

Australian Standard™

Flanges for pipes, valves and fittings

This Australian Standard was prepared by Committee ME/1, Pressure Equipment. It was approved on behalf of the Council of Standards Australia on 17 September 1999 and published on 17 January 2000.

The following interests are represented on Committee ME/1:

A.C.T. WorkCover
 Australasian Corrosion Association
 Australasian Institute of Engineer Surveyor
 Australian Aluminium Council
 Australian Building Codes Board
 Australian Chamber of Commerce and Industry
 Australian Industry Group
 Australian Institute of Energy
 Australian Institute of Petroleum
 Boiler and Pressure Vessel Manufacturers Association of Australia
 Bureau of Steel Manufacturers of Australia
 Department for Administration and Information Services, S.A.
 Department of Employment Training and Industrial Relations, Qld
 Department of Industries and Business, N.T.
 Department of Infrastructure, Energy and Resources (Tasmania)
 Department of Labour, New Zealand
 Electricity Engineers Association (New Zealand)
 Electricity Supply Association of Australia
 Institute of Materials Engineering Australasia
 Institution of Engineers, Australia
 Institution of Professional Engineers, New Zealand
 National Association of Testing Authorities, Australia
 New Zealand Engineering Federation
 New Zealand Heavy Engineering Research Association
 New Zealand Institute of Welding
 New Zealand Petrochemical Users Group
 Victorian WorkCover Authority
 Welding Technology Institute of Australia
 WorkCover N.S.W.
 WorkSafe Western Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about Standards can be found by visiting the Standards Australia web site at www.standards.com.au and looking up the relevant Standard in the on-line catalogue.

Alternatively, the printed Catalogue provides information current at 1 January each year, and the monthly magazine, *The Australian Standard*, has a full listing of revisions and amendments published each month.

We also welcome suggestions for the improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.com.au, or write to the Chief Executive, Standards Australia International Ltd, PO Box 1055, Strathfield, NSW 2135.

This Standard was issued in draft form for comment as DR 98317.

Australian Standard™

Flanges for pipes, valves and fittings

Originated in part as AS B52.1 — 1931
(being endorsement of BS 10.1 — 1928 without amendment).
Previous edition AS 2129 — 1994.
Third edition 2000.

COPYRIGHT

© Standards Australia International

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Published by Standards Australia International Ltd
PO Box 1055, Strathfield, NSW 2135, Australia

ISBN 0 7337 3065 5

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME/1, Pressure Equipment Standard to supersede AS 2129—1994.

This Standard is the result of a consensus among representatives on the Joint Committee to produce it as an Australian Standard. Consensus means general agreement by all interested parties. Consensus includes an attempt to remove all objections and implies much more than the concept of a simple majority, but not necessarily unanimity. It is consistent with this meaning that a member may be included in the Committee list and yet not be in full agreement with all clauses of this Standard.

This Standard is derived from the British inch series flange Standard BS 10:1962, *Flanges and bolting for pipes, valves and fittings*. BS 10 was made obsolescent in 1970, however, it is still called up in British pressure equipment Standards. A 1992 survey of Australian industry showed that flanges in accordance with AS 2129 were still in great demand. As a result it was determined that AS 2129 should be revised and updated rather than being made obsolescent.

It is anticipated flanges to AS 2129 will remain in use for at least 50 years, particularly for replacement flanges. Consideration should be given to the use of alternative flanges, such as those to AS/NZS 4331, *Metallic flanges* (series), BS 4504, *Circular flanges for pipes valves and fittings, (PN designated)*, ANSI/ASME B16.5, *Pipe flanges and flanged fittings*, and AS 4087, *Metallic flanges for waterworks purposes*.

The main changes in this edition are as follows:

- (a) Incorporation of Amendment No. 1 to the 1994 edition.
- (b) Deletion of Table C which is now covered in AS 4087.
- (c) Updated referenced documents.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

The term 'normative' has been used in this Standard to define the application of the Appendices. A 'normative' appendix is an integral part of this Standard.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	4
1.2 OBJECTIVE	4
1.3 APPLICATION	4
1.4 REFERENCED DOCUMENTS	4
1.5 DEFINITIONS	5
1.6 CONFIGURATION	5
1.7 LIMITATIONS ON THE USE OF FLANGES	6
1.8 NON-STANDARD THICKNESS FLANGES	6
1.9 NOMINAL SIZE AND OUTSIDE DIAMETER	6
SECTION 2 TEMPERATURE/PRESSURE RATINGS	
2.1 GENERAL	7
2.2 INTERPOLATION OF INTERMEDIATE VALUES	7
SECTION 3 MATERIALS	
3.1 SELECTION OF MATERIALS	11
3.2 MATERIALS FOR FLANGES	11
3.3 LIMITATIONS ON THE USE OF PARTICULAR MATERIALS	11
3.4 ALTERNATIVE MATERIAL SPECIFICATIONS	11
SECTION 4 MANUFACTURING REQUIREMENTS AND DIMENSIONS	
4.1 MANUFACTURING METHODS	16
4.2 FLANGE DIMENSIONS	16
4.3 FLANGE FACES	16
4.4 PREPARATION FOR ATTACHMENT OF FLANGES	17
4.5 BOLT HOLES	19
4.6 SPOT-FACING AND BACK-FACING OF FLANGES	19
SECTION 5 MARKING AND MATERIAL CERTIFICATES	
5.1 MARKING	20
5.2 MATERIAL CERTIFICATES	20
SECTION 6 DIMENSIONS OF FLANGES	21
APPENDICES	
A SELECTION OF BOLTING	42
B ASSEMBLY OF FLANGED JOINTS	46
C LIST OF REFERENCED DOCUMENTS	48
D NOMINAL SIZE AND OUTSIDE DIAMETER OF PIPES	50

STANDARDS AUSTRALIA

Australian Standard

Flanges for pipes, valves and fittings

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard specifies requirements for circular flanges of nominal sizes DN 15 to DN 3000, inclusive, and their bolting for use on pipes, valves, fittings and other pressure-retaining equipment containing fluid at pressures up to 19 300 kPa and at temperatures in the range -200°C to $+525^{\circ}\text{C}$.

These flanges are manufactured from carbon steel, carbon-manganese steel, alloy steel, stainless steel, grey iron, malleable iron, ductile cast iron*, or copper alloy.

This Standard is applicable to flanges for water, steam, compressed air, chemical and petroleum plants, hydraulic piping and where other Standards require compliance with this Standard.

This Standard is not intended to apply to flanges for water or waste water covered by AS 4087.

Flanges R, S and T are designated obsolescent and are not recommended for use in new equipment. They are retained to provide for the servicing of existing equipment that is expected to have a long working life. For new equipment, flanges R, S and T should be replaced with flanges to AS/NZS 4331, Parts 1 to 3, ANSI B16.5 or BS 4504 (series).

The history of AS 2129 flanges (and its predecessor BS 10) and the future use of these flanges is given in the Preface.

1.2 OBJECTIVE The objective of this Standard is to provide guidance to manufacturers and users on the materials, manufacturing requirements and dimensions of circular flanges for use with existing or new equipment.

1.3 APPLICATION

1.3.1 Flanges Flanges shall comply with the relevant requirements of this Section and with the specific requirements of the following Sections, as appropriate:

Section 2—Temperature/Pressure Ratings.

Section 3—Materials.

Section 4—Manufacturing Requirements and Dimensions.

Section 5—Marking and Material Certificates.

Section 6—Dimensions of Flanges.

1.3.2 Bolting Bolting for flanges shall comply with the requirements of Appendix A.

1.3.3 Assembly The assembly of flanged joints shall comply with the requirements of Appendix B.

1.4 REFERENCED DOCUMENTS The documents referred to in this Standard are listed, with titles, in Appendix C.

* Alternative names for ductile cast iron are 'spheroidal graphite iron', 'SG iron', and 'nodular graphite iron'.

1.5 DEFINITIONS For the purposes of this Standard, the following definitions apply:

1.5.1 Flange contact surface—that part of the flange face upon which the gasket is compressed.

1.5.2 Flange face—the reference plane which is perpendicular to the axis of the flange and coincident with the front of the flange from which is measured the thickness of the flange and also the height of the raised face or the depth of the O-ring groove. The profile of the front of a flange may be flat face*, raised face, or flat face with O-ring. (See Figure 1.1.)

NOTE: For convenience, only the flat face variant of each type has been illustrated.

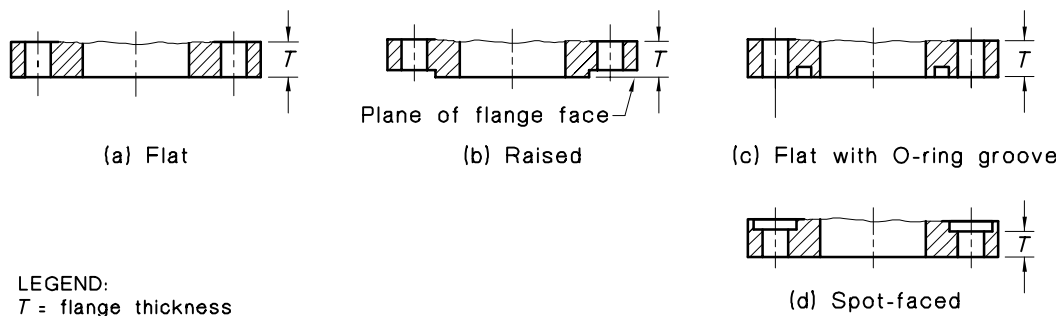


FIGURE 1.1 FLANGE FACE AND FLANGE THICKNESS

1.5.3 Flange thickness—the distance from the flange face to the back face of a flange or, if the bolt holes are spot-faced, from the flange face to the spot facing. (See Figure 1.1 and Clause 4.6.4).

1.5.4 Fluid—any vapour, liquid, gas or mixture thereof.

1.5.5 Integral flange—a flange which is cast or forged as part of a pressure-containing component.

1.5.6 Nominal size (DN)—a numerical designation of size which is common to all components in a piping system other than components designated by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

1.5.7 Pressure—the gauge pressure of the fluid contained by the pressure-containing component.

1.5.8 Temperature—the temperature of the fluid contained by the pressure-containing component to which the flange is attached, unless otherwise stated.

1.6 CONFIGURATION

1.6.1 General Flange configuration is determined by—

- (a) the type, as specified in Clause 1.6.2; and
- (b) the face, as specified in Clause 1.6.3.

1.6.2 Type The types of flanges are as illustrated in Figure 1.2.

1.6.3 Flange faces Each of the basic types may have, subject to the limitations given in Table 4.1, any one of the faces illustrated in Figure 1.1.

NOTE: For convenience, only the flat face variant of each type has been illustrated.

* An alternative term for 'flat face' is 'full face'.

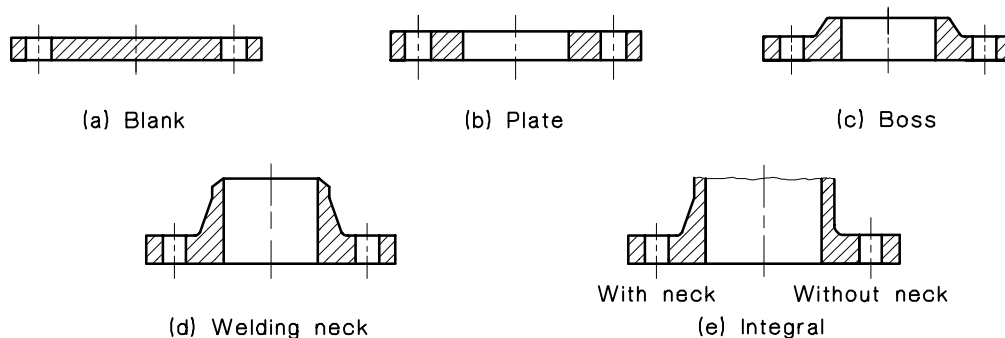
1.7 LIMITATIONS ON THE USE OF FLANGES Limitation on the use of a flange may be imposed by any one or more of the following:

- (a) Material.
- (b) Flange table.
- (c) Flange type.
- (d) Fluid.
- (e) Temperature.
- (f) Hydrostatic test pressure.

The hydrostatic test pressure of a flange, when installed in a system, shall not exceed the maximum allowable hydrostatic test pressure (at nominal 20°C) shown in the appropriate Table (Tables 2.1 to 2.10).

Limitations of a particular nature may be imposed for specific applications by the relevant application Standard which should be consulted.

Flange Tables A, D and E may not be suitable for use with hard gaskets, such as spiral wound gaskets, or narrow face gaskets, as the flange may deform permanently before satisfactory seating loads are achieved. (Refer also to Paragraph B3.2 for gasket selection.)



NOTE: For convenience, only the flat face variant of each type has been illustrated.

FIGURE 1.2 FLANGE TYPES

1.8 NON-STANDARD THICKNESS FLANGES The thickness of a flange may be reduced by up to 5% from the tabulated thickness provided—

- (a) the yield strength of the flange material is at least 20% stronger than the minimum specified yield strength of a material listed for the particular flange;
- (b) the purchaser agrees; and
- (c) the flange is designated as non-standard.

1.9 NOMINAL SIZE AND OUTSIDE DIAMETER Appendix D tabulates, for the nominal size (DN), the outside diameter of pipes in accordance with the relevant Standards.

SECTION 2 TEMPERATURE / PRESSURE RATINGS

2.1 GENERAL The temperature/pressure ratings of flanges shall be as shown in Tables 2.1 to 2.10, subject to the limitations listed in Clause 1.7.

The integrity of a flanged joint is dependent upon the correct selection of bolting (see Appendix A), the gasket, and on the method of assembly (see Appendix B).

The pressure ratings given in these Tables are maximum permissible non-shock pressures at the temperatures shown. Where a flange is subject to shock or fatigue, calculations are to be made to ensure that the selected pressure rating is suitable.

The maximum hydrostatic test pressure shown in the tables should be considered in relation to the test pressure of the system (see Appendix B).

The various types of flanges are not necessarily applicable to all temperature, pressure and size ranges. References are to be made to the appropriate clauses and tables for details.

2.2 INTERPOLATION OF INTERMEDIATE VALUES Where the temperature lies between tabulated values, the related pressure shall be obtained by linear interpolation between the adjacent figures.

TABLE 2.1
TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF CARBON
STEEL AND CARBON-MANGANESE STEEL

Flange Table	Pressure, kPa												Maximum allowable hydrostatic test pressure kPa
	Temperature, °C												
	−18 to 120	−50 to 232	250	275	300	325	350	375	400	425	450	475	
A	300	170*	—	—	—	—	—	—	—	—	—	—	525
D	—	700	650	600	570	550	500	450	400	350	—	—	1 050
E	—	1 400	1 300	1 200	1 100	1 000	950	900	800	700	—	—	2 100
F	—	2 100	2 000	1 800	1 700	1 600	1 400	1 300	1 200	1 000	—	—	3 150
H	—	3 500	3 300	3 100	2 900	2 600	2 400	2 200	2 000	1 700	1 300	900	5 250
J	—	4 800	4 600	4 300	4 000	3 700	3 400	3 100	2 700	2 400	1 900	1 300	7 200
K	—	6 200	5 900	5 500	5 100	4 700	4 300	3 900	3 500	3 100	2 400	1 600	9 300
R	—	8 300	7 900	7 400	6 800	6 300	5 800	5 200	4 700	4 200	3 200	2 200	12 450
S	—	12 400	11 800	11 100	10 300	9 500	8 700	7 900	7 100	6 300	4 800	3 300	18 600
T	—	19 300	18 400	17 200	16 000	14 700	13 500	12 200	11 000	9 800	7 500	5 100	28 950

* This rating applies to temperatures greater than 120°C but less than 232°C and does not apply to flange sizes greater than 900 nominal size.

