41
NPS 6	380	55.6	55.6	140	235	168.3	—	215.9	241	211.12	11.91	7.92	0.8	12	32	317.5	R45
NPS 8	470	63.5	63.5	162	298	219.1	—	269.9	308	269.88	11.91	7.92	0.8	12	38	393.7	R49
NPS 10	545	69.9	69.9	184	368	273.0	—	323.8	362	323.85	11.91	7.92	0.8	16	38	469.9	R53
NPS 12	610	79.4	79.4	200	419	323.8	11	381.0	419	381.00	11.91	7.92	0.8	20	38	533.4	R57
NPS 14	640	85.8	85.8	213	451	355.6	11	412.8	467	419.10	16.66	11.13	1.5	20	41	558.8	R62
NPS 16	705	88.9	88.9	216	508	406.4	11	469.9	524	469.90	16.66	11.13	1.5	20	44	616.0	R66
NPS 18	785	101.6	101.6	229	565	457.0	11	533.4	594	533.40	19.84	12.70	1.5	20	51	685.8	R70
NPS 20	855	108	108	248	622	508.0	11	584.2	648	584.20	19.84	12.70	1.5	20	54	749.3	R74
NPS 24	1040	139.7	139.7	292	749	610.0	11	692.2	772	692.15	26.97	15.88	2.4	20	67	901.7	R78
NPS 26	1085	139.7	160.0	286	775	660	11	749	832	749.30	30.16	17.46	2	20	73	952	R100
NPS 28	1170	143	171	298	830	711	13	800	889	800.10	33.34	17.46	2	20	79	1022	R101
NPS 30	1230	149	183	311	890	762	13	857	946	857.25	33.34	17.46	2	20	79	1086	R102
NPS 32	1315	159	194	330	945	813	13	914	1003	914.40	33.34	17.46	2	20	86	1156	R103
NPS 34	1395	165	205	349	1005	864	14	965	1067	965.20	36.51	20.64	2	20	92	1226	R104
NPS 36	1460	171	214	362	1065	914	14	1022	1124	1022.35	36.51	20.64	2	20	92	1289	R105

(Continued)

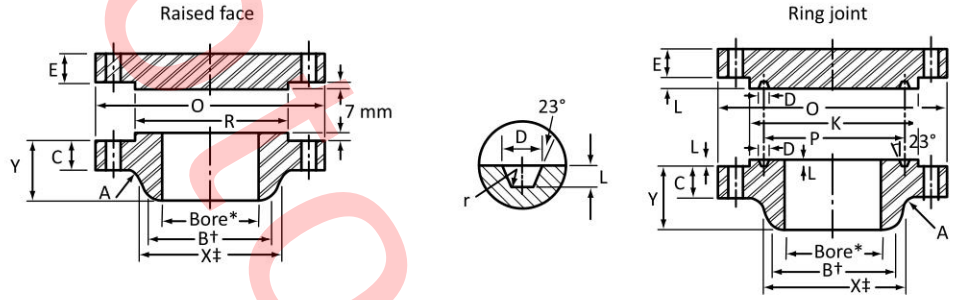
Table 9 (Concluded)

	Flange dimensions, mm								Facing dimensions, mm						Drilling			
		Flange thickness								Ring joint						Diameter, mm		
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 38	1460	190	216	352	1075	965	19	1099	—	—	—	—	—	20	92	1289	—
NPS 40	1510	197	224	364	1125	1016	21	1162	—	—	—	—	—	24	92	1340	—
NPS 42	1560	206	232	371	1175	1067	21	1213	—	—	—	—	—	24	92	1391	—
NPS 44	1650	214	243	391	1235	1118	22	1270	—	—	—	—	—	24	98	1464	—
NPS 46	1735	225	256	411	1290	1168	22	1334	—	—	—	—	—	24	105	1537	—
NPS 48	1785	233	264	419419	1345	1219	24	1384	—	—	—	—	—	24	105	1588	—

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Note: *The ring number shall be used when ordering gasket rings.*

Table 10
Dimensions of PN 250 standard flanges, raised face and ring joint
(See Clause 10.1.)



