

BS 10:2009

Incorporating Corrigendum No. 1



BSI Standards Publication

Specification for flanges and bolting for pipes, valves and fittings

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Foreword

Publishing information

This British Standard is published by  BSI Standards Limited, under licence from The British Standards Institution  and came into effect on 30 April 2009. It was prepared by Technical Committee PSE/15, *Flanges*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 10:1962, which is withdrawn.

Information about this document

The start and finish of text introduced or altered by Corrigendum No. 1 is indicated in the text by tags  and .

It should be noted that, apart from cast iron flanges, the hydraulic test pressure applied to a flange joint is limited to one-and-a-half times the highest rated pressure of the flange (see Clause 8).

This is a full revision of the standard, and introduces the following principal changes:

- Materials have been updated;
- The standard has been re-arranged to reflect the most common used materials and types in service;
- Review of tables:

BS 10 flanges have been in use since 1904 and have been developed continuously to meet increasing pressure and temperature requirements. At the time of this revision, flange joints with carbon steel pipe flanges for high temperatures and pressures to the British Standard tables have been in service throughout the world for periods equal to the economic life of primary plant. The tables have therefore remained in the standard for guidance.

NOTE When it is required to convert the figures in this standard from imperial units into metric units it is recommended that the conversion factors and the table of conversion contained in BS 350, "Conversion factors and tables", be used. Attention is also drawn to BS 2856, "Precise conversion of inch and metric sizes on engineering drawings".

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for a series of carbon steel, alloy steel, cast iron and copper alloy flanges, and also appropriate bolts and nuts, for use with pipes, valves and fittings containing steam, oil, compressed air or water.

NOTE 1 The use of flanges complying with this standard for temperatures below -17.8°C (0°F) should be agreed between purchaser and manufacturer. These flanges may also be used on pipes, valves and fittings carrying other fluids for which the same requirements for safety and joint tightness are appropriate.

The applicability relationship between temperature and pressure for the above materials is specified for each table of flanges in Table 2 and Annex B.

NOTE 2 The types of gasket, and gasket materials, and the surface finish of the jointing face are matters for agreement between the purchaser and the manufacturer. When a raised jointing face is specified the outside diameter of the gasket should extend at least to the outside diameter of the raised face. For steel flanges when a raised jointing face is not specified, the gasket should be within the bolt holes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 21, *Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions)*

BS 84, *Parallel screw threads of Whitworth form – Requirements*

BS 916, *Specification for black bolts screws and nuts – Hexagon & square, with B.S.W. threads, and partly machined bolts, screws & nuts, hexagon & square with B.S.W. or B.S.F. threads*

BS 1580-1, *Unified screw threads – Part 1: Screw threads with diameters $\frac{1}{4}$ in and larger – Requirements*

BS 1769, *Specification for unified black hexagon bolts, screws and nuts – (UNC and UNF threads) – heavy series*

BS 3410, *Specification for metal washers for general engineering purposes*

BS EN 10090, *Wrought steels in the form of bars, billets, and forgings, up to 6 in ruling section, for automobile and general engineering purposes – En series*

BS EN 10025-2, *Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels*

BS EN 10222-2, *Steel forgings for pressure purposes – Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

BS EN 13480 Parts 1-5, *Metallic industrial piping*

BS EN 14324, *Brazing – Guidance on the application of brazed joints*

BS ISO 10204, *Iron ores – Determination of magnesium – Flame atomic absorption spectrometric method*

3 Design temperature and pressure

3.1 The design temperature and pressure shall be stated by the purchaser. The tables provided in this standard are for guidance only and are based on historical data contained in previous revisions of this standard. If verification is required, this shall be the responsibility of the purchaser. One method of verification that could be used is BS EN 1591-1.

3.2 Where there is an appropriate application standard the purchaser shall ensure that the design temperature and pressure stated conform to the requirements of that standard.

NOTE The temperature-pressure ratings given in Table 2 and Annex B are design temperatures and pressures.

3.3 The pressure ratings, with the exception of those in the second column in Table B.2, shall be applied to installations subject to moderate shock such as might occur in an efficiently designed and operated boiler feed main.

3.4 Where a system might be subject to more severe shock, the purchaser shall make a suitable allowance when stating the design pressure or the flange table.

4 Designation

Flange sizes shall be designated by the nominal bores of their respective pipes as given in the first and last column of each table.

5 Flange dimensions

5.1 General

Flange dimensions shall conform to those specified in the appropriate tables and Figure 3 to Figure 7.

NOTE The thicknesses and diameters of flanges specified are minima.

5.2 Raised jointing faces for steel flanges only (see Figure 3 to Figure 6)

NOTE 1 Raised jointing faces specified in Table H, Table J and Table K are recommended only for steel flanges.

If a raised jointing face is required on a steel flange specified in Table A, Table D, Table E and Table F, the diameter shall be $\frac{1}{4}$ in less than the diameter of the inscribed circle touching the bolt holes.