TABLE 2.2
TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF LOW ALLOY STEEL

Flange Table	Pressure, kPa														Maximum allowable hydro- static test pressure kPa
	Temperature, °C														
	−100 to 232	250	275	300	325	350	375	400	425	450	475	482	500	525	
H	3 500	3 300	3 200	3 000	2 800	2 600	2 500	2 300	2 100	2 000	1 800	1 700	1 200	500	5 250
J	4 800	4 700	4 400	4 200	3 900	3 700	3 500	3 200	3 000	2 700	2 500	2 400	1 700	700	7 200
K	6 200	6 000	5 700	5 400	5 100	4 700	4 400	4 100	3 800	3 500	3 200	3 100	2 200	940	9 300
R	8 300	8 000	7 600	7 200	6 700	6 300	5 900	5 500	5 100	4 700	4 300	4 100	3 000	1 300	12 450
S	12 400	12 000	11 400	10 700	10 100	9 500	8 900	8 300	7 600	7 000	6 400	6 200	4 400	1 900	18 600
T	19 300	18 600	17 600	16 700	15 700	14 800	13 800	12 800	11 900	10 900	9 900	9 700	6 900	3 000	28 950

TABLE 2.3
**TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF
STAINLESS STEEL TYPES 304, 316, 321, 347 AND 348**

Flange Table	Pressure, kPa														Maximum allowable hydrostatic test pressure kPa
	Temperature, °C														
	−200 to 50	100	150	200	250	275	300	325	350	375	400	425	450	475	
D	700	700	700	650	650	600	570	550	500	450	400	350	—	—	1 430
E	1 400	1 400	1 400	1 300	1 300	1 200	1 100	1 000	950	900	800	700	—	—	2 850
F	2 100	2 100	2 100	2 000	1 900	1 800	1 700	1 600	1 400	1 300	1 200	1 000	—	—	4 350
H	3 500	3 500	3 500	3 300	3 200	3 100	2 900	2 600	2 400	2 200	2 000	1 700	1 300	900	7 200

TABLE 2.4
**TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF
STAINLESS STEEL TYPES 304L AND 316L**

Flange Table	Pressure, kPa														Maximum allowable hydrostatic test pressure kPa
	Temperature, °C														
	−200 to 50	100	150	200	250	275	300	325	350	375	400	425	450	475	
D	700	700	650	600	550	550	550	550	500	450	400	350	—	—	1 200
E	1 400	1 400	1 300	1 200	1 100	1 100	1 100	1 000	950	900	800	700	—	—	2 400
F	2 100	2 100	1 900	1 800	1 700	1 600	1 600	1 600	1 400	1 300	1 200	1 000	—	—	3 750
H	3 500	3 500	3 200	2 900	2 800	2 800	2 800	2 600	2 400	2 200	2 000	1 700	1 300	900	6 150

TABLE 2.5
TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF
STAINLESS STEEL TYPES 309 AND 310

Flange Table	Pressure, kPa														Maximum allowable hydrostatic test pressure kPa
	Temperature, °C														
	−200 to 50	100	150	200	250	275	300	325	350	375	400	425	450	475	
D	700	700	700	700	650	600	570	550	500	450	400	350	—	—	1 350
E	1 400	1 400	1 400	1 400	1 300	1 200	1 100	1 000	950	900	800	700	—	—	2 700
F	2 100	2 100	2 400	2 100	2 000	1 800	1 700	1 600	1 400	1 300	1 200	1 000	—	—	4 200
H	3 500	3 500	3 500	3 500	3 300	3 100	2 900	2 600	2 400	2 200	2 000	1 700	1 300	900	6 900

TABLE 2.6
TEMPERATURE/PRESSURE RATINGS FOR
FLANGES OF MALLEABLE IRON,
AND DUCTILE IRON

Flange Table	Pressure, kPa						Maximum allowable hydrostatic test pressure
	Temperature, °C						
	−18 to 120	150	175	190	200	220	kPa
A	350	290	230	200	190	170	700

TABLE 2.7
TEMPERATURE/PRESSURE RATINGS FOR
FLANGES OF GREY IRON

Flange Table	Pressure, kPa						Maximum allowable hydrostatic test pressure
	Temperature, °C						
	−18 to 120	150	175	190	200	220	kPa
A	350	290	230	200	190	170	700
D	700	510	440	390	370	340	1 400
E	400	1 200	1 000	850	800	650	2 800
F	2 100	1 800	1 500	1 400	1 300	1 000	4 200
H	3 500	2 800	2 300	2 000	1 800	1 200	7 000

TABLE 2.8
TEMPERATURE/PRESSURE RATINGS FOR
FLANGES OF DUCTILE IRON (SEE NOTE)

Flange Table								Maximum allowable hydrostatic test pressure
	Temperature, °C							
	−18 to 232	250	275	300	325	350	375	kPa
D	700	660	610	570	540	490	440	1 400
E	1 400	1 300	1 200	1 100	1 000	950	900	2 800
F	2 100	2 000	1 800	1 700	1 600	1 400	1 300	4 200
H	3 500	3 300	3 100	2 900	2 600	2 400	2 200	7 000

NOTE: For temperature/pressure rating of Table A ductile iron flanges, see Table 2.6.

TABLE 2.9
TEMPERATURE/PRESSURE RATINGS FOR
FLANGES OF COPPER ALLOY DN 15
TO DN 80 INCLUSIVE

Flange Table	Pressure, kPa							Maximum allowable hydrostatic test pressure
	Temperature, °C							
	−200 to 120	150	175	200	225	232	250	kPa
A	350	170	170	170	170	170	—	525
D	700	650	650	570	500	450	400	1 050
E	1 400	1 400	1 400	1 200	1 000	900	750	2 100
F	2 100	2 100	2 100	1 800	1 400	1 350	1 200	3 150
H	3 500	3 500	3 500	2 900	2 400	2 300	1 900	5 250
J	3 800	3 600	3 600	3 100	2 800	2 700	2 500	5 700
K	4 800	4 600	4 600	4 000	3 600	3 500	3 200	7 200

TABLE 2.10
TEMPERATURE/PRESSURE RATINGS FOR FLANGES OF
COPPER ALLOY DN 90 AND LARGER

Flange Table	Pressure, kPa									Maximum allowable hydrostatic test pressure
	Temperature, °C									
	−200 to 120			150	175	200	225	232	250	
	Nominal size									
	DN 90 to DN 200	DN 250 to DN 600	DN 650 to DN 1200	DN 90 to DN 200						kPa
A	350	350	—	170	170	170	170	170	—	525
D	700	700	—	650	600	550	500	450	400	1 050
E	1 200	1 200	—	1 100	1 100	950	850	800	750	1 800
F	1 700	1 700	—	1 700	1 500	1 400	1 200	1 250	1 100	2 550
H	2 800	2 800	—	2 600	2 400	2 200	2 000	1 900	1 800	4 200
J	3 800	—	—	3 600	3 400	3 100	2 800	2 700	2 500	5 700
K	4 800	—	—	4 600	4 300	3 900	3 600	3 500	3 200	7 200

SECTION 3 MATERIALS

3.1 SELECTION OF MATERIALS Materials shall be appropriate to the method of manufacture and shall be selected according to the temperature, pressure and service conditions of the flange.

3.2 MATERIALS FOR FLANGES Materials for flanges shall comply with the appropriate standard and grade shown in Tables 3.1 to 3.5, and shall be sound and free from injurious segregation, laminations, cracks or surface flaws.

NOTE: Materials for bolts are given in Appendix A.

3.3 LIMITATIONS ON THE USE OF PARTICULAR MATERIALS

3.3.1 Limitations based on temperature Specific materials and grades shall be used within the temperature ranges shown in Tables 3.1 to 3.5.

3.3.2 Limitations based on pressure Specific materials and grades shown in Tables 3.1 to 3.5 shall be used at pressures which are appropriate for the temperatures, and shall not exceed those shown in Tables 2.1 to 2.10.

3.3.3 Limitations based on service Specific materials and grades shown in Tables 3.1 to 3.5 shall be used within the limitations specified in Clause 1.7 and those in the appropriate application Standard.

3.4 ALTERNATIVE MATERIAL SPECIFICATIONS Where a material conforming to one of the specifications listed in Clause 3.2 is not available or an alternative is desired, alternative materials may be used provided they comply with the requirements of AS/NZS 1200 for new or alternative materials.

TABLE 3.1
CARBON STEEL, CARBON-MANGANESE STEEL AND LOW ALLOY STEEL FOR FLANGES FOR
TEMPERATURES BETWEEN -100°C AND 525°C

Flange Table		Material standard and grade						
		Temperature range, °C						
		-100 to -18*	-50 to -18*	-30 to -18*	-18 to 400	-18 to 482	-18 to 525	
A D E F H J	Plates BS/EN 10028.4:503 LT100	AS 1548	7-430 L40 7-460 L40 7-490 L40	AS 1548: 7-430 L20, 7-460 L20, 7-490 L20	AS/NZS 3678: -200, -250, -300, -350 -400	AS 1548: 7-430, 7-460, 7-490	—	
		BS/EN 10028.3: P275 NL2			BS/EN 10028.2: P235 GH, P265 GH,			
		Castings ASTM A352LC3	AS 2074: ASTM A352: BS EN 10213	L3A LCB	—	AS 2074: C3 BS EN 10213		AS 2074: L5A
K R S T	Forgings BS 1503: 503-490 LT80 ASTM A350LF3		BS 1503: 223-410 LT50, -430 LT40, 224-410 LT50, -430 LT40,	BS 1503: 223-410 LT20, -460 LT20	—	BS 1503: 221-430, -460, -490 ASTM A105	—	
		Plates BS/EN 10028.4:503 LT100	AS 1548: BS/EN 10028.3: P275 NL2	7-430 L40, 7-460 L40, 7-490 L40	AS 1548: 7-430 L20, 7-460 L20, 7-490 L20	BS/EN 10028.2: P235 GH, P265 GH		AS 1548: 7-430, 7-460, 7-490
		Castings BS EN 10213.3: G9Ni 14I ASTM A352: LC3	AS 2074: BS EN 10213.3 G9Ni 14I ASTM A352: LCB	L3A G9Ni 14I	ASTM A352: LCA	AS 2074: C3		AS 2074: L5A ASTM A216 WCA
	Forgings BS 1503:503-490 LT80 ASTM A350: LF3	BS 1503: ASTM A350: LF2	224-410 LT50 LCB	BS 1503: 224-430 LT40 ASTM A350: LF1	BS 1503: 221-430, 221-460, 221-490	BS 1503: 221-430, 221-460, 221-490 ASTM A182: F1	—	

(continued)

TABLE 3.1 (continued)

Flange Table		Material standard and grade					
		Temperature range, °C					
		—100 to —18*	—50 to —18*	—30 to —18*	—18 to 400	—18 to 482	—18 to 525
H J K R S T	Plates	—	—	—	—	—	BS/EN 10028-4: 620 ASTM A387: 9, 11, 12
	Casting	—	—	—	—	—	AS 2074: L5B ASTM A216: WCB, WCC
	Forgings	—	—	—	—	—	BS 1503: 620-440 ASTM A182: F11, F12

* Materials nominated in these temperature ranges may be used to higher temperatures within the scope of the material standards.

TABLE 3.2
STAINLESS STEEL FLANGES FOR TEMPERATURES BETWEEN
−200°C AND 475°C

Flange Table	Material standard and grade	
	Temperature range, °C	
	−200 to 425	−200 to 475
D E F	Plates ASTM A240: 304, 304L, 309S, 310S, 316, 316L, 321, 347, 348	—
	Forgings ASTM A182: F304, F304L, F310, F316, F316L, F321, F347, F348	—
	Castings ASTM A351: CF3, CF3M, CF8M, CF8C, CH8, CH20, CK20	—
H	Plates —	ASTM A240: 304, 304L, 309, 310, 316, 316L, 321, 347, 348
	Forgings —	ASTM A182: F304, F304L, F310, F316, F316L, F321, F347, F348
	Castings —	ASTM A351: CF3, CF3M, CF8M, CF8C, CH8, CH20, CK20

TABLE 3.3
GREY IRON AND MALLEABLE IRON
FOR FLANGES FOR TEMPERATURE
BETWEEN −18°C AND 220°C

Flange Table	Material standard and grade
	Temperature range, °C
	−18 to 220
A	AS 1830: T-180, T-220, T-260
	AS 1832: W400-5, W350-4, B350-10, B300-6
	BS/EN 1561: −200, −250
D E F H	AS 1830: T-180, T-220, T-260
	BS/EN 1561: −200, −250

TABLE 3.4
DUCTILE IRON FLANGES FOR TEMPERATURES
BETWEEN −18°C AND 375°C

Flange Table	Material standard and grade	
	Temperature range, °C	
	−18 to 232	Over 232 to 375
A D E F H	AS 1831: 500-7, 400-12, 370-17	AS 1831: 370-17

TABLE 3.5
COPPER ALLOY FOR FLANGES FOR TEMPERATURES
BETWEEN −200°C AND 250°C

Flange Table	Material standard and grade
	Temperature range, −200°C to 250°C
A D E F H J K	AS 1565: C83600, C83700, C92610, C92410

SECTION 4 MANUFACTURING REQUIREMENTS AND DIMENSIONS

4.1 MANUFACTURING METHODS Flanges may be produced from—

- (a) one piece of material without welding except for repairs permitted by the material standard; or
- (b) by ring rolling, or segments of plate or bar welded with a full penetration weld(s) made in accordance with a pressure vessel standard and with the purchaser's agreement.

Where welding neck flanges are forged, the direction of the grain flow in the material in the neck shall be parallel to the longitudinal axis and, in the face, perpendicular to the longitudinal axis of the flange.

4.2 FLANGE DIMENSIONS

4.2.1 General The dimensions of flanges shall be as given in Section 6. For guidance on tolerances not specified in this Standard, refer to the AS/NZS 4331 series.

4.2.2 Tolerance on flange thickness The actual flange thickness shall be not less than:

- (a) For grey iron, malleable iron, ductile iron $0.95T + 0.75$ mm.
- (b) For all other material $T - 0.5$ mm.

NOTE: To achieve the surface requirements of Clause 4.3.2, it may be necessary to machine the contact surface after the flange has been welded or brazed to the pipe, valve or fitting. Such cases may necessitate a machining allowance in the original thickness.

4.2.3 Dimensions of O-ring grooves The dimensions for the O-ring groove, shall be as specified in the flange Tables of Section 6.

4.2.4 Height of raised face The height of a raised face shall be 1.6 mm.

4.3 FLANGE FACES

4.3.1 General Flanges shall be manufactured with a flat face, raised face, or flat face with an O-ring groove, as limited by the flange table, the flange material and the type of flange as shown in Table 4.1.

4.3.2 Contact surface for flange faces

4.3.2.1 General The contact surface for flange faces shall be machined or otherwise finished so that the flatness and squareness to the axis and the surface finish are appropriate to the type of gasket.

4.3.2.2 Surface finish Where turning (see Note) is used to generate either a spiral groove or concentric grooves, the tool shall be round-nosed and have a radius of approximately 1.5 mm.

The approximate dimensions of the groove shall be as follows:

- (a) Pitch 0.8 mm.
- (b) Depth 0.05 mm.

The contact surface produced by turning shall be not rougher than R_a 12.5 μm , nor smoother than R_a 3.2 μm , in accordance with AS 2536.

NOTE: The term 'turning' includes any method of machine operation which produces either spiral or concentric grooves.

The contact surface produced by means other than turning shall be not rougher than R_a 6.3 μm , nor smoother than R_a 3.2 μm , in accordance with AS 2536.

TABLE 4.1
LIMITATIONS ON FLANGE FACE TYPE AND MATERIAL

Flange Table	Flange face		
	Flange material		
	Carbon steel, carbon-manganese steel, low alloy steel and stainless steel		Malleable iron, grey iron, ductile iron and copper alloy
	Type of flange		
	Integral	Blank, plate, boss and welding neck	
A D } E F H }	{ Flat* Raised†	{ Flat* Raised† Flat with O-ring	Flat‡
J K	Raised	{ Flat† Raised Flat with O-ring	Flat‡
R S T	Raised	Raised	—

* Flat face gaskets are not suitable for all installations (see Appendix B).

† Non-preferred flange face.

‡ To be mated only to a flat face flange or flat face with O-ring (see Appendix B).