Nominal flange size	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint							Diameter, mm	
	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	120	22.3	22.3	60	38	21.3	—	34.9	60.5	39.67	8.74	6.35	0.8	4	22	82.6	R12
NPS 3/4	130	25.4	25.4	70	44	26.7	—	42.9	66.5	44.45	8.74	6.35	0.8	4	22	88.9	R14
NPS 1	150	28.6	28.6	73	52	33.4	—	50.8	71.5	50.80	8.74	6.35	0.8	4	25	101.6	R16
NPS 1-1/4	160	28.6	28.6	73	64	42.2	—	63.5	81.0	60.33	8.74	6.35	0.8	4	25	111.1	R18
NPS 1-1/2	180	31.8	31.8	83	70	48.3	—	73.0	92.0	68.27	8.74	6.35	0.8	4	29	123.8	R20
NPS 2	215	38.1	38.1	102	105	60.3	—	92.1	124	95.25	11.91	7.92	0.8	8	25	165.1	R24
NPS 2-1/2	245	41.3	41.3	105	124	73.0	—	104.8	137	107.95	11.91	7.92	0.8	8	29	190.5	R27
NPS 3	265	47.7	47.7	117	133	88.9	—	127.0	168	136.53	11.91	7.92	0.8	8	32	203.2	R35
NPS 4	310	54.0	54.0	124	162	114.3	—	157.2	194	161.93	11.91	7.92	0.8	8	35	241.3	R39
NPS 5	375	73.1	73.1	156	197	141.3	—	185.7	229	193.68	11.91	7.92	0.8	8	42	292.1	R44
NPS 6	395	82.6	82.6	171	229	168.3	—	215.9	248	211.14	13.49	9.52	1.5	12	38	317.5	R46
NPS 8	485	92.1	92.1	213	292	219.1	—	269.9	318	269.88	16.66	11.13	1.5	12	44	393.7	R50
NPS 10	585	108.0	108.0	254	368	273.0	—	323.8	371	323.85	16.66	11.13	1.5	12	51	482.6	R54
NPS 12	675	123.9	123.9	283	451	323.8	—	381.0	438	381.00	23.01	14.27	1.5	16	54	571.5	R58
NPS 14	750	133.4	133.4	298	495	355.6	—	412.8	489	419.10	26.97	15.88	2.4	16	60	635.0	R63

(Continued)

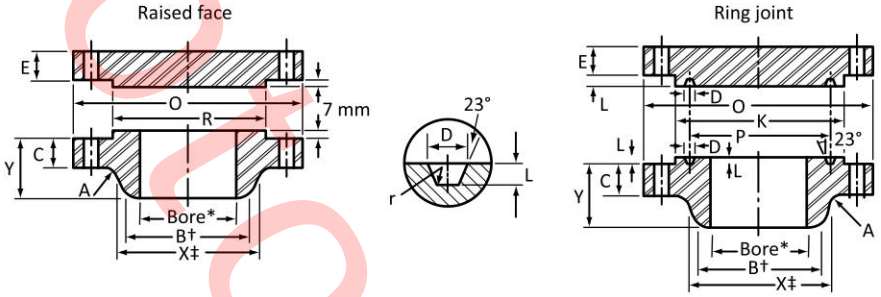
Table 10 (Concluded)

	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 16	825	146.1	146.1	311	552	406.4	—	469.9	546	469.90	30.18	17.48	2.4	16	67	704.8	R67
NPS 18	915	162.0	162.0	327	597	457.0	—	533.4	613	533.40	30.18	17.48	2.4	16	73	774.7	R71
NPS 20	985	177.8	177.8	356	641	508.0	—	584.2	673	584.20	33.32	17.48	2.4	16	79	831.8	R75
NPS 24	1170	203.2	203.2	406	762	610.0	—	692.2	794	692.15	36.53	20.62	2.4	16	92	990.6	R79

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Note: *The ring number shall be used when ordering gasket rings.*

Table 11
Dimensions of PN 420 standard flanges, raised face and ring joint
(See Clause 10.1.)