NOTE 2 Raised jointing faces are not specified in Table H, Table J and Table K because it is not customary to use them on these flanges.

Raised jointing faces as specified in Table R, Table S and Table T shall be used.

5.3 Flange thicknesses (see Figure 3 to Figure 7)

NOTE 1 The thickness (T) specified in the tables includes a raised jointing face having a height not exceeding $\frac{1}{16}$ in. Where there is no raised face, T is the thickness of the flange. If the height of the raised jointing face is more than $\frac{1}{16}$ in, the thickness (T) is increased by an equivalent amount.

The backs of integrally cast steel flanges shall be machined.

NOTE 2 This machining may be either by spot-facing at the bolt holes or by back-facing at the option of the manufacturer (see Figure 5). The backs of other flanges may be left unmachined at the option of the manufacturer unless otherwise specified by the purchaser.

After machining, the thickness of the flange shall be not less than the thickness specified.

5.4 Flange drilling

Unless otherwise specified by the purchaser all bolt holes shall be drilled, shall be equally spaced on the bolt pitch circle diameter, and in the case of integral flanges the bolt holes shall be drilled off centres.

For ½ inch and ⅝ inch bolts, the diameters of the holes shall be ⅛ inch larger than the diameters of the bolts, except that for cast iron flanges with ⅝ inch bolts the holes can be ⅛ inch larger than the diameters of the bolts. For ¾ inch bolts and larger, the diameter of the holes shall be not greater than ⅛ inch larger than the diameters of the bolts in all cases.

6 Flange materials

6.1 Steel flanges either forged, stamped or plate shall be manufactured from materials conforming to the minimum requirements as set out in Table 1.

NOTE Alternative materials can be used providing that the mechanical properties at operating temperature are not inferior to those given in the specifications set out in Table 1.

Table 1 Flange materials – minimum requirements

Flange table	Temperature range –17.8 °C to 427 °C inc. (0 °F to 800 °F inc.)
A to J inclusive	BS EN 10025-2, S235JR
K to T inclusive	BS EN 10025-2, S275JR BS EN 10222-2, P245GH

NOTE For the minimum requirements of steel that can be used for flanges in Table A to Table H inclusive for temperatures from –17.8 °C (0 °F) to 260 °C (500 °F), see Annex B.

6.2 Flanges shall be free from laminations and surface defects.

6.3 Where welding neck flanges are made from wrought steel the direction of the fibres of the material in the neck shall be parallel to the longitudinal axis of the flange.

6.4 If the purchaser requires certificates of the process, chemical analysis of the specified elements and physical properties of the materials, this shall be stated on the order. C1 (See Clause 9). C1

6.5 When the purchaser requires the individual flange he has ordered to be marked to identify the materials used, the system of marking to be employed shall be the subject of agreement between the purchaser and the manufacturer.

7 Attachment of flanges

7.1 The method of securing flanges (other than integral flanges) to pipes and fittings supplied complete by manufacturers shall be in accordance with the appropriate application standard. Where there is no appropriate application standard, the methods of attachment shall be the subject of agreement between the purchaser and the manufacturer.

NOTE Where there is no appropriate application standard, the methods shown in BS EN 13480, Parts 1 to 5 and BS EN 12449 should be regarded as minimum requirements.

7.2 If flanges are to be supplied loose, they shall, unless otherwise specifically called for by the purchaser, be prepared for attachment to pipes as follows.

a) *Steel flanges.*

- 1) Boss flanges, sizes 6 in and smaller, screwed in accordance with BS 21.
- 2) Boss flanges, sizes 7 in to 12 in machined in the bore to slip over the outside diameter of the pipe or fitting; suitable for welding.
- 3) Plain flanges $\frac{1}{2}$ in thick and thicker, machined in the bore; suitable for welding-on to form one of the types in the appropriate application standard as required by the purchaser. The purchaser shall specify the type of preparation required.
- 4) Welding neck flanges, machined in the bore to a diameter to be specified by the purchaser, and suitably bevelled for welding to pipes or fittings.

b) *Copper alloy flanges.* Machined in the bore to slip over the outside diameter of the pipe or fitting; suitable for fusion welding (where applicable).

8 Hydraulic testing of flange joints

8.1 This standard does not specify the hydraulic test pressures for flanged pipes or components, details of which shall be obtained from the appropriate standards which specify test pressures for pipes or components but in any case, the test pressure to be applied to the joint shall not exceed one-and-a-half times the highest rated pressures for steel and copper alloy flanges, and twice the highest rated pressures for cast iron flanges.

8.2 Where flanged assemblies are not covered by any standard specifying test pressures but incorporate flanges conforming to this standard, or where any assembly is to be used for duties of a special nature, the test pressure shall be agreed between the purchaser and the manufacturer.

9 Certification

The flange manufacturer shall use respective procedures to ensure material traceability and to avoid material exchange and shall be able to provide retrospective certification for the base material used. Certificates shall be provided in accordance with BS ISO 10204, Type 