4.3.3 Contact surface for O-rings In addition to the surface finish required for the contact surface of the flange face, the surface of the O-ring groove and the annulus on the mating flange which makes contact with the O-ring shall be not rougher than $R_a 0.8 \mu\text{m}$, in accordance with AS 2536.

4.3.4 Determination of contact surface roughness The roughness of the contact surface should be determined by visual and tactile means using appropriate surface roughness comparison specimens as specified in AS 2382. Measurement by instruments is not required.

4.4 PREPARATION FOR ATTACHMENT OF FLANGES

4.4.1 General Flanges specified in this Standard are rated on the basis of pipe outside diameters as shown in Appendix D. Other pipe diameters may be used if justified by suitable analysis and as agreed between the parties concerned.

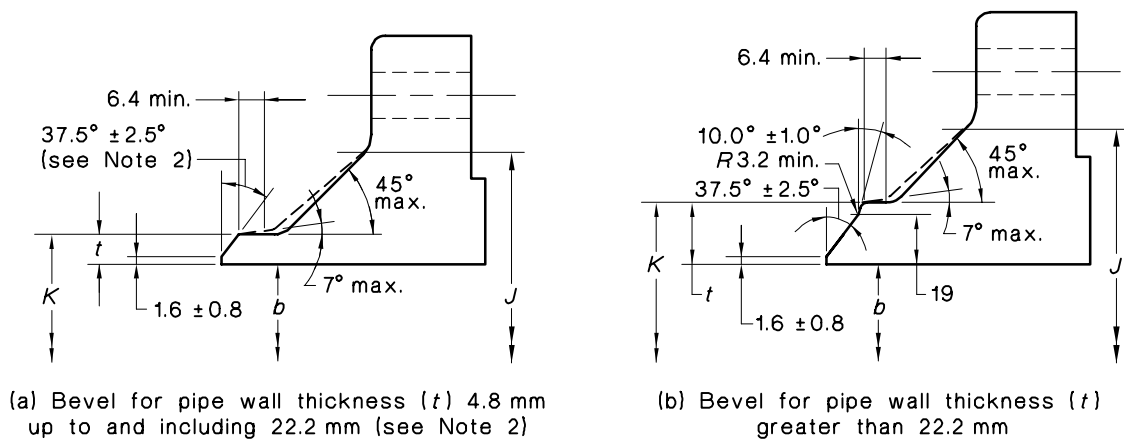
4.4.2 Welding-neck flanges

4.4.2.1 Bore Welding-neck flanges shall be machined in the bore to match the internal diameter of the pressure-retaining component.

4.4.2.2 Weld preparation The weld preparation for welding neck-flanges shall be appropriate to the wall thickness, t , of the pressure-retaining component and shall be as shown in Figure 4.1.

4.4.2.3 Dimensional tolerances Dimensional tolerances for welding-neck flanges shall be as follows:

- (a) *On the overall length (dimension $L + T$):*
 - (i) Nominal sizes less than or equal to DN 250 $\pm 2 \text{ mm}$.
 - (ii) Nominal sizes greater than DN 250 $\pm 3 \text{ mm}$.
- (b) *On the outside diameter of the welding end (dimension K):*
 - (i) Nominal sizes less than or equal to DN 125 $+3, -1 \text{ mm}$.
 - (ii) Nominal sizes greater than DN 125 $+4, -1 \text{ mm}$.



(a) Bevel for pipe wall thickness (t) 4.8 mm up to and including 22.2 mm (see Note 2)

(b) Bevel for pipe wall thickness (t) greater than 22.2 mm

LEGEND:

- K = diameter at small end of neck (nominal outside diameter of pipe)
- b = nominal inside diameter of pipe
- t = nominal wall thickness of pipe
- J = diameter at large end of neck

NOTES:

- 1 These drawings are to be read in conjunction with Clause 4.4.2.3 and the appropriate table of flange dimensions.
- 2 For flanges connecting with ferritic steel pipe of nominal wall thickness less than 4.8, the welding ends should be finished to a slight chamfer or be square, at the option of the manufacturer.
- 3 For flanges connecting with austenitic stainless steel pipe of nominal wall thickness 3.2 or less, the welding ends shall be finished to a slight chamfer.
- 4 Where flanges are intended for service with light-wall high-strength pipe, the thickness of the hub at the bevel may be greater than that of the pipe to which the flange is joined. Under these conditions, a single taper hub may be provided and the diameter at the large end of the neck (dimension J) may be modified.

DIMENSIONS IN MILLIMETRES

FIGURE 4.1 DETAILS OF WELDING ENDS OF WELDING-NECK FLANGES

4.4.3 Boss flanges

4.4.3.1 Boss flanges for threading Threads shall extend to the flange face and shall be normal to the flange face within $\pm 0.3^\circ$.

To facilitate engagement of the threaded joint and to protect the threads, the lead-in at the back of the flange shall be chamfered to an angle of approximately 45° .

The thread form and thread type for boss flanges are not specified in this Standard.

4.4.3.2 Boss flanges for welding Boss flanges manufactured from copper alloy and of nominal sizes up to and including DN 600, and from carbon steel, carbon-manganese steel, alloy steel and stainless steel and of nominal sizes up to and including DN 300, that are to be welded, shall be machined in the bore to have a clearance fit on the pipe, fitting or pressure-containing component.

The maximum radial clearance shall be 2 mm and the maximum diametral clearance shall be 4 mm.

The weld preparation shall comply with the type specified in the appropriate application Standard.

4.4.3.3 Boss flanges for brazing Boss flanges manufactured from copper alloy, that are to be brazed, shall be machined in the bore to have a clearance fit on the pipe fitting or pressure-containing component.

The clearance shall be appropriate to the brazing process, parent material and the filler metal to be used, but the maximum radial clearance should not exceed 0.1 mm.

4.4.4 Plate flanges

4.4.4.1 Plate flanges for welding Plate flanges that are to be welded, shall have a clearance fit on the pipe, fitting or pressure-containing component.

The maximum radial clearance shall be 2 mm, and the maximum diametral clearance shall be 4 mm.

The weld preparation shall comply with the type specified in the appropriate application Standard.

4.4.4.2 Plate flanges for brazing Plate flanges manufactured from copper alloy that are to be brazed shall be machined in the bore to have a clearance fit on the pipe, fitting or pressure-containing component.

The clearance shall be appropriate to the brazing process, parent material and the filler metal to be used, but the maximum radial clearance should not exceed 0.1 mm.

4.5 BOLT HOLES

4.5.1 Position and size The pitch circle diameter (dimension P) and the bolt hole diameter (dimension V) shall be as specified in the appropriate flange table.

Bolt holes shall be spaced equally on the pitch circle circumference and, for integral flanges, the bolt holes shall be spaced equally off the centreline of the component of which it forms part and shall be parallel to the axis of the flange.

The tolerance on the pitch circle diameter shall be—

- (a) on flanges up to and including 500 DN ± 0.75 mm
- (b) on flanges above 500 DN ± 1.0 mm

The tolerance on the centre-to-centre distance of adjacent bolt holes shall be—

- (i) on flanges up to and including 500 DN ± 0.5 mm
- (ii) on flanges above 500 DN ± 0.75 mm

4.5.2 Method Bolt holes shall be drilled or cored.

4.6 SPOT-FACING AND BACK-FACING OF FLANGES

4.6.1 Parallelism of bearing surfaces The bearing surfaces on the flange for the heads of bolts and for nuts shall be parallel to the flange face with a tolerance of 1.2° .

4.6.2 Diameter of spot-facing The diameter of spot-facing shall be not less than the dimension across the corners of the appropriate nut plus 3 mm. Where spot-facing cuts into the fillet of a flange, the diameter shall not exceed the dimension across the corners of the nut by more than 5 mm.

4.6.3 Back-facing Where a flange is back-faced, the fillet may be reduced but shall not be eliminated entirely. A sharp corner at the junction of a flange and its hub shall be avoided.

4.6.4 Thickness of flanges after spot-facing or back-facing The thickness of a flange (see Clause 1.5.3), after spot-facing or back-facing, shall be as shown for dimension T in the appropriate flange Table, subject to the tolerance allowed by Clause 4.2.2.

SECTION 5 MARKING AND MATERIAL CERTIFICATES

5.1 MARKING

5.1.1 General Flanges (other than integral flanges) shall be permanently and legibly marked—

- (a) on the rim; or
- (b) on the back of the flange between the rim and the pitch circle diameter.

Integral flanges need not be marked in accordance with this Standard if the product Standard specifies information to be marked on the product.

Where the marking is indented, low-stress (e.g. round-nosed) stamps shall be used.

5.1.2 Size The height of lettering shall be not less than 3 mm for flanges less than 10 mm thickness, or 5 mm for other flanges.

5.1.3 Information The following information shall be marked:

- (a) The flange designation comprising the number of this Standard, the nominal size (DN) and the flange Table, e.g. AS 2129/DN 400/E.
- (b) Indication of the material standard and grade from which it is made, e.g. AS 1548-7-430 (see Section 3).
- (c) Manufacturer's name or trademark.
- (d) Identification marking correlating the material test certificate of the flange with the certificate of analysis of the material (see Clause 5.2).

5.2 MATERIAL CERTIFICATES Material test certificates complying with DIN 50049 shall be supplied with flanges (other than integral flanges) that fall within the following categories:

- (a) Low alloy steel and stainless steel flanges.
- (b) Carbon steel or carbon-manganese steel flanges to Tables J, K, R, S and T.
- (c) Carbon steel or carbon-manganese steel flanges greater than DN 200, for use with boilers, pressure vessels or associated pressure piping.

The certificate shall be dated and identified with the information specified in Clause 5.1.3.

S E C T I O N 6 D I M E N S I O N S O F F L A N G E S

This Section gives the dimensions of flanges and their bolts for flange Tables A, D, E, F, H, J, K, R, S and T for different—

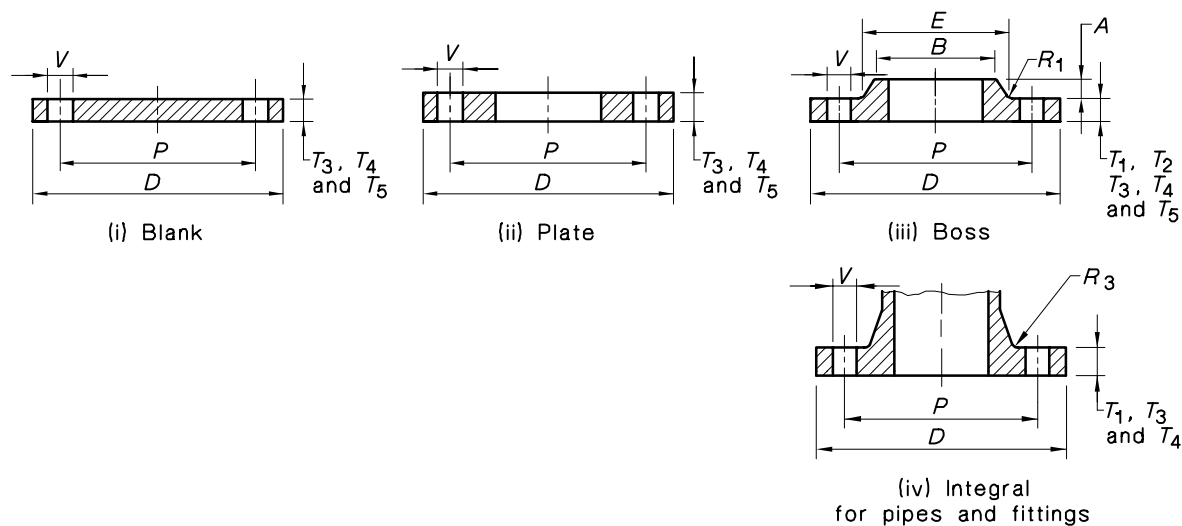
- (a) types (see Clause 1.6.2);
- (b) flanges faces (see Clause 1.6.3); and
- (c) materials (see Section 3).

In these Tables, the word ‘steel’ (if not otherwise qualified) includes—

- (i) cast, forged and plate; and
- (ii) carbon steel, carbon-manganese steel, low alloy steel and stainless steel.

NOTE: Tables R, S and T flanges are obsolescent (see Clause 1.1).

TABLE A—



(a) Alternative flange types (Figures (i) to (iv))

NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

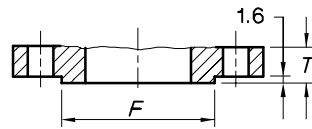
Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face†	Bolting details			
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*
DN	D	S	F	P	N	V	O
15	95	—	47	67	4	14	M12
20	100	—	53	73	4	14	M12
25	115	—	63	83	4	14	M12
32	120	—	67	87	4	14	M12
40	135	—	78	98	4	14	M12
50	150	—	90	114	4	18	M16
65	165	—	103	127	4	18	M16
80	185	—	122	146	4	18	M16
(90)	205	—	141	165	4	18	M16
100	215	—	154	178	4	18	M16
125	255	—	186	210	4	18	M16
150	280	—	211	235	4	18	M16
200	335	—	268	292	8	18	M16
250	405	—	328	356	8	22	M20
300	455	370	378	406	8	22	M20
350	525	430	438	470	8	26	M24
400	580	485	489	521	12	26	M24
450	640	545	552	584	12	26	M24
500	705	605	609	641	12	26	M24
(550)	760	655	663	699	12	30	M27
600	825	715	720	756	12	30	M27
(650)	845	740	745	781	16	30	M27
700	870	765	770	806	16	30	M27
(750)	945	840	847	883	20	30	M27
800	1 005	900	904	940	20	30	M27
(850)	1 030	925	929	965	20	30	M27
900	1 105	1 000	1 005	1 041	24	30	M27
1 000	1 180	1 075	1 082	1 118	24	30	M27
1 200	1 415	1 310	1 317	1 353	28	30	M27
1 400	1 700	1 565	1 573	1 615	32	36	M33
1 600	1 910	1 775	1 783	1 825	32	36	M33
1 800	2 110	1 970	1 974	2 019	36	39	M36

() Non-preferred size.

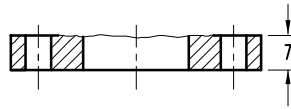
* For inch series, see Paragraph A5 of Appendix A.

† Non-preferred, see Table 4.1.