	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm			
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia., K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 1/2	135	30.2	30.2	73	43	21.3	—	34.9	65.0	42.88	8.74	6.35	0.8	4	22	88.9	R13
NPS 3/4	140	31.8	31.8	79	51	26.7	—	42.9	73.0	50.80	8.74	6.35	0.8	4	22	95.2	R16
NPS 1	160	35.0	35.0	89	57	33.4	—	50.8	82.5	60.33	8.74	6.35	0.8	4	25	108.0	R18
NPS 1-1/4	185	38.1	38.1	95	73	42.2	—	63.5	102	72.23	11.91	7.92	0.8	4	29	130.2	R21
NPS 1-1/2	205	44.5	44.5	111	79	48.3	—	73.0	114	82.55	11.91	7.92	0.8	4	32	146.0	R23
NPS 2	235	50.9	50.9	127	95	60.3	—	92.1	133	101.60	11.91	7.92	0.8	8	29	171.4	R26
NPS 2-1/2	265	57.2	57.2	143	114	73.0	—	104.8	149	111.13	13.49	9.53	0.8	8	32	196.8	R28
NPS 3	305	66.7	66.7	168	133	88.9	—	127.0	168	127.00	13.49	9.53	1.5	8	35	228.6	R32
NPS 4	355	76.2	76.2	190	165	114.3	—	157.2	203	157.18	16.66	11.13	1.5	8	42	273.0	R38
NPS 5	420	92.1	92.1	229	203	141.3	—	185.7	241	190.50	19.84	12.70	1.5	8	48	323.8	R42

(Continued)

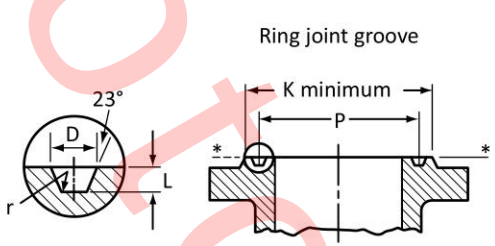
Table 11 (Concluded)

	Flange dimensions, mm							Facing dimensions, mm						Drilling			
		Flange thickness							Ring joint						Diameter, mm		
Nominal flange size	Flange OD, O	Weld neck, C	Blind, E	Hub length, Y	Hub OD, X‡	Bevel OD, B†	Min. fillet radius, A	Raised face dia., R	Facing dia. , K	Pitch dia., P	Groove width, D	Groove depth, L	Groove radius, r	Number of bolt holes	Bolt holes	Bolt circle	Ring number
NPS 6	485	108.0	108.0	273	235	168.3	—	215.9	279	228.60	19.84	12.70	1.5	8	54	368.3	R47
NPS 8	550	127.0	127.0	318	305	219.1	—	269.9	340	279.40	23.01	14.27	1.5	12	54	438.2	R51
NPS 10	675	165.1	165.1	419	375	273.0	—	323.8	425	342.90	30.18	17.48	2.4	12	67	539.8	R55
NPS 12	760	184.2	184.2	464	441	323.8	—	381.0	495	406.40	33.32	17.48	2.4	12	73	619.1	R60

* *Bore — see purchase order.*
† *Where the grade of the flange is less than that of the matching pipe, this dimension shall be increased as specified in Clause 5.2.3.*
‡ *For single-slope hubs where the hub angle exceeds 18°, dimension X shall be reduced to modify the hub angle to 18 ± 1°.*

Note: *The ring number shall be used when ordering gasket rings.*

Table 12
Tolerances of standard flanges
(See Clause 10.1.)



L (depth)	+0.40 –0.00
D (width)	± 0.20
P (pitch diameter)	± 0.13
r (radius)	max.
23° (angle)	± 1/2°

** This edge may be machined (as shown by the solid line) or left unmachined (as shown by the dotted line). Where the edge is machined, the height of the raised portion is equal to the depth of groove "L", but it is not subject to the tolerance for "L".*

Nominal flange size	Raised face diameter, R		Height of raised face, i.e., 2 or 7 mm	Flange thick-ness (C and E)	Welding end		Overall length of welding neck flanges	Bolt circle diameter	Adjacent bolt holes, centre-to-centre	Eccentricity, bolt circle to facing diameter	Diameter of bolt holes
	2 mm	7 mm			Bore	Bevel OD					
NPS 1/2–2-1/2	± 1	± 1	± 1	+3, –0	± 1	+2, –1	± 2	± 2	± 1	± 1	+2.5, –0.5
NPS 3 – 5	± 1	± 1	± 1	+3, –0	± 1	+2, –1	± 2	± 2	± 1	± 2	+2.5, –0.5
NPS 6 – 10	± 1	± 1	± 1	+3, –0	± 1	+4, –1	± 2	± 2	± 1	± 2	+2.5, –0.5
NPS 12 – 18	± 1	± 1	± 1	+3, –0	± 2	+4, –1	± 3	± 2	± 1	± 2	+2.5, –0.5
NPS 20 – 24	± 1	± 1	± 1	+5, –0	+3, –2	+4, –1	± 3	± 2	± 1	± 2	+2.5, –0.5
NPS 26 – 60	± 2	± 2	± 1	+5, –0	+3, –2	+5, –2	± 5	± 2	± 1	± 2	+2.5, –0.5

Notes:

1) *Regardless of the tolerances specified for the bore and bevel OD, the thickness of the hub at the welding end shall never be less than 87.5% for flanges NPS 18 and smaller, or less than 92% for flanges larger than NPS 18, of the nominal wall thickness of the matching pipe multiplied by the ratio of the grade of the matching pipe to the grade of the flange, except that if the grade of the flange exceeds that of the matching pipe, the value 1.0 shall be used for the ratio, instead of the calculated value.*
2) *All tolerances, except for angles, are in millimetres.*

Table 13
Permissible sizes and separation of imperfections in flange facing finish for raised-face flanges
(See Clause 10.4.)

Nominal flange size	Maximum permissible radial projection of imperfections that are not deeper than the bottom of the serrations, mm	Maximum permissible depth and radial projection of imperfections that are deeper than the bottom of the serrations, mm
NPS 1/2	3.0	1.5
NPS 3/4	3.0	1.5
NPS 1	3.0	1.5
NPS 1-1/4	3.0	1.5
NPS 1-1/2	3.0	1.5
NPS 2	3.0	1.5
NPS 2-1/2	3.0	1.5
NPS 3	4.5	1.5
NPS 3-1/2	6.0	3.0
NPS 4	6.0	3.0
NPS 5	6.0	3.0
NPS 6	6.0	3.0
NPS 8	8.0	4.5
NPS 10	8.0	4.5
NPS 12	8.0	4.5
NPS 14	8.0	4.5
NPS 16	10.0	4.5
NPS 18 and larger	12.0	6.0

Notes:
1) *Imperfections shall be separated by at least four times the permissible radial projection.*
2) *Protrusions above the serrations shall not be permitted*

Figure 1A
Hub designs — Double-slope hub
(See Clause 5.2.)

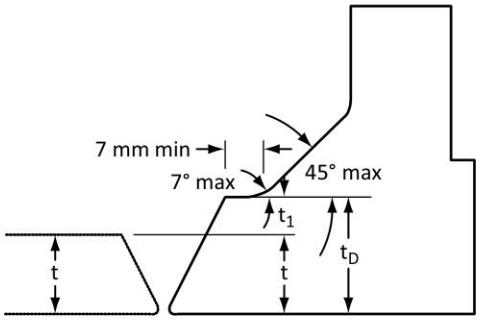


Figure 1B
Hub designs — Single-slope hub
(See Clause 5.2.)

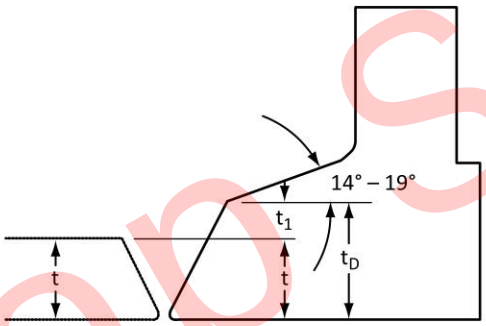


Figure 1C
Hub designs — Double-slope hub
(See Clause 5.2.)

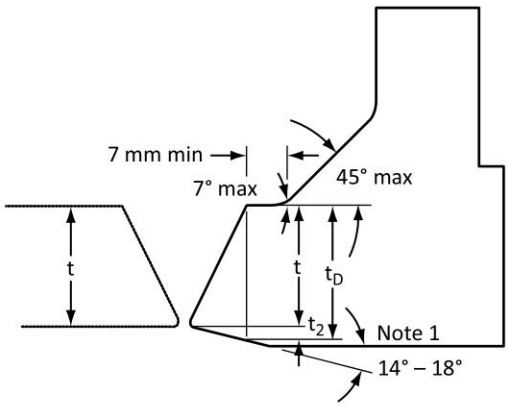


Figure 1D
Hub designs — Single-slope hub
(See Clause 5.2.)