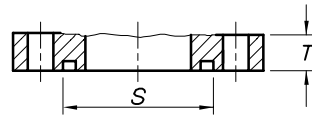
DIMENSIONS OF FLANGES



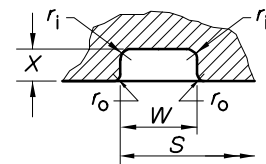
(v) Raised



(vi) Flat



(vii) Flat with O-ring groove

O-ring groove details
(For Figure (vii))

LEGEND:

 $X = 6.0 \pm 0.15$ $W = 9.40 \pm 0.15$ $r_o = 0.13 \text{ to } 0.25$ $r_i = 0.51 \text{ to } 0.76$ For details of surface
finish, see Clause 4.3.3

RADII DETAILS
(For Figures (iii) and (iv))
 $R_1 = 1.6$ for DN 15 to DN 90
 $= 3.5$ for DN 100 to DN 200
 $= 5.0$ for DN 250 to DN 300
 $R_3 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90

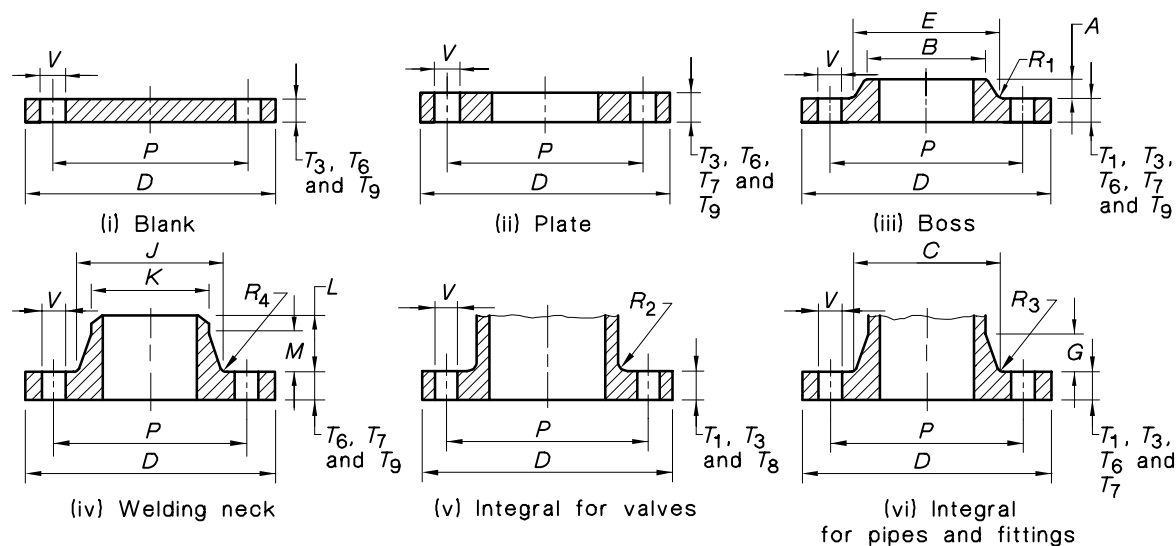
(b) Alternative flange faces (Figures (v) to (vii))
 For limitations on flange faces, see Table 4.1

Dimension of boss			Thickness of flange					millimetres
Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss	Grey or ductile iron; boss or integral for pipes and fittings	Malleable iron; boss	Copper alloy; blank, plate, boss or integral for pipes and fittings	Steel; blank, plate, boss or integral for pipes and fittings	Steel; blank, plate or boss, with O-ring groove	Nominal size
A	B	E	T_1	T_2	T_3	T_4	T_5	DN
10	33	38	13	5	6	5 $\frac{1}{2}$	—	15
11	38	44	13	5	6	5 $\frac{1}{2}$	—	20
11	48	52	13	5	8	5 $\frac{1}{2}$	—	25
11	56	58	16	6	8	6 $\frac{1}{2}$	—	32
13	62	70	16	6	10	6 $\frac{1}{2}$	—	40
13	75	79	16	8	10	8 $\frac{1}{2}$	—	50
16	90	93	17	8	11	8 $\frac{1}{2}$	—	65
16	106	112	17	10	13	10 $\frac{1}{2}$	—	80
17	119	130	19	10	14	10 $\frac{1}{2}$	—	(90)
19	133	140	19	10	16	10 $\frac{1}{2}$	—	100
19	160	171	19	13	17	13	—	125
19	186	197	21	13	17	13	—	150
22	241	254	22	—	19	13	—	200
27	298	310	24	—	19	16	—	250
29	349	360	24	—	22	19	25	300
—	—	—	25	—	25	22	28	350
—	—	—	27	—	25	22	28	400
—	—	—	27	—	27	22	28	450
—	—	—	29	—	29	25	31	500
—	—	—	30	—	30	25	31	(550)
—	—	—	30	—	30	25	31	600
—	—	—	32	—	—	25	31	(650)
—	—	—	32	—	—	25	31	700
—	—	—	32	—	—	25	31	(750)
—	—	—	32	—	—	25	31	800
—	—	—	32	—	—	29	35	(850)
—	—	—	35	—	—	29	35	900
—	—	—	35	—	—	29	35	1 000
—	—	—	38	—	—	32	38	1 200
—	—	—	44	—	—	35	41	1 400
—	—	—	48	—	—	38	44	1 600
—	—	—	60	—	—	44	50	1 800

‡ Plate flanges less than 12.0 mm thickness may suffer unacceptable distortion after welding to the pipe.

() Non-preferred size.

TABLE D—



(a) Alternative flange types (Figures (i) to (vi))

NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

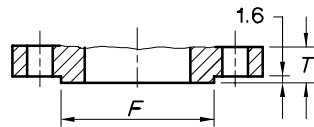
Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face†	Bolting details				Dimensions of boss			Dimensions of neck for grey or ductile iron integral flange for pipes, valves and fittings	
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss	Maximum diameter at large end of neck	Minimum length of taper
DN	D	S	F	P	N	V	O	A	B	E	C	G
15	95	—	47	67	4	14	M12	10	33	38	—	—
20	100	—	53	73	4	14	M12	11	38	44	—	—
25	115	—	65	83	4	14	M12	11	48	52	—	—
32	120	—	67	87	4	14	M12	11	56	58	—	—
40	135	—	78	98	4	14	M12	13	62	70	—	—
50	150	—	90	114	4	18	M16	13	75	79	—	—
65	165	—	103	127	4	18	M16	16	90	93	—	—
80	185	—	122	146	4	18	M16	16	106	112	103	32
(90)	205	—	141	165	4	18	M16	17	119	130	—	—
100	215	—	154	178	4	18	M16	19	133	140	135	32
125	255	—	186	210	8	18	M16	19	160	171	—	—
150	280	—	211	235	8	18	M16	19	186	197	192	36
200	335	—	268	292	8	18	M16	22	241	254	258	42
250	405	—	328	356	8	22	M20	27	298	310	306	39
300	455	370	378	406	12	22	M20	29	349	360	—	—
350	525	430	438	470	12	26	M24	—	—	—	—	—
400	580	485	489	521	12	26	M24	—	—	—	—	—
450	640	545	532	584	12	26	M24	—	—	—	526	57
500	705	605	609	641	16	26	M24	—	—	—	576	57
(550)	760	655	637	699	16	30	M27	—	—	—	—	—
600	825	715	720	756	16	30	M27	—	—	—	685	71
700	910	805	809	845	20	30	M27	—	—	—	—	—
(750)	995	880	888	927	20	33	M30	—	—	—	850	72
800	1 060	935	942	984	20	36	M33	—	—	—	—	—
(850)	1 090	970	974	1 016	20	36	M33	—	—	—	—	—
900	1 175	1 045	1 050	1 092	24	36	M33	—	—	—	—	—
1 000	1 255	1 125	1 133	1 175	24	36	M33	—	—	—	—	—
1 200	1 490	1 360	1 368	1 410	32	36	M33	—	—	—	—	—
1 400	1 700	1 565	1 573	1 615	36	36	M33	—	—	—	—	—
1 600	1 910	1 775	1 780	1 825	40	39	M36	—	—	—	—	—
1 800	2 110	1 965	1 971	2 019	44	42	M39	—	—	—	—	—
2 000	2 345	2 195	2 202	2 250	44	42	M39	—	—	—	—	—
2 200	2 560	2 400	2 406	2 460	44	48	M45	—	—	—	—	—
2 400	2 775	2 615	2 619	2 673	52	48	M45	—	—	—	—	—
2 800	3 200	3 030	3 036	3 090	56	48	M45	—	—	—	—	—
3 000	3 430	3 250	3 254	3 315	60	55	M52	—	—	—	—	—

() Non-preferred size.

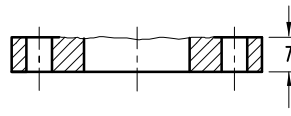
* For inch series, see Paragraph A5 of Appendix A.

† Non-preferred, see Table 4.1.

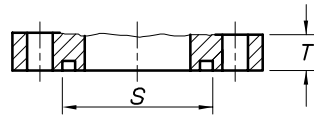
DIMENSIONS OF FLANGES



(vii) Raised



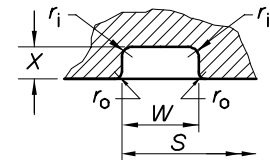
(viii) Flat



(ix) Flat with O-ring groove

RADII DETAILS
(For Figures (iii) to (vi))

- $R_1 = 1.6$ for DN 15 to DN 90
 $= 3.5$ for DN 100 to DN 200
 $= 5.0$ for DN 250 to DN 300
 $R_2 = 3.5$ for DN 15 to DN 40
 $= 6.5$ for DN 50 to DN 450
 $= 10.0$ for over DN 450
 $R_3 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90
 $R_4 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90



O-ring groove details
(For Figure (ix))

LEGEND:

$X = 6.0 \pm 0.15$

$W = 9.40 \pm 0.15$

$r_o = 0.13$ to 0.25

$r_i = 0.51$ to 0.76

For details of surface finish, see Clause 4.3.3

(b) Alternative flange faces (Figures (vii) to (ix))

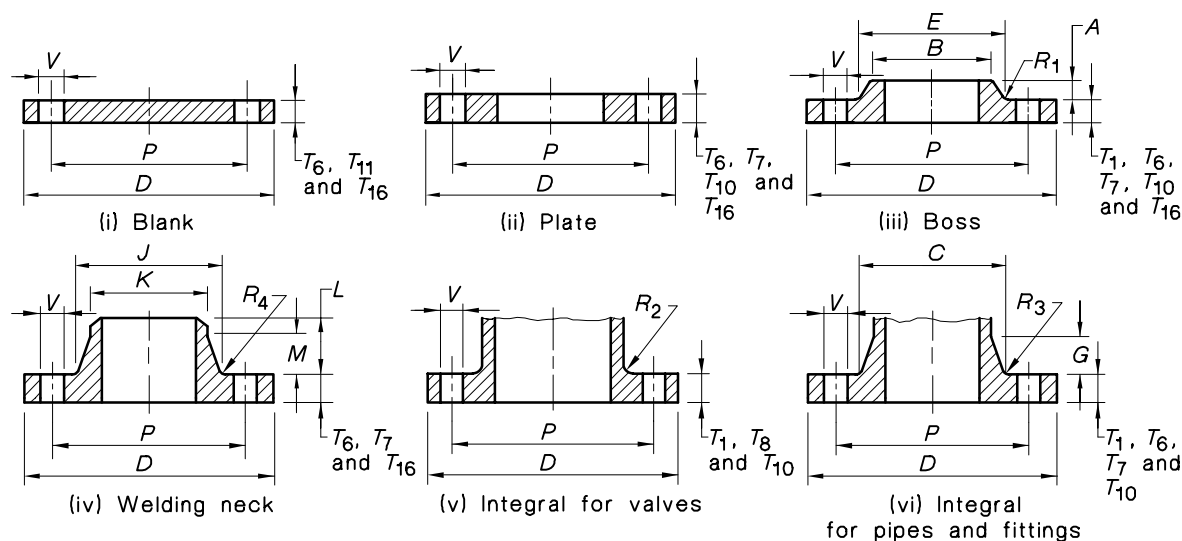
For limitations on flange faces, see Table 4.1

millimetres										
Dimensions of welding neck				Thickness of flange						Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Grey or ductile iron; boss or integral for pipes, valves and fittings	Copper alloy; blank, plate, boss or integral for pipes, valves and fittings	Forged or plate steel; blank, plate, boss, welding neck or integral for pipes, and fittings	Cast steel; plate, boss, welding neck or integral for pipes, and fittings	Cast or forged steel; integral for valves	Steel; blank, plate, boss or; welding neck, with O-ring groove	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T</i> ₁	<i>T</i> ₃	<i>T</i> ₆	<i>T</i> ₇	<i>T</i> ₈	<i>T</i> ₉	
27	22	22	16	13	6	5†	10‡	10	—	15
33	27	22	16	13	6	5†	10‡	10	—	20
43	34	22	16	13	8	5†	10‡	10	—	25
49	43	25	16	16	8	6†	13	13	—	32
59	49	29	19	16	10	6†	13	13	—	40
70	61	29	19	17	10	8†	14	14	—	50
83	76	32	22	17	11	8†	14	14	—	65
102	89	35	25	19	13	10†	14	14	—	80
114	102	35	25	19	14	10†	14	14	—	(90)
130	115	41	32	19	16	10†	17	17	—	100
152	142	44	32	21	17	13	17	17	—	125
184	169	48	32	21	17	13	17	17	—	150
241	220	51	35	22	19	13	19	19	—	200
292	274	64	44	25	19	16	19	19	—	250
343	324	70	51	25	22	19	22	22	25	300
387	356	73	54	29	25	22	25	25	28	350
—	—	—	—	29	25	22	25	25	28	400
—	—	—	—	32	29	25	29	29	31	450
—	—	—	—	32	32	29	32	32	35	500
—	—	—	—	35	32	29	32	32	35	(550)
—	—	—	—	35	35	32	35	35	38	600
—	—	—	—	38	—	35	38	38	41	700
—	—	—	—	41	—	41	41	41	47	(750)
—	—	—	—	41	—	41	41	41	47	800
—	—	—	—	41	—	44	44	41	50	(850)
—	—	—	—	44	—	48	48	44	54	900
—	—	—	—	44	—	51	51	44	57	1 000
—	—	—	—	51	—	60	60	51	66	1 200
—	—	—	—	57	—	60	60	57	66	1 400
—	—	—	—	60	—	64	64	60	70	1 600
—	—	—	—	67	—	73	73	67	79	1 800
—	—	—	—	70	—	76	—	—	82	2 000
—	—	—	—	73	—	83	—	—	89	2 200
—	—	—	—	83	—	92	—	—	98	2 400
—	—	—	—	89	—	102	—	—	108	2 800
—	—	—	—	95	—	114	—	—	120	3 000

‡ Plate flanges less than 12 mm thickness may suffer unacceptable distortion after welding to the pipe.

() Non-preferred size.

TABLE E—



NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

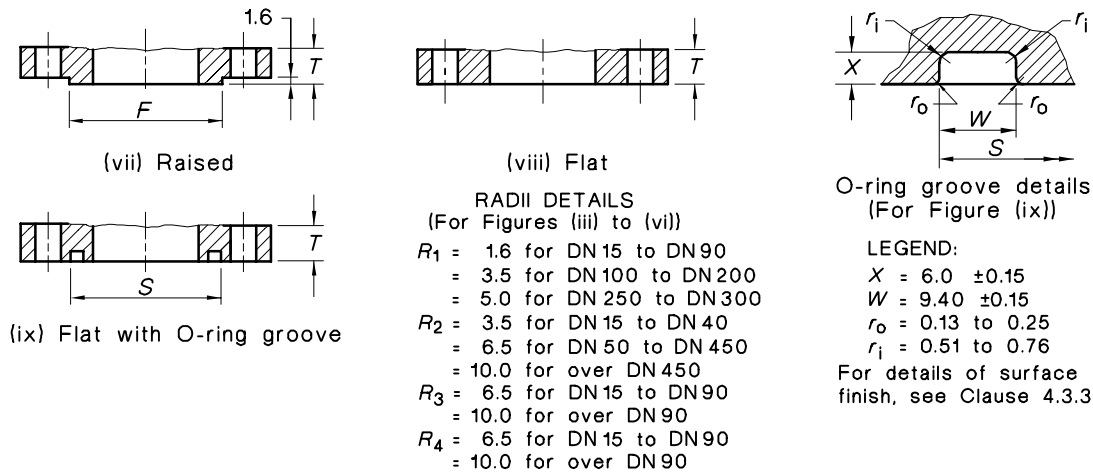
Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face†	Bolting details				Dimensions of boss			Dimensions of neck for grey or ductile iron; integral flange for pipes and fittings	
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss	Maximum diameter at large end of neck	Minimum length of taper
DN	D	S	F	P	N	V	O	A	B	E	C	G
15	95	—	47	67	4	14	M12	10	33	38	—	—
20	100	—	53	73	4	14	M12	11	38	44	—	—
25	115	—	63	83	4	14	M12	11	48	52	—	—
32	120	—	67	87	4	14	M12	11	56	58	—	—
40	135	—	78	98	4	14	M12	13	62	70	—	—
50	150	—	90	114	4	18	M16	13	75	79	—	—
65	165	—	103	127	4	18	M16	16	90	93	—	—
80	185	—	122	146	4	18	M16	16	106	112	103	32
(90)	205	—	141	165	8	18	M16	17	119	130	—	—
100	215	—	154	178	8	18	M16	19	133	140	—	—
125	255	—	186	210	8	18	M16	19	160	171	—	—
150	280	—	207	235	8	22	M20	19	186	191	185	29
200	335	—	264	292	8	22	M20	22	241	249	242	39
250	405	—	328	356	12	22	M20	27	298	310	306	39
300	455	370	374	406	12	26	M24	29	349	354	349	41
350	525	430	438	470	12	26	M24	—	—	—	—	—
400	580	485	489	521	12	26	M24	—	—	—	—	—
450	640	545	552	584	16	26	M24	—	—	—	527	54
500	705	605	609	641	16	26	M24	—	—	—	577	55
(550)	760	655	663	699	16	30	M27	—	—	—	—	—
600	825	710	717	756	16	33	M30	—	—	—	680	61
700	910	800	806	845	20	33	M30	—	—	—	—	—
(750)	995	880	885	927	20	36	M33	—	—	—	845	65
800	1 060	935	942	984	20	36	M33	—	—	—	—	—
(850)	1 090	970	974	1 016	20	36	M33	—	—	—	—	—
900	1 175	1 045	1 050	1 092	24	36	M33	—	—	—	—	—
1 000	1 255	1 125	1 130	1 175	24	39	M36	—	—	—	—	—
1 200	1 490	1 360	1 365	1 410	32	39	M36	—	—	—	—	—

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

† Non-preferred, see Table 4.1.