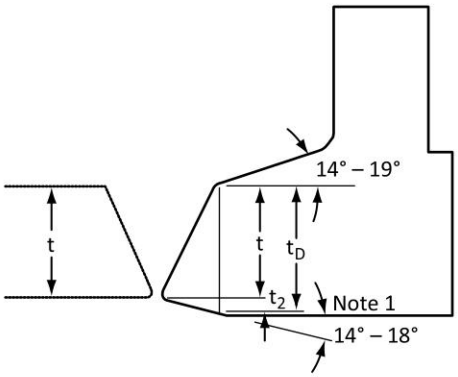


Figure 1E
Hub designs — Double-slope hub
(See Clause 5.2.)

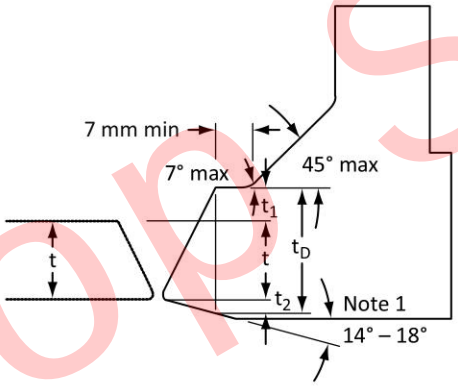
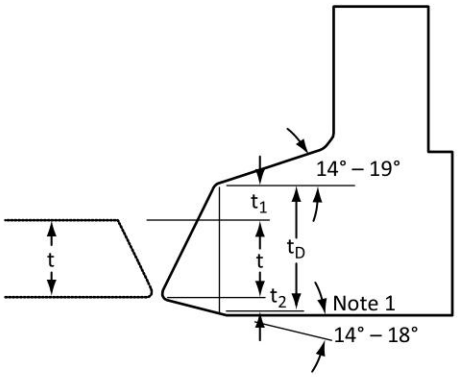
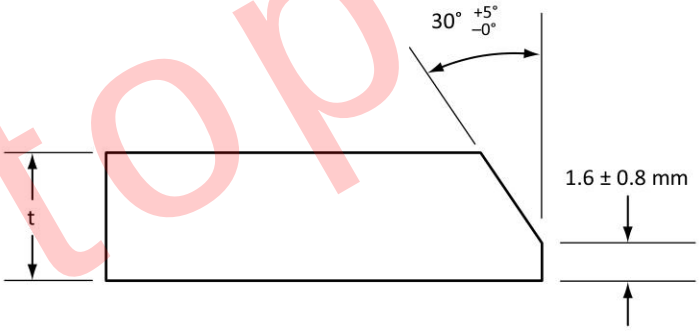


Figure 1F
Hub designs — Single-slope hub
(See Clause 5.2.)



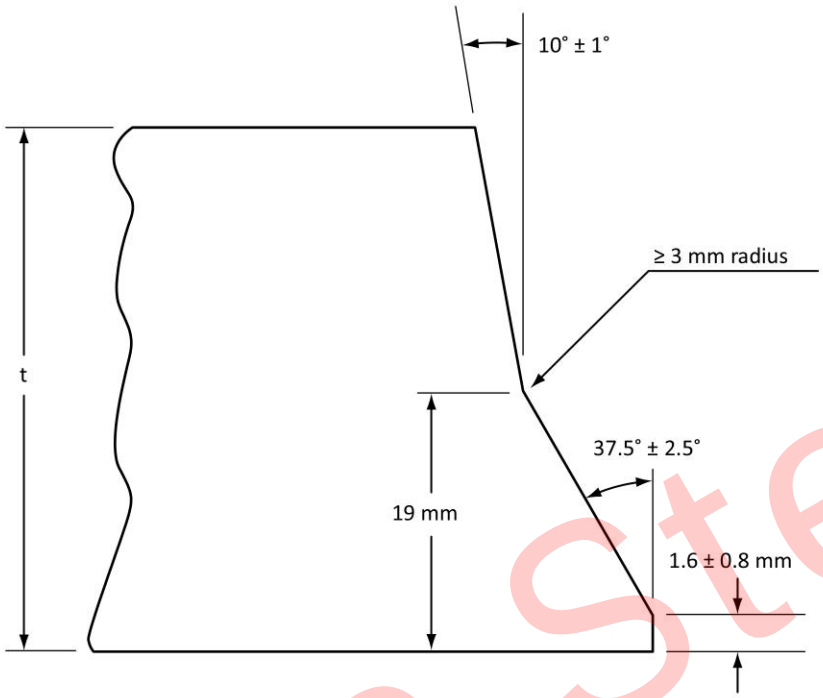
Notes:
1) *The increase in wall thickness on the ID is limited by the 14°–18° end-bevel angle.*
2) *Neither t_1, t_2, nor their sum shall exceed 0.5t.*
3) *t_D = t when the SMYS (specified minimum yield strength) of the flange is greater than or equal to that of the matching pipe.*

Figure 2A
Recommended end preparation for wall thickness at end of flange (t) ≤ 22 mm
(See Clause 10.3.)



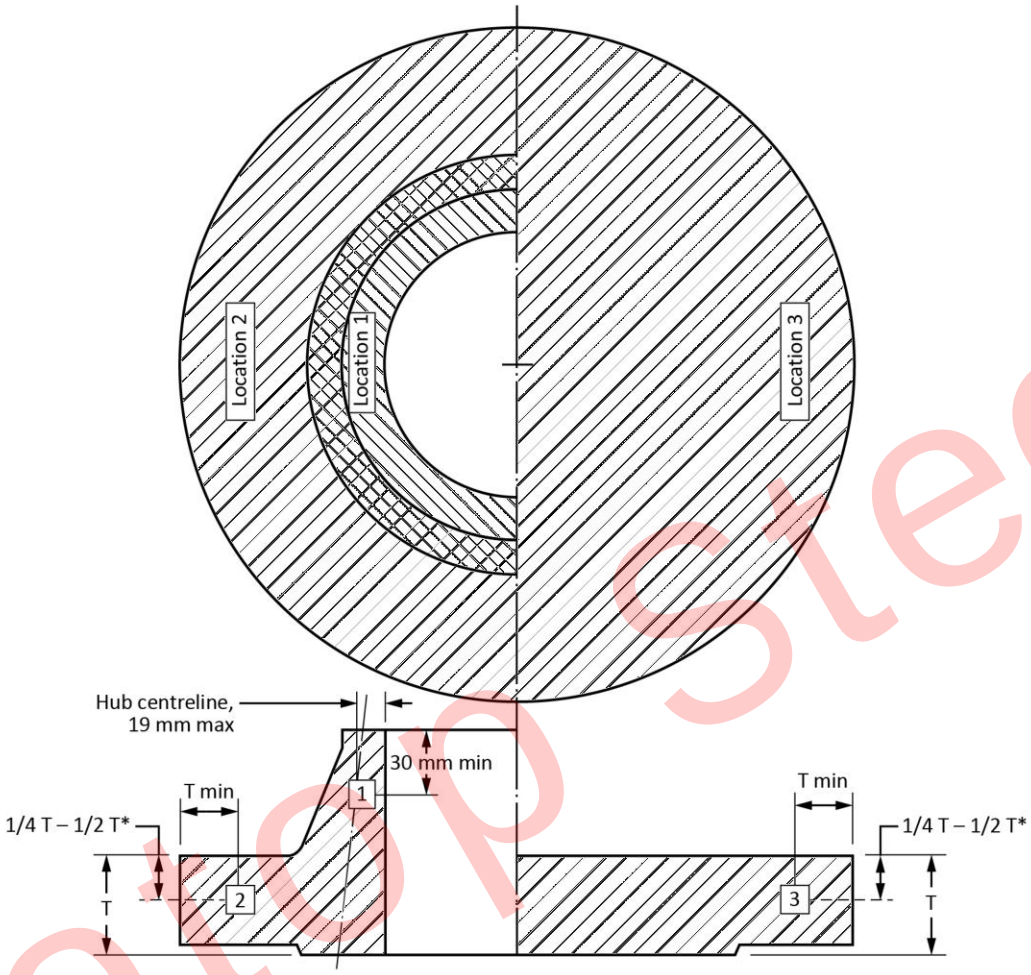
Note: *At the option of the manufacturer, NPS 24 and smaller flanges may be furnished with a 37.5° ± 2.5° bevel.*

Figure 2B
Recommended end preparation for wall thickness at end of flange (t) > 22 mm
(See Clause 10.3.)



Note: *At the option of the manufacturer, NPS 24 and smaller flanges may be furnished with a 37.5° ± 2.5° bevel.*

Figure 3
Test specimen locations
(See Clauses 8.1, 9.1.1.1, and 9.3.2.)