DIMENSIONS OF FLANGES



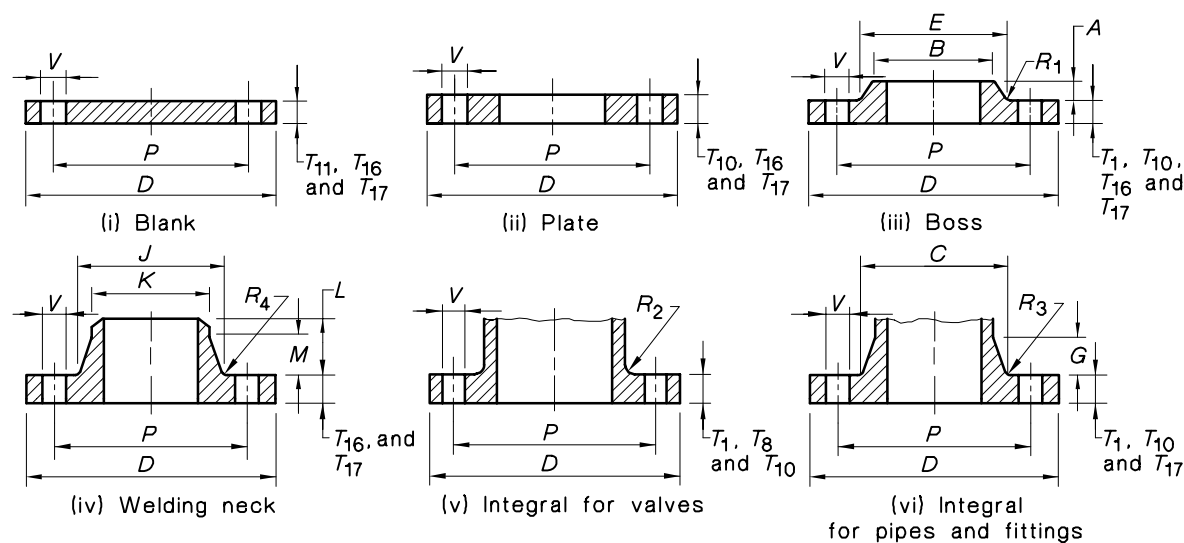
(b) Alternative flange faces (Figures (vii) to (ix))
 For limitations on flange faces, see Table 4.1

millimetres											
Dimensions of welding neck				Thickness of flange							Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Grey or ductile iron; boss or integral for pipes, valves and fittings	Copper alloy; plate, boss or integral for pipes, valves and fittings	Copper alloy; blank	Forged or plate steel; blank, plate, boss, welding neck or integral for pipes and fittings	Cast steel; plate, boss, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	Steel; blank, plate, boss or welding neck, with O-ring groove	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T₁</i>	<i>T₁₀</i>	<i>T₁₁</i>	<i>T₆</i>	<i>T₇</i>	<i>T₈</i>	<i>T₁₆</i>	DN
27	22	22	16	13	6	6	6 [‡]	10 [‡]	10	—	15
33	27	22	16	13	6	6	6 [‡]	10 [‡]	10	—	20
43	34	22	16	13	8	8	7 [‡]	10 [‡]	10	—	25
49	43	25	16	16	8	8	8 [‡]	13	13	—	32
59	49	29	19	16	10	10	9 [‡]	13	13	—	40
70	61	29	19	19	10	10	10 [‡]	14	14	—	50
83	76	32	22	19	11	11	10 [‡]	14	14	—	65
102	89	35	25	19	13	13	11 [‡]	14	14	—	80
114	102	35	25	19	14	14	12 [‡]	14	14	—	(90)
130	115	41	32	22	16	16	13	17	17	—	100
152	142	44	32	22	17	17	14	17	17	—	125
184	169	48	32	22	17	17	17	17	17	—	150
241	220	51	35	25	19	20	19	19	19	—	200
292	274	64	44	25	22	25	22	22	22	—	250
343	324	70	51	29	25	28	25	25	25	31	300
387	356	73	54	32	25	32	29	29	25	35	350
—	—	—	—	32	25	36	32	32	25	38	400
—	—	—	—	35	29	41	35	35	29	41	450
—	—	—	—	38	32	46	38	38	32	44	500
—	—	—	—	38	35	49	44	44	35	50	(550)
—	—	—	—	41	38	—	48	48	38	54	600
—	—	—	—	44	—	—	51	51	44	57	700
—	—	—	—	48	—	—	54	54	48	60	(750)
—	—	—	—	48	—	—	54	54	48	60	800
—	—	—	—	51	—	—	57	57	51	63	(850)
—	—	—	—	51	—	—	64	64	51	70	900
—	—	—	—	54	—	—	67	67	54	73	1 000
—	—	—	—	60	—	—	79	79	60	85	1 200

[‡] Plate flanges less than 12 mm thickness may suffer unacceptable distortion after welding to the pipe.

() Non-preferred size.

TABLE F—



NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

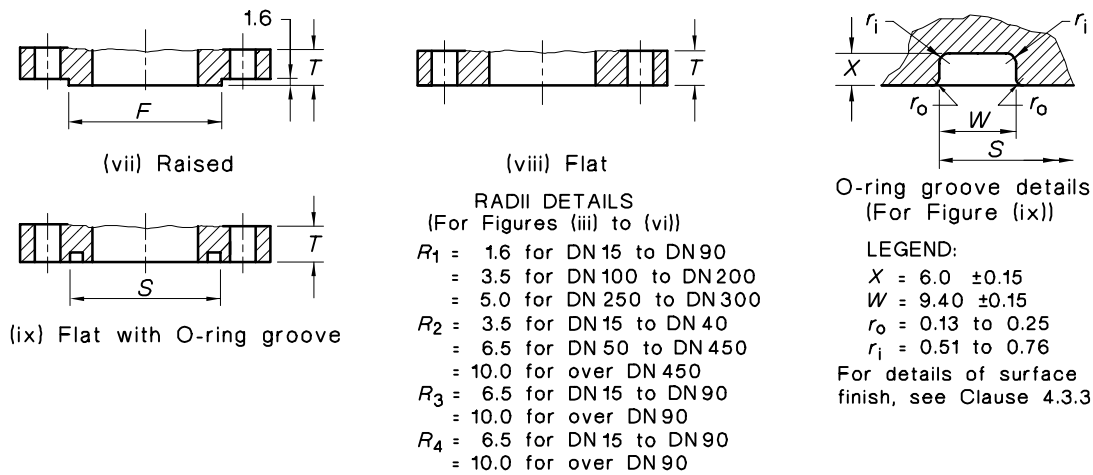
Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face†	Bolting details				Dimensions of boss			Dimensions of neck for grey or ductile iron integral flange for pipes and fittings	
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss	Maximum diameter at large end of neck	Minimum length of taper
DN	D	S	F	P	N	V	O	A	B	E	C	G
15	95	—	47	67	4	14	M12	10	33	38	25	13
20	100	—	53	73	4	14	M12	11	38	44	32	13
25	120	—	63	87	4	18	M16	11	48	52	41	13
32	135	—	74	98	4	18	M16	11	56	64	51	16
40	140	—	81	105	4	18	M16	13	62	70	57	16
50	165	—	103	127	4	18	M16	13	75	93	76	19
65	185	—	122	146	8	18	M16	16	90	112	92	19
80	205	—	141	165	8	18	M16	16	106	130	122	32
(90)	215	—	154	178	8	18	M16	17	119	144	121	22
100	230	—	167	191	8	18	M16	19	133	152	148	29
125	280	—	207	235	8	22	M20	19	160	191	165	25
150	305	—	232	260	12	22	M20	19	186	216	210	32
200	370	—	296	324	12	22	M20	22	241	279	244	35
250	430	—	349	381	12	26	M24	27	298	329	324	35
300	490	400	406	438	16	26	M24	29	349	386	381	38
350	550	455	459	495	16	30	M27	—	—	—	410	35
400	610	510	516	552	20	30	M27	—	—	—	464	35
450	675	565	571	610	20	33	M30	—	—	—	541	51
500	735	630	634	673	24	33	M30	—	—	—	597	48
(550)	785	680	685	724	24	33	M30	—	—	—	629	41
600	850	735	739	781	24	36	M33	—	—	—	700	58
700	935	810	815	857	24	36	M33	—	—	—	768	48
(750)	1 015	890	898	940	28	36	M33	—	—	—	851	51
800	1 060	935	942	984	28	36	M33	—	—	—	890	52
(850)	1 090	970	974	1 016	32	36	M33	—	—	—	927	54
900	1 185	1 055	1 060	1 105	32	39	M36	—	—	—	1 010	57
1 000	1 275	1 145	1 149	1 194	36	39	M36	—	—	—	1 092	60
1 200	1 530	1 385	1 385	1 441	40	42	M39	—	—	—	1 334	67

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

† Non-preferred, see Table 4.1.

DIMENSIONS OF FLANGES



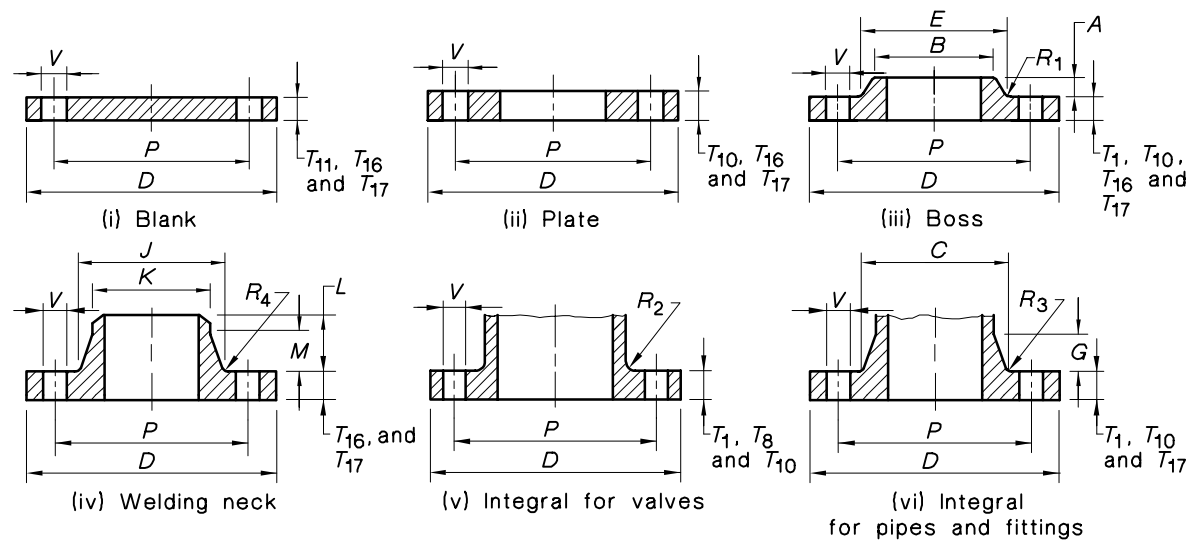
(b) Alternative flange faces (Figures (vii) to (ix))
 For limitations on flange faces, see Table 4.1

millimetres										
Dimensions of welding neck				Thickness of flange						Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Grey or ductile iron; boss or integral for pipes, valves and fittings	Copper alloy; plate, boss or integral for pipes, valves and fittings	Copper alloy; blank	Steel; blank, plate, boss, welding neck or integral for pipes, and fittings	Cast or forged steel; integral for valves	Steel; blank, plate, boss or welding neck, with O-ring groove	
J	K	L	M	T_1	T_{10}	T_{11}	T_{17}	T_8	T_{16}	DN
27	22	22	16	13	8	8	10 $\frac{1}{2}$	10	—	15
33	27	22	16	13	8	8	10 $\frac{1}{2}$	10	—	20
43	34	29	16	13	10	10	10 $\frac{1}{2}$	10	—	25
52	43	35	19	16	10	10	13	13	—	32
59	49	35	19	16	11	11	13	13	—	40
70	61	35	19	19	11	12	16	16	—	50
86	76	38	19	19	13	13	16	16	—	65
102	89	44	25	19	14	15	16	16	—	80
114	102	44	25	22	16	16	19	19	—	(90)
130	115	51	32	22	17	17	19	19	—	100
159	142	57	38	25	19	20	22	22	—	125
184	169	57	38	25	22	23	22	22	—	150
241	220	67	44	29	25	28	25	25	—	200
298	274	73	51	29	25	32	29	25	—	250
352	324	79	57	32	29	37	32	29	38	300
387	356	86	64	35	32	42	35	32	41	350
—	—	—	—	35	32	47	41	32	47	400
—	—	—	—	38	35	52	44	35	50	450
—	—	—	—	41	38	57	51	38	57	500
—	—	—	—	41	38	63	54	38	60	(550)
—	—	—	—	44	41	68	57	41	63	600
—	—	—	—	48	—	—	60	48	66	700
—	—	—	—	51	—	—	67	51	73	(750)
—	—	—	—	52	—	—	68	52	74	800
—	—	—	—	54	—	—	70	54	76	(850)
—	—	—	—	57	—	—	76	57	82	900
—	—	—	—	60	—	—	83	60	89	1 000
—	—	—	—	67	—	—	95	67	101	1 200

‡ Plate flanges less than 12 mm thickness may suffer unacceptable distortion after welding to the pipe.

() Non-preferred size.

TABLE H—



(a) Alternative flange types (Figures (i) to (vi))

NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

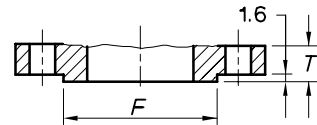
Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face†	Bolting details				Dimensions of boss			Dimensions of neck for grey or SG iron integral flange for pipes and fittings	
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss	Maximum diameter at large end of neck	Minimum length of taper
DN	D	S	F	P	N	V	O	A	B	E	C	G
15	115	—	57	83	4	18	M16	10	33	48	25	13
20	115	—	57	83	4	18	M16	11	38	48	35	13
25	120	—	64	87	4	18	M16	11	48	52	44	13
32	135	—	76	98	4	18	M16	11	56	64	54	16
40	140	—	83	105	4	18	M16	13	62	70	64	16
50	165	—	102	127	4	18	M16	13	75	93	79	19
65	185	—	114	146	8	18	M16	16	90	112	95	19
80	205	—	127	165	8	18	M16	16	106	130	122	22
(90)	215	—	140	178	8	18	M16	17	119	144	130	22
100	230	—	152	191	8	18	M16	19	133	152	148	19
125	280	—	178	235	8	22	M20	19	160	191	171	25
150	305	—	210	260	12	22	M20	19	186	216	210	22
200	370	—	260	324	12	22	M20	22	241	279	274	26
250	430	—	311	381	12	26	M24	27	298	329	324	23
300	490	395	362	438	16	26	M24	29	349	386	381	26
350	550	455	419	495	16	30	M27	—	—	—	425	35
400	610	510	483	552	20	30	M27	—	—	—	483	35
450	675	565	533	610	20	33	M30	—	—	—	541	35
500	735	630	597	673	24	33	M30	—	—	—	597	32
(550)	785	680	648	724	24	33	M30	—	—	—	648	44
600	850	735	699	781	24	36	M33	—	—	—	701	38

() Non-preferred size.