T = total flange thickness

Location 1 — used where size allows
Location 2 — used for flanges too small for location 1
Location 3 — used for blinds

** 1/2 T if T ≤ 50 mm for grade less than 359*
1/4 T if T > 50 mm for grade less than 359
19 mm max if grade ≥ 359

Annex A (informative)
Pipeline component size nomenclature

Note: *This Annex is not a mandatory part of this Standard.*

Table A.1
Pipeline component size nomenclature
(See Clause 1.2.1.)

Nominal flange size		Matching steel line pipe size OD, mm
NPS 1/2	DN 15	21.3
NPS 3/4	DN 20	26.7
NPS 1	DN 25	33.4
NPS 1-1/4	DN 32	42.2
NPS 1-1/2	DN 40	48.3
NPS 2	DN 50	60.3
NPS 2-1/2	DN 65	73.0
NPS 3	DN 80	88.9
NPS 3-1/2	DN 90	101.6
NPS 4	DN 100	114.3
NPS 5	DN 125	141.3
NPS 6	DN 150	168.3
NPS 8	DN 200	219.1
NPS 10	DN 250	273.1
NPS 12	DN 300	323.9
NPS 14	DN 350	355.6
NPS 16	DN 400	406.4
NPS 18	DN 450	457
NPS 20	DN 500	508
NPS 22	DN 550	559
NPS 24	DN 600	610
NPS 26	DN 650	660
NPS 28	DN 700	711
NPS 30	DN 750	762
NPS 32	DN 800	813
NPS 34	DN 850	864
NPS 36	DN 900	914
NPS 38	DN 950	965
NPS 40	DN 1000	1016

(Continued)

Table A.1 (Concluded)

Nominal flange size		Matching steel line pipe size OD, mm
NPS 42	DN 1050	1067
NPS 44	DN 1100	1118
NPS 46	DN 1150	1168
NPS 48	DN 1200	1219
NPS 50	DN 1250	1270
NPS 52	DN 1300	1321
NPS 54	DN 1350	1372
NPS 56	DN 1400	1422
NPS 58	DN 1450	1473
NPS 60	DN 1500	1524

Notes:

1) *"NPS" means "nominal pipe size", and the NPS system of nominal size designation is contained in Standards prepared by the American Society of Mechanical Engineers (ASME). The NPS size is dimensionless, and the numerical portion of the designation is identical to the numerical portion of the previously used inch nominal size designation.*
2) *"DN" means "diamètre nominal" (nominal diameter), and the DN system of nominal size designation is contained in Standards prepared by the International Organization for Standardization (ISO).*
3) *The DN nominal sizes listed in this Table have generally been extracted from various ISO Standards, but in some cases have been assigned arbitrarily. Caution should be exercised in the use of this Table, because in many cases the DN nominal size shown is identical to that used in ISO Standards to designate components for pipe having a specified outside diameter that differs slightly from the pipe OD size listed.*

Annex B (informative)
Nominal pressure class

Note: *This Annex is not a mandatory part of this Standard.*

Table B.1
Nominal pressure class
(See Clause 1.2.3 and Table 1.)

ASME class designation	Nominal pressure class
150	PN 20
300	PN 50
400	PN 68
600	PN 100
900	PN 150
1500	PN 250
2500	PN 420

Notes:

1) *ASME class designations are designations given to flanges to indicate the manufacturing dimensions and maximum allowable non-shock working pressure, considering the material used and the operating temperature.*
2) *"PN" means "pression nominale" (nominal pressure); the PN system of nominal pressure class designation is contained in standards prepared by the International Organization for Standardization (ISO). The numerical part of the designation approximates the maximum cold working-pressure rating in bars (100 kPa).*

Annex C (normative)
Requirements for the calibration and survey of heat treating equipment

Note: *This Annex is a mandatory part of this Standard.*

C.1 Furnace calibration and survey

C.1.1
A temperature survey within each furnace working zone shall be performed on each furnace at the maximum and minimum temperatures of the range for which the furnace is qualified for use.

C.1.2
The total number of thermocouple test locations in the working zone of a furnace shall be not fewer than four for furnace working zones of 2 m^3 or less. The location of the thermocouples shall be at the manufacturer's discretion.

C.1.3
Furnace working zones greater than 2 m^3 and less than or equal to 10 m^3 shall use not fewer than nine thermocouples. The location of the thermocouples shall be as specified in Figure C.1.