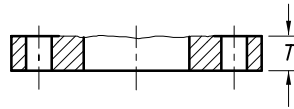
* For inch series, see Paragraph A5 of Appendix A.

† Non-preferred, see Table 4.1.

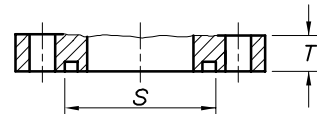
DIMENSIONS OF FLANGES



(vii) Raised



(viii) Flat

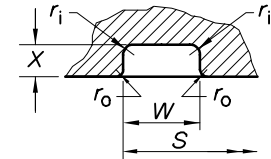


(ix) Flat with O-ring groove

RADII DETAILS

(For Figures (iii) to (vi))

- $R_1 = 1.6$ for DN 15 to DN 90
 $= 3.5$ for DN 100 to DN 200
 $= 5.0$ for DN 250 to DN 300
 $R_2 = 3.5$ for DN 15 to DN 40
 $= 6.5$ for DN 50 to DN 450
 $= 10.0$ for over DN 450
 $R_3 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90
 $R_4 = 10.0$

O-ring groove details
(For Figure (ix))

LEGEND:

 $X = 6.0 \pm 0.15$ $W = 9.40 \pm 0.15$ $r_o = 0.13$ to 0.25 $r_i = 0.51$ to 0.76

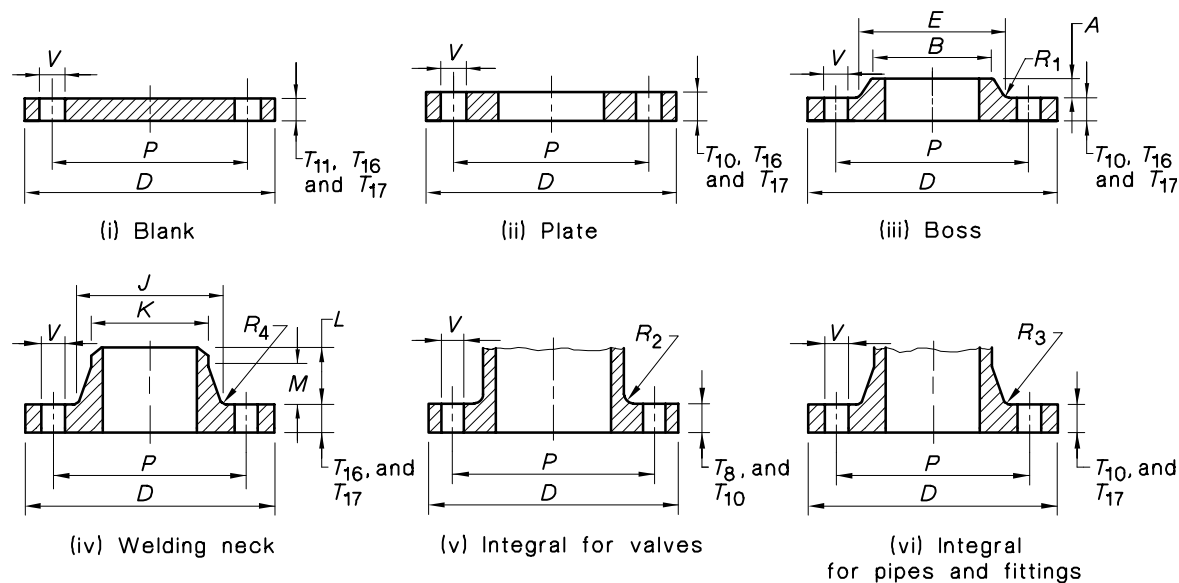
For details of surface finish, see Clause 4.3.3

(b) Alternative flange faces (Figures (vii) to (ix))

millimetres										
Dimensions of welding neck				Thickness of flange						Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Grey or ductile iron; boss or integral for pipes, valves and fittings	Copper alloy; plate, boss or integral for pipes valves and fittings	Copper alloy; blank	Steel; blank, plate, boss, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	Steel; blank, plate, boss or welding neck, with O-ring groove	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T₁</i>	<i>T₁₀</i>	<i>T₁₁</i>	<i>T₁₇</i>	<i>T₈</i>	<i>T₁₆</i>	DN
30	22	29	16	16	10	11	13	13	—	15
35	27	29	16	16	10	11	13	13	—	20
43	34	29	16	19	11	12	14	14	—	25
52	43	35	19	22	11	13	17	17	—	32
59	49	35	19	22	13	14	17	17	—	40
70	61	35	19	25	13	16	19	19	—	50
86	76	38	19	25	14	17	19	19	—	65
102	89	44	25	29	16	19	22	22	—	80
114	102	44	25	29	17	21	22	22	—	(90)
130	115	51	32	32	19	23	25	25	—	100
159	142	57	38	35	22	27	29	29	—	125
184	169	57	38	35	25	30	29	29	—	150
241	220	67	44	38	32	39	32	32	—	200
298	274	73	51	41	35	45	35	35	—	250
352	324	79	57	44	38	52	41	38	47	300
387	356	86	64	48	41	58	48	41	54	350
—	—	—	—	51	44	64	54	44	60	400
—	—	—	—	54	48	71	60	48	66	450
—	—	—	—	57	51	78	67	51	73	500
—	—	—	—	60	54	84	70	54	76	(550)
—	—	—	—	64	57	92	76	57	82	600

() Non-preferred size.

TABLE J—



(a) Alternative flange types (Figures (i) to (vi))

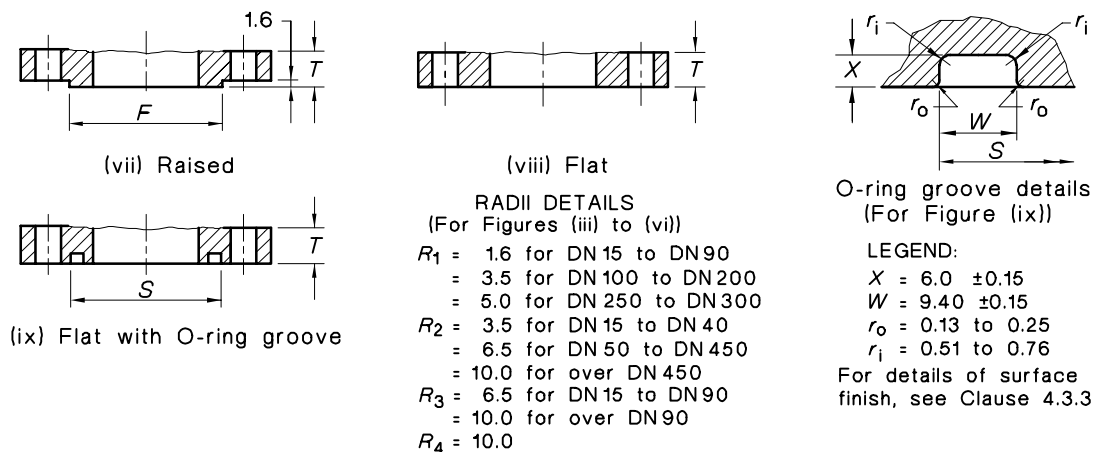
NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face	Bolting details				Dimensions of boss		
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Length of boss	Minimum diameter at small end of boss	Maximum diameter at root of boss
DN	D	S	F	P	N	V	O	A	B	E
15	115	—	57	83	4	18	M16	10	33	48
20	115	—	57	83	4	18	M16	11	38	48
25	120	—	64	87	4	18	M16	11	48	52
32	135	—	76	98	4	18	M16	11	56	64
40	140	—	83	105	4	18	M16	13	62	70
50	165	—	102	127	4	22	M20	13	75	87
65	185	—	114	146	8	22	M20	16	90	106
80	205	—	127	165	8	22	M20	16	106	125
(90)	215	—	140	178	8	22	M20	17	119	138
100	230	—	152	191	8	22	M20	19	133	148
125	280	—	178	235	8	26	M24	19	160	187
150	305	—	210	260	12	26	M24	19	186	212
200	370	—	260	324	12	26	M24	—	—	—
250	430	—	311	381	12	30	M27	—	—	—
300	490	395	362	438	16	30	M27	—	—	—
350	550	450	419	495	16	33	M30	—	—	—
400	610	505	483	552	20	33	M30	—	—	—
450	675	560	533	610	20	36	M33	—	—	—
500	735	625	597	673	24	36	M33	—	—	—
(550)	785	675	648	724	24	36	M33	—	—	—
600	850	730	699	781	24	39	M36	—	—	—

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

DIMENSION OF FLANGES

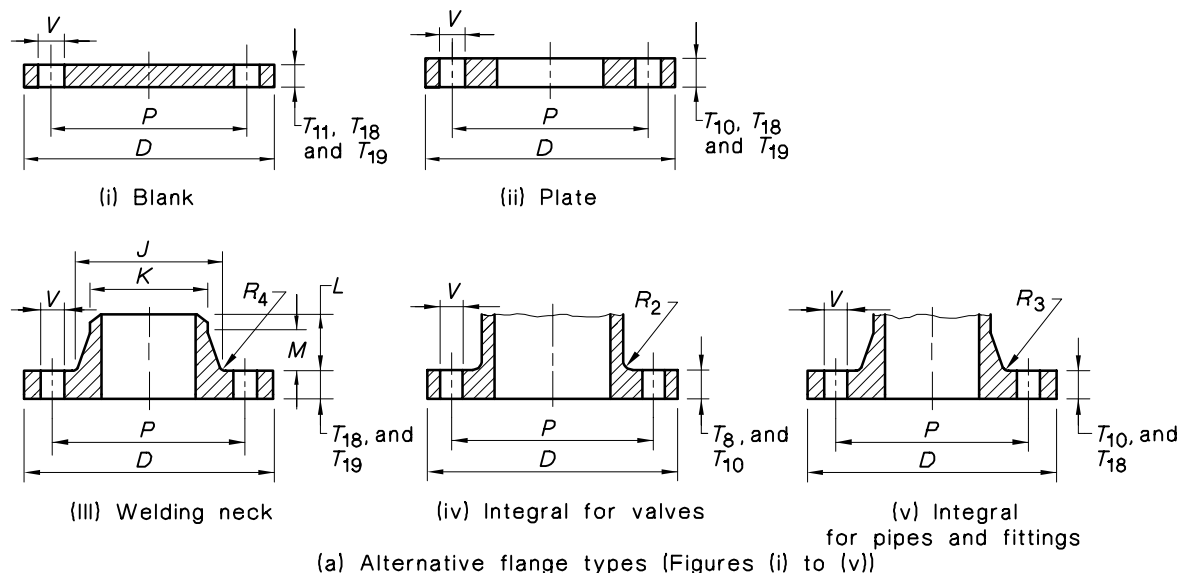


(b) Alternative flange faces (Figures (vii) to (ix))
 For limitations on flange faces, see Table 4.1

millimetres									
Dimensions of welding neck				Thickness of flange					Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Copper alloy; plate, boss or integral for pipes valves and fittings	Copper alloy; blank	Steel; blank, plate, boss, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	Steel; blank, plate, boss or welding neck, with O-ring groove	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T</i> ₁₀	<i>T</i> ₁₁	<i>T</i> ₁₇	<i>T</i> ₈	<i>T</i> ₁₆	DN
30	22	29	16	16	16	16	16	—	15
35	27	29	16	16	16	16	16	—	20
43	34	29	16	19	19	19	19	—	25
52	43	35	19	19	19	19	19	—	32
59	49	35	19	22	22	22	22	—	40
70	61	35	19	25	25	25	25	—	50
86	76	38	19	25	25	25	25	—	65
102	89	44	25	32	32	32	32	—	80
114	102	44	25	32	32	32	32	—	(90)
130	115	51	32	35	35	35	35	—	100
159	142	57	38	38	38	38	38	—	125
184	169	57	38	38	38	38	38	—	150
241	220	67	44	41	46	41	41	—	200
298	274	73	51	—	—	48	48	—	250
352	324	79	57	—	—	51	51	57	300
387	356	86	64	—	—	57	54	63	350
—	—	—	—	—	—	64	57	70	400
—	—	—	—	—	—	70	60	76	450
—	—	—	—	—	—	79	64	85	500
—	—	—	—	—	—	86	67	92	(550)
—	—	—	—	—	—	92	70	98	600

() Non-preferred size.

TABLE K—



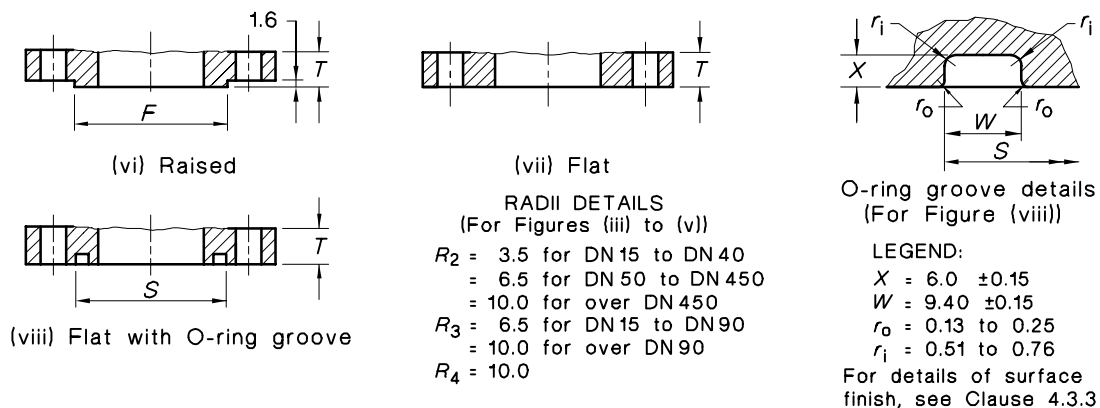
NOTE: For convenience, only the flat face variant of each type of flange is illustrated.

Nominal size	Diameter of flange	Outside diameter of O-ring groove	Diameter of raised face	Bolting details				Dimensions of	
				Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Diameter at large end of neck	Diameter at small end of neck
DN	D	S	F	P	N	V	O	J	K
15	115	—	64	83	4	18	M16	30	22
20	115	—	64	83	4	18	M16	35	27
25	125	—	76	95	4	18	M16	44	34
32	135	—	76	98	4	18	M16	52	43
40	150	—	89	114	4	22	M20	59	49
50	165	—	102	127	8	18	M16	70	61
65	185	—	114	146	8	22	M20	86	76
80	205	—	127	165	8	22	M20	102	89
(90)	230	—	140	184	8	26	M24	114	102
100	240	—	152	197	8	26	M24	130	115
125	280	—	178	235	12	26	M24	159	142
150	305	—	210	260	12	26	M24	184	169
200	370	—	260	318	12	30	M27	241	220
250	430	—	311	381	16	30	M27	298	274
300	490	385	362	432	16	33	M30	352	324
350	570	460	419	508	16	36	M33	387	356
400	630	515	483	565	20	36	M33	—	—
450	720	605	572	654	20	39	M36	552	457
500	785	655	622	711	20	42	M39	597	508
(550)	870	715	673	781	20	55	M52	641	559

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

DIMENSIONS OF FLANGES



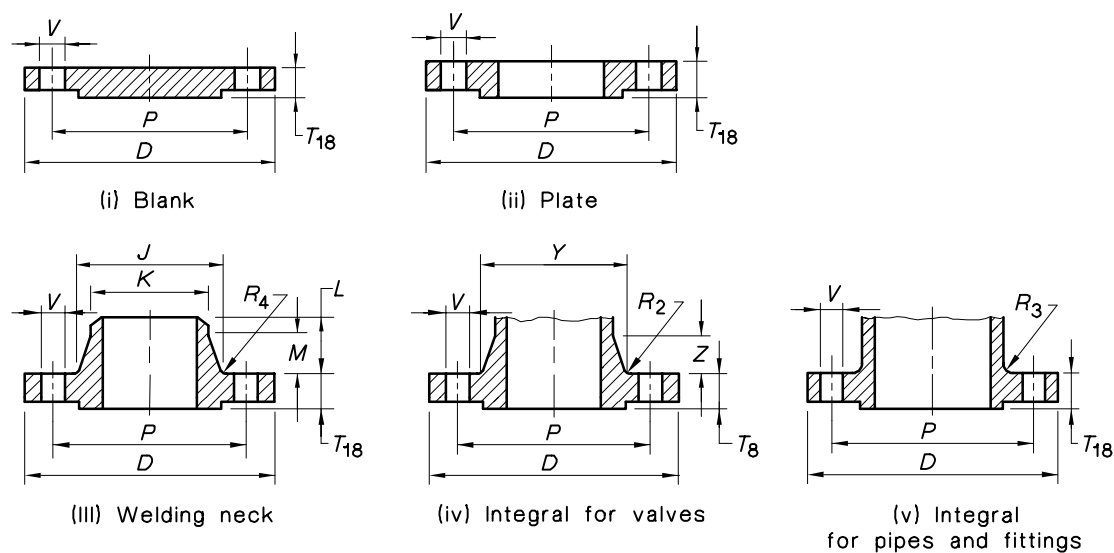
(b) Alternative flange faces (Figures (vi) to (viii))
 For limitations on flange faces, see Table 4.1

							millimetres
welding neck		Thickness of flange					Nominal size
Total length of neck	Length of taper	Copper alloy; plate, or integral for pipes valves and fittings	Copper alloy; blank	Steel; blank, plate, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	Steel; blank, plate or welding neck, with O-ring groove	
L	M	T_{10}	T_{11}	T_{18}	T_8	T_{19}	
29	16	19	19	19	19	—	15
29	16	19	19	19	19	—	20
35	19	22	22	22	22	—	25
35	19	22	22	22	22	—	32
35	19	25	25	25	25	—	40
35	19	25	25	25	25	—	50
38	19	29	29	29	29	—	65
44	25	32	32	32	32	—	80
44	25	32	32	32	32	—	(90)
51	32	35	35	35	35	—	100
57	38	41	41	41	41	—	125
57	38	41	43	41	41	—	150
67	44	48	52	48	48	—	200
73	51	—	—	51	51	—	250
83	57	—	—	57	57	63	300
95	70	—	—	67	60	73	350
—	—	—	—	76	67	82	400
111	76	—	—	89	76	95	450
117	83	—	—	98	83	104	500
117	83	—	—	105	89	111	(550)

() Non-preferred size.

TABLE R—

NOTE: Table R Flanges are obsolescent, see Clause 1.1.



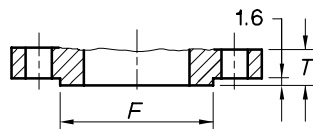
(a) Alternative flange types (Figures (i) to (v))

Nominal size	Diameter of flange	Diameter of raised face	Bolting details				Dimensions of neck for integrally cast or forged steel flanges (valves only)	
			Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Diameter at large end of neck	Length of taper
DN	D	F	P	N	V	O	Y	Z
15	115	64	83	4	18	M16	32	19
20	115	64	83	4	18	M16	38	19
25	125	76	95	4	18	M16	44	22
32	135	76	98	4	18	M16	54	22
40	150	89	114	4	22	M20	60	25
50	165	102	127	8	18	M16	76	25
65	185	114	146	8	22	M20	98	29
80	205	127	165	8	22	M20	114	32
(90)	230	140	184	8	26	M24	130	32
100	240	152	197	8	26	M24	146	35
125	280	178	235	12	26	M24	175	41
150	305	210	260	12	26	M24	203	44
200	370	260	324	12	30	M27	260	51
250	430	311	387	16	30	M27	318	57
300	510	362	457	16	33	M30	381	64
350	585	419	527	16	36	M33	451	70
400	640	483	584	20	36	M33	508	76
450	735	572	673	20	39	M36	584	83
500	805	622	730	20	42	M39	635	89
(550)	895	673	806	20	55	M52	699	95

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

DIMENSIONS OF FLANGES



(vi) Raised

RADII DETAILS

(For Figures (iii) to (v))

- $R_2 = 3.5$ for DN 15 to DN 40
 $= 6.5$ for DN 50 to DN 450
 $= 10.0$ for over DN 450
 $R_3 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90
 $R_4 = 10.0$

For details of surface finish, see Clause 4.3.3

(b) Flange face (Figure (vi))

NOTE: For this Table, only the raised face flange is to be used (see Table 4.1).

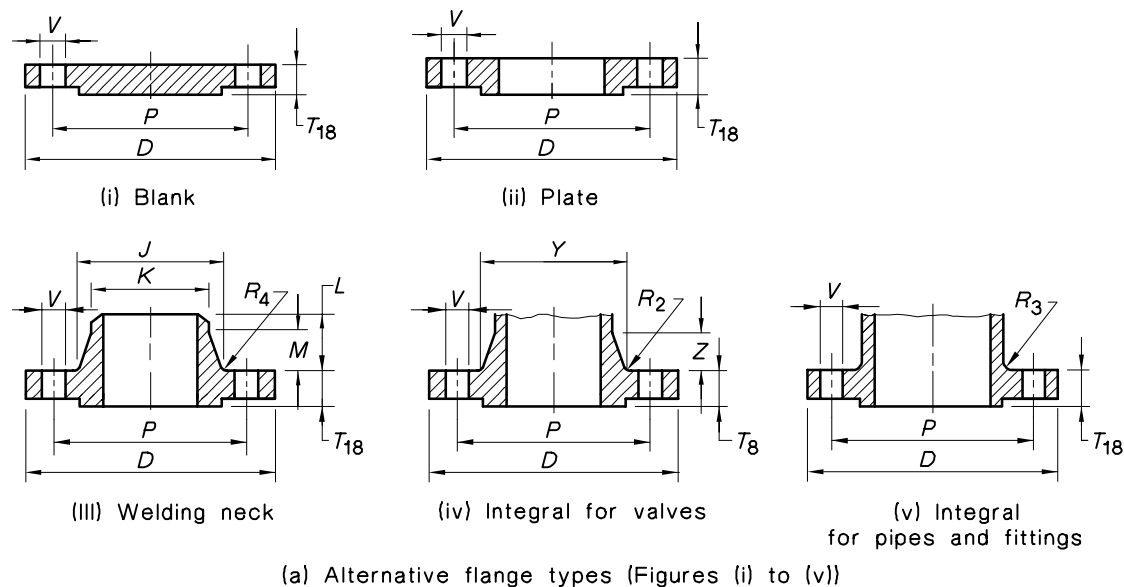
millimetres

Dimensions of welding neck				Thickness of flange		Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Steel; blank, plate, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T₁₈</i>	<i>T₈</i>	DN
30	22	29	16	19	19	15
35	27	29	16	19	19	20
44	34	35	19	22	22	25
52	43	35	19	22	22	32
59	49	35	19	25	25	40
70	61	35	19	25	25	50
86	76	38	19	29	29	65
102	89	44	25	32	32	80
114	102	44	25	32	32	(90)
130	115	51	32	35	35	100
159	142	57	38	41	41	125
187	169	67	44	44	44	150
244	220	73	51	51	51	200
305	274	92	64	60	57	250
359	324	102	70	70	64	300
423	356	114	83	79	70	350
480	407	127	92	89	76	400
572	457	137	102	98	83	450
616	508	137	102	105	89	500
667	559	143	108	114	95	(550)

() Non-preferred size.

TABLE S—

NOTE: Table S Flanges are obsolescent, see Clause 1.1.

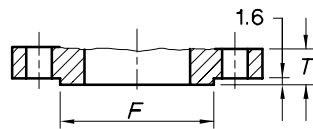


Nominal size	Diameter of flange	Diameter of raised face	Bolting details				Dimensions of neck for integrally cast or forged steel flanges (valves only)	
			Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Diameter at large end of neck	Length of taper
DN	D	F	P	N	V	O	Y	Z
15	125	64	89	4	22	M20	35	22
20	125	64	89	4	22	M20	41	22
25	140	76	102	4	22	M20	51	25
32	145	83	108	4	22	M20	57	29
40	160	89	121	4	22	M20	64	29
50	170	89	133	8	22	M20	79	32
65	185	102	146	8	22	M20	105	32
80	205	114	165	8	26	M24	117	35
(90)	235	127	191	8	26	M24	133	38
100	250	159	203	8	30	M27	146	41
125	285	191	235	12	26	M24	178	44
150	325	210	273	12	30	M27	213	51
200	415	273	356	12	36	M33	283	64
250	485	330	425	16	36	M33	343	73
300	580	381	508	16	42	M39	406	83
350	650	438	578	20	42	M39	470	95
400	745	495	660	20	48	M45	527	108

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

DIMENSIONS OF FLANGES



(vi) Raised

RADII DETAILS
(For Figures (iii) to (v))
 $R_2 = 3.5$ for DN15 to DN 40
 $= 6.5$ for DN 50 to DN 400
 $R_3 = 6.5$ for DN15 to DN 90
 $= 10.0$ for over DN 90
 $R_4 = 10.0$

For details of surface finish, see Clause 4.3.3

(b) Flange face (Figure (vi))

NOTE: For this Table, only the raised face flange is to be used (see Table 4.1).

millimetres

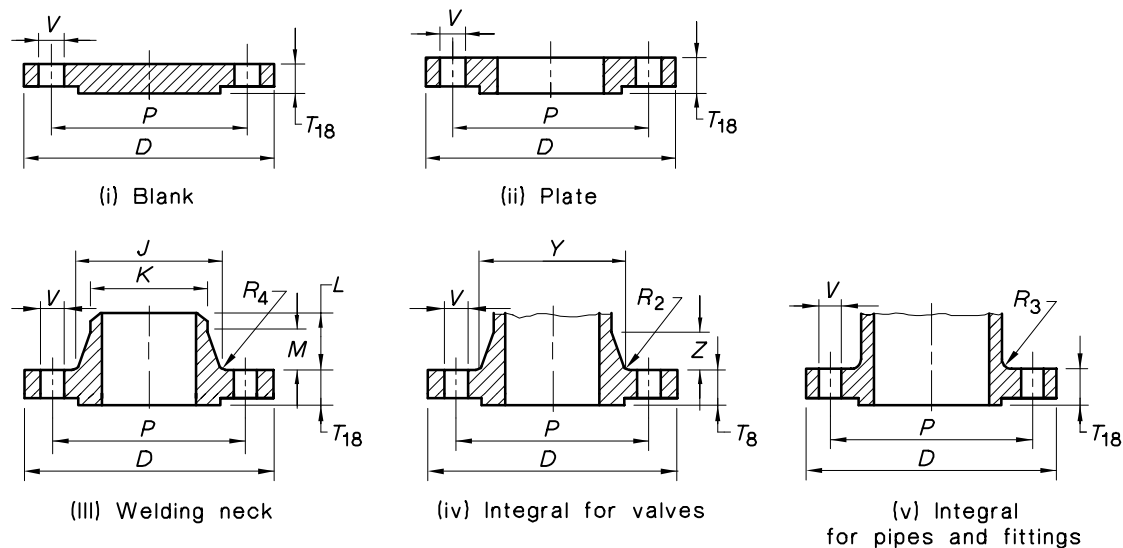
Dimensions of welding neck				Thickness of flange		Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Steel; blank, plate, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves only	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T₁₈</i>	<i>T₈</i>	DN
33	22	38	22	22	22	15
38	27	38	22	22	22	20
48	34	44	25	25	25	25
57	43	48	29	29	29	32
65	49	51	32	29	29	40
76	61	51	32	32	32	50
92	76	54	32	32	32	65
105	89	54	32	35	35	80
117	102	54	32	38	38	(90)
140	115	60	38	41	41	100
171	142	60	38	44	44	125
203†	169†	76	51	51	51	150
273	220	86	57	64	64	200
337	274	111	76	79	73	250
400	324	127	89	92	83	300
457	356	143	102	105	95	350
514	407	159	114	117	108	400

† See Appendix D.

() Non-preferred size.

TABLE T—

NOTE: Table T flanges are obsolescent, see Clause 1.1.



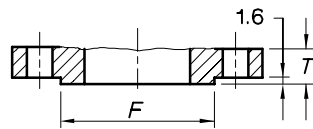
(a) Alternative flange types (Figures (i) to (v))

Nominal size	Diameter of flange	Diameter of raised face	Bolting details				Dimensions of neck for integrally cast or forged steel flanges (valves only)	
			Pitch circle diameter	Number of holes	Diameter of holes	Fastener size and thread*	Diameter at large end of neck	Length of taper
DN	D	F	P	N	V	O	Y	Z
15	140	64	102	4	22	M20	45	25
20	140	64	102	4	22	M20	51	25
25	145	76	108	4	22	M20	57	29
32	160	83	121	4	26	M24	64	32
40	170	89	133	8	22	M20	70	35
50	185	102	146	8	22	M20	89	35
65	205	114	165	8	26	M24	114	41
80	235	127	191	8	30	M27	133	48
(90)	265	146	216	8	33	M30	152	54
100	285	159	235	8	33	M30	171	57
125	325	210	273	12	33	M30	210	67
150	375	229	318	12	36	M33	248	73
200	475	298	406	12	42	M39	318	89
250	560	356	489	16	42	M39	381	108
300	655	413	572	16	48	M45	457	121

() Non-preferred size.

* For inch series, see Paragraph A5 of Appendix A.

DIMENSIONS OF FLANGES



(vi) Raised

RADII DETAILS

(For Figures (iii) to (vi))

- $R_2 = 3.5$ for DN 15 to DN 40
 $= 6.5$ for DN 50 to DN 300
 $R_3 = 6.5$ for DN 15 to DN 90
 $= 10.0$ for over DN 90
 $R_4 = 10.0$

For details of surface finish, see Clause 4.3.3

(b) Flange face (Figure (vi))

NOTE: For this Table, only the raised face flange is to be used (see Table 4.1).

millimetres

Dimensions of welding neck				Thickness of flange		Nominal size
Diameter at large end of neck	Diameter at small end of neck	Total length of neck	Length of taper	Steel; blank, plate, welding neck or integral for pipes and fittings	Cast or forged steel; integral for valves	
<i>J</i>	<i>K</i>	<i>L</i>	<i>M</i>	<i>T₁₈</i>	<i>T₈</i>	DN
33	22	38	22	25	25	15
38	27	38	22	25	25	20
48	34	44	25	29	29	25
57	43	48	29	32	32	32
76	49	51	32	35	35	40
92	61	54	32	35	35	50
108	76	60	38	41	41	65
121	89	60	38	48	48	80
137	102	70	44	54	54	(90)
152	115	76	51	57	57	100
197	142	92	64	67	67	125
229	169	102	70	73	73	150
286 †	220 †	114	76	89	89	200
375	274	146	102	108	108	250
441	324	171	121	121	121	300

† See Appendix D.

() Non-preferred size.

APPENDIX A

SELECTION OF BOLTING

(Normative)

A1 SCOPE This Appendix gives the requirements for the selection of carbon, carbon manganese, low alloy and stainless steel bolting for flanges.

NOTE: The integrity of a flanged joint at its temperature/pressure rating is dependent on the application of bolting as set out in this Appendix.

A2 BASIS OF SELECTION The type of bolting to be used for joining flanges is dependent on the flange table, temperature and the conditions of service. Bolting shall be selected from Table A1.

TABLE A1
BOLTS AND STUDBOLTS FOR FLANGES

1	2	3	4	5	6	7
Flange Table	Temperature range, °C	Type of bolting	Type of studbolt (See Figure A1)	Identification symbol		
				Bolt	Studbolt	Nut
A and D	−200 to 50	Studbolt	a, c or d	—	B8	8
	−100 to 200	Studbolt	a, c or d	—	L7	L4 or 4
	−30 to 250*	Bolt or studbolt	—	4.6	—	5
	−45 to 375	Studbolt	a, b or e	—	4.6	5
	−30 to 425	Studbolt	a, c or d	—	B7	2H
	−30 to 425	Studbolt	a, c or d	—	B16	8
E and F	−200 to 50	Studbolt	a, c or d	—	B8	8
	−100 to 200	Studbolt	a, c or d	—	L7	L4 or 4
	−30 to 250*	Bolt or studbolt	—	4.6	—	5
	−45 to 375	Studbolt	a, b or e	—	4.6	5
	−30 to 425	Studbolt	a, c or d	—	B7	2H
	−30 to 425	Studbolt	a, c or d	—	B16	8
H, J and K	−200 to 50	Studbolt	a, c or d	—	B8	8
	−100 to 200	Studbolt	a, c or d	—	L7	L4 or 4
	−30 to 350	Bolt or studbolt	—	8.8	—	5 or 8
	−45 to 375	Studbolt	a, b or e	—	8.8	5 or 8
	−30 to 425	Studbolt	a, c or d	—	B7	2H
	−30 to 425	Studbolt	a, c or d	—	B16	8
R, S and T	−100 to 200	Studbolt	a, c or d	—	L7	L4 or 4
	−30 to 350	Bolt or studbolt	—	8.8	—	8
	−45 to 375	Studbolt	a, b or e	—	8.8	8
	−30 to 425	Studbolt	a, c or d	—	B7	2H
	−30 to 425	Studbolt	a, c or d	—	B16	8

* Free-cutting steel shall not be used for bolts or studbolts for property class 4.6 which are to be used at temperatures greater than 200°C.

A3 TYPES OF BOLTING Bolting shall be appropriate for the temperature and the thread shall be metric series or inch series as shown in Table A2.

A4 GRADES OF BOLTING

A4.1 Bolts The material grades for both metric and inch series bolts shall be as shown in Table A3.

A4.2 Studbolts Where inch series studbolts are used in place of metric series Grade 4.6 or Grade 8.8 studbolts, the material shall be that identified as B7.

A5 SIZES OF BOLTING Where inch series bolting is used in place of metric series bolting, the sizes shall be as shown in Table A4.

A6 SELECTION OF STUDBOLTS For some applications, studbolts are preferred to bolts because of their inherent ease of insertion and removal from either side of a flange joint. This is of particular advantage where thermal insulation is applied close to a flange or where the shape of a valve body limits access.

Studbolts have been rationalized to five types as depicted in Figure A1, which are designated as 'a', 'b', 'c', 'd' and 'e' as follows:

- (a) Type 'a'—threaded full length.
- (b) Type 'b'—threaded each end with a body diameter approximately equal to the nominal diameter.
- (c) Type 'c'—threaded each end with a body diameter less than the minor diameter.
- (d) Type 'd'—threaded each end with two reduced diameter portions (less than the minor diameter) and a body diameter approximately equal to the nominal diameter.
- (e) Type 'e'—threaded each end with a body diameter approximately equal to the pitch diameter.

The types of studbolts which may be used are shown in Table A1 and the selection of the type required is to be made after consideration has been given to the environment and service conditions of the flanged joint.

Type 'a' studbolts are both easy to locate in the bolt holes and are free from significant stress-raisers. However, in certain environments and because of the increased surface area, they may be subject to excessive corrosion, thus making removal difficult.

Type 'b' studbolts are susceptible to severe stress-raisers at the junction of the threaded and plain portion.

Type 'c' studbolts are free from significant stress raisers but may be difficult to locate in the bolt holes.

Type 'd' studbolts overcome the difficulty of location, but rely on the smooth blending of the reduced portion into the full diameter portion for freedom from significant stress-raisers.

Type 'e' studbolts are susceptible to stress-raisers at the junction of the threaded and plain portion.

In addition to the stress concentration at the root of a screw thread, a stress-raiser can be present if the thread runout at the shank is not gradual.

The effect of thread runout can be eliminated by providing a portion of the shank with a diameter less than the root diameter of the thread, or by threading the full length of the studbolt.

By reducing the shank diameter for the full length between the threaded ends bending stresses are reduced, consequently greater relaxation of the bolted joint can be tolerated and resistance to shock is improved.

Consequently, studbolts of types 'a', 'c' and 'd' are suitable for flanges subject to fatigue and which are to be operated under stress-cycling conditions. Studbolts of type 'c' are suitable for use where shock loading may be encountered or where flat metallic gaskets are to be used.

A7 GALVANIZED COATING Galvanized coating may be used on Grade 4.6 and Grade 8.8 carbon steel bolting and Grade 5 and Grade 8 carbon steel nuts, but only within the temperature range -18°C to 120°C .

TABLE A2
THREAD SERIES FOR BOLTING

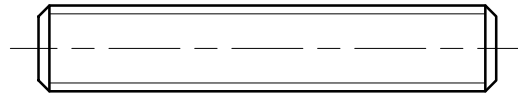
Temperature range, $^{\circ}\text{C}$	Series
-200 to -30	Inch
over -30 to 300	Metric or inch
over 300 to 525	Inch

TABLE A3
MATERIAL GRADES FOR BOLTS

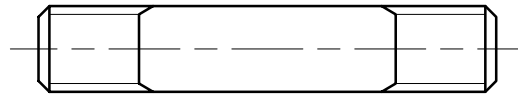
Metric series	Inch series	
AS/NZS 1110, AS/NZS 1111 and AS 2528	AS/NZS 2451	AS/NZS 2465
Grade 4.6	28 tonf/in ² tensile strength	Grade 2
Grade 8.8	—	Grade 5

TABLE A4
EQUIVALENT INCH SERIES BOLTING

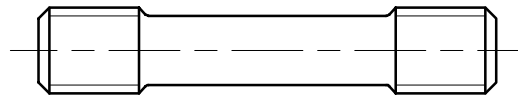
Metric series	Inch series
M12	1/2
M16	5/8
M20	3/4
M24	7/8
M27	1
M30	1 1/8
M33	1 1/4
M36	1 3/8
M39	1 1/2
M45	1 3/4
M52	2



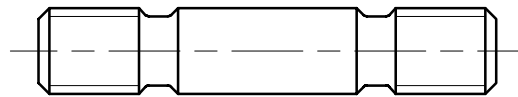
Type 'a'



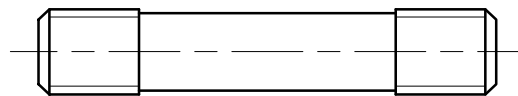
Type 'b'



Type 'c'



Type 'd'



Type 'e'

NOTE: For details of these studbolts, see AS 2528.

FIGURE A1 TYPES OF STUDBOLTS

APPENDIX B

ASSEMBLY OF FLANGED JOINTS

(Normative)

B1 SCOPE This Appendix gives the requirements for the assembly of flanged joints.

B2 FLANGE FACES

B2.1 Flanges mating with iron or copper flanges A flange that mates with a flange of grey cast iron, malleable cast iron, ductile cast iron, or copper alloy shall have a flat face.

B2.2 Flanges mating with flat face O-ring flanges The contact surface of a flange that mates with a flat face O-ring flange shall be machined in accordance with Clause 4.3.2 and, in addition, the annulus which makes contact with the O-ring shall have a surface not rougher than grade R_a $0.8 \mu\text{m}$, in accordance with AS 2536 (see also Clause 4.3.4).

B2.3 Thickness and contact surface The thickness (dimension T) and the contact surface specified in Clause 4.3.2 shall be maintained after the flange has been welded or brazed to a pipe, valve, fitting or pressure-retaining component. (See Note to Clause 4.2.2.)

B3 GASKETS

B3.1 Designation Gaskets are designated in relation to their widths as 'flat face' or 'narrow face' as follows:

- (a) A flat-face gasket extends over the full width of the flange.
- (b) A narrow-face gasket does not extend beyond the inside of the bolt holes.

B3.2 Selection Gaskets shall be suitable for the pressure temperature rating of the flange, the fluid and the environment.

Flat face gaskets are suitable only when used with comparatively soft jointing and are not recommended for pressures exceeding 2100 kPa or temperatures exceeding 260°C. Where the nominal size of the flange exceeds DN 600, the working pressure should not exceed 1400 kPa.

B3.3 Material Gaskets shall be made of materials that are not injuriously affected by the fluid, temperature, or environmental conditions to which the gasket will be subjected in service and will not injuriously affect the other materials of the system and shall be safe to humans.

Asbestos gaskets may not be permitted for most applications. Non-asbestos substitutes may not be suitable for all situations. The gasket supplier should be consulted for gasket choice, thermal resistance, contact face and if special bolt tightening procedures are required.

B3.4 Dimensions The dimensions of a gasket shall be established by reference to the type of gasket and its material properties, including density, flexibility and compressibility.

When the internal diameter is being determined, consideration shall be given to the detrimental effect of any intrusion of the gasket into the bore of the flange or of a pocket between the inside diameter of the gasket and the flange face.

A flat-face gasket shall have an outside diameter equal to the outside diameter of the flange (dimension D).

A narrow-faced gasket shall have an outside diameter equal to either of the following:

- (a) The pitch circle diameter minus one bolt hole diameter (dimension P minus dimension V). This is recommended for ease of assembly.
- (b) The diameter of the raised face (dimension F).

B4 O-RINGS (ELASTOMERIC TOROIDAL SEALING RINGS)

B4.1 Material O-rings shall be made of material that is not injuriously affected by the fluid, temperature or environmental conditions to which the O-ring will be subjected in service.

B4.2 Method of manufacture The material shall be cut and scarfed to form an O-ring or be moulded as an O-ring.

B4.3 Dimensions The diameter of the material shall be 7 mm. The outside diameter of the O-ring shall be the outside diameter of the O-ring groove of the flange minus 2 mm.

B4.4 Assembly An O-ring may be retained in its groove during assembly by the application of a non-injurious soft-setting material. A hard-setting material shall not be used.

B5 BOLTING Before a joint is bolted, the gasket shall be centralized. When the joint is bolted, the contact faces of the flanges shall bear uniformly on the gasket which shall be compressed in accordance with the design principles applicable to the type of gasket.

Bolting should be lubricated before assembly and tightened in four stages, and a uniform torque should be applied.

Bolting shall be engaged so that there is visible evidence of complete threading through the nuts.

Where an O-ring is used, the flange faces shall be in contact over the full surface and, to avoid overstressing the bolts and studs, a tightening torque based on a bolting stress of 100 MPa is recommended.

Galvanized bolting should not be used to bolt flanges made from low alloy steel, stainless steel or copper alloy.

B6 TESTING

B6.1 Flanges This Appendix does not specify requirements for the hydrostatic testing of individual flanges.

Integral flanges should be hydrostatically tested to the requirements of the standard that is appropriate to the pressure-containing component of which they form part.

B6.2 Flanged joints Flanged joints should be hydrostatically tested as part of the piping, pressure vessel or other equipment to which the flanges are attached.

The hydrostatic test pressure to be applied to a flanged joint shall not exceed that shown in the appropriate table (Tables 2.1 to 2.10).

The joint shall be deemed satisfactory if it does not leak or crack.

NOTE: A flanged joint should be free from pressure before any change is made to the tightness of the bolting.

APPENDIX C

LIST OF REFERENCED DOCUMENTS

(Normative)

AS

- 1074 Steel tubes and tubulars for ordinary service
- 1432 Copper tubes for plumbing, gasfitting and drainage applications
- 1548 Steel plates for pressure equipment
- 1565 Copper and copper alloys—Ingots and castings
- 1572 Copper and copper alloys—Seamless tubes for engineering purposes
- 1579 Arc welded steel pipes and fittings for water and waste water
- 1830 Iron castings—Grey cast iron
- 1831 Iron castings—Spheroidal or nodular graphite cast iron
- 1832 Iron castings—Malleable cast iron
- 2074 Steel castings
- 2382 Surface roughness comparison specimens
- 2528 Bolts, studbolts and nuts for flanges and other high and low temperature applications
- 2536 Surface texture
- 4087 Metallic flanges for waterworks purposes

AS/NZS

- 1110 ISO metric precision hexagon bolts and screws
- 1111 ISO metric hexagon commercial bolts and screws
- 1200 Pressure equipment
- 2280 Ductile iron pressure pipes and fittings
- 2451 Bolts, screws and nuts with British Standard Whitworth threads
- 2465 Unified hexagon bolts, screws and nuts (UNC and UNF threads)
- 2544 Grey iron pressure fittings
- 3678 Structural steel—Hot rolled plates, floorplates and slabs
- 4331 Metallic flanges
 - 4331.1 Part 1: Steel flanges
 - 4331.2 Part 2: Cast iron flanges
 - 4331.3 Part 3: Copper alloy and composite flanges

ANSI/ASME

- B16.5 Pipe flanges and flanged fittings
- B36.10M Welded and seamless wrought steel pipe
- B36.19M Stainless steel pipe

ASTM

- A105 Specifications for carbon steel forgings for piping applications

ASTM

- A182 Specification for forged or rolled alloy-steel pipe flanges, forged fittings, and valves and parts for high-temperature service
- A216 Specification for steel castings, carbon, suitable for fusion welding for high-temperature service
- A240 Specification for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels
- A350 Specification for carbon and low-alloy steel forgings, requiring notch toughness testing for piping components
- A351 Specification for castings, austenitic, austenitic-ferritic (duplex) for pressure-containing parts
- A352 Specification for steel castings, ferritic and martensitic, for pressure-containing parts suitable for low-temperature service
- A387 Specification for pressure vessel plates, alloy steel, chromium-molybdenum

BS

- 10 Flanges and bolting for pipes, valves and fittings (obsolescent 1970)
- 1503 Specification for steel forgings for pressure purposes
- 4504 Circular flanges for pipes, valves and fittings (PN designated) (series)

BS/EN

- 1561 Founding—Grey cast irons
- 10028 Flat products made of steels for pressure purposes
- 10028-2 Part 2: Non-alloy and alloy steels with specified elevated temperature properties
- 10028-3 Part 3: Weldable fine grained steels, normalized
- 10028-4 Part 4: Nickel alloy steels with specified low temperature properties
- 10213 Technical delivery conditions for steel castings for pressure purposes
- 10213-1 Part 1: General
- 10213-2 Part 2: Steel grades for use at room temperature and at elevated temperatures
- 10213-3 Part 3: Steels for use at low temperatures

DIN

- 50049 Inspection documents for the delivery of metallic products

APPENDIX D
NOMINAL SIZE AND OUTSIDE DIAMETER
OF PIPES
(Normative)

Table D1 shows, in tabular sequence of nominal sizes, the outside diameter of the pipe in accordance with the relevant Standard. Reference should be made to the appropriate Standard for availability and other data.

TABLE D1
OUTSIDE DIAMETER OF PIPES

Nominal size DN	Steel pipe (Not tube)*		Iron pipe to AS/NZS 2280 or AS/NZS 2544	Copper tube to AS 1432 or AS 1572
	ANSI/ASME B36.10M or B36.19M	AS 1074 or AS 1579		
15	21.3	21.3	—	12.7
20	26.7	26.9	—	19.05
25	33.4	33.7	—	25.4
32	42.2	42.4	—	31.75
40	48.3	48.3	—	38.1
50	60.3	60.3	—	50.8
65	73	76.2	—	63.5
80	88.9	88.9	—	76.2
(90)	101.6	101.6	—	88.9
100	114.3	114.3	121.9	101.6
125	141.3	139.7	—	127.0
150	168.3	165.1	177.3	152.4
200	219.1	—	232.2	203.2
250	273.1	—	286.0	254.0
300	323.8	—	354.5	—
350	355.6	—	—	—
400	406.4	—	—	—
450	457	—	507	—
500	508	—	560.3	—
(550)	559	—	—	—
600	610	—	667.0	—
650	660	—	—	—
700	711	—	—	—
(750)	762	—	826	—
800	813	—	—	—
(850)	864	—	—	—
900	914	—	—	—
1 000	1 016	—	—	—
1 200	1 219	—	—	—
1 400	1 422	—	—	—
1 600	1 626	—	—	—
1 800	1 829	—	—	—
2 000	2 032	—	—	—

* Steel includes: Carbon, carbon-manganese, low alloy and stainless steel.

() Non-preferred size.

This page has been left blank intentionally.