C.1.4
Furnace working zones greater than 10 m^3 shall utilize a minimum of nine thermocouples, plus one additional thermocouple for each 3 m^3 of working zone exceeding 10 m^3. Additional thermocouples may be used. The location of the first nine thermocouples shall be as specified in Figure C.1. The placement of additional thermocouples shall be at the manufacturer's discretion and shall be recorded on the survey records.

C.1.5
After the thermocouples have been installed, readings shall be taken at least once every 3 min to determine when the temperature of the furnace working zone approaches the bottom of the temperature range being surveyed.

C.1.6
Once the furnace temperature has reached the set point temperature, the temperature of each thermocouple shall be recorded at maximum intervals of 2 min, for at least 10 min. Then, readings shall be taken at maximum intervals of 5 min for a time sufficient to determine the recurrent temperature pattern of the working zone for at least 30 min.

C.1.7
After the furnace control set point temperature is reached, the temperature at any point in the working zone shall not vary by more than 15 °C from the set point temperature.

C.1.8
Furnaces that have been subjected to a change in burner quantity or location, or both, shall be surveyed, and the requirements of Clause C.1.7 shall be met.

C.1.9

Furnaces that have been subjected to a change in the type of lining shall be surveyed, and the requirements of Clause C.1.7 shall be met.

Note: *An example of a change in the type of lining is from brick to fibre.*

C.1.10

Except as specified by Clauses C.1.8 and C.1.9, furnaces that have been repaired or rebuilt shall be surveyed if deemed necessary by the manufacturer. For any such survey, the requirements of Clause C.1.7 shall be met.

C.2 Instruments

C.2.1 Accuracy of production instruments

The production instruments (thermocouples, controllers, and recorders) used for the heat treatment process shall be accurate to within ± 1% over the heat treatment range.

C.2.2 Calibration of production instruments

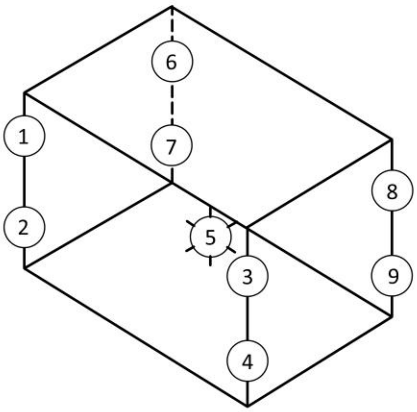
Equipment used to calibrate production instruments shall be accurate to within ± 0.25% of their full-scale range.

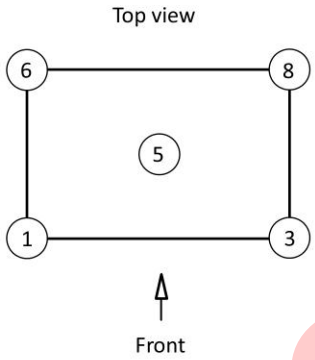
C.3 Records

Records of furnace calibration and surveys shall be maintained for at least five years.

Figure C.1
Thermocouple locations
(See Clauses C.1.3 and C.1.4.)

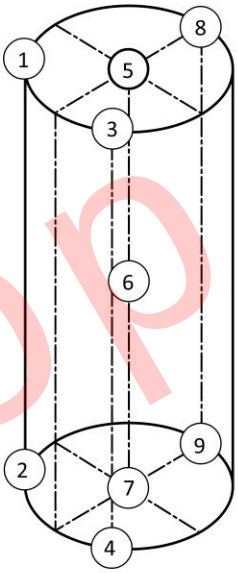
1) Front/left/top
2) Front/left/bottom
3) Front/right/top
4) Front/right/bottom
5) Centre/centre
6) Back/left/top
7) Back/left/bottom
8) Back/right/top
9) Back/right/bottom

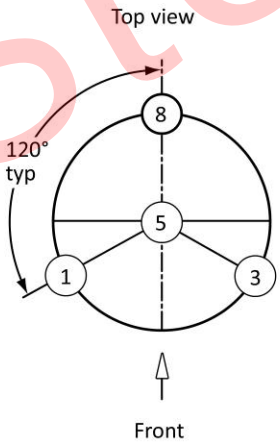




Rectangular furnace

1) Front/left/top
2) Front/left/bottom
3) Front/right/top
4) Front/right/bottom
5) Centre/top
6) Centre/centre
7) Centre/bottom
8) Back/centre/top
9) Back/centre/bottom





Cylindrical furnace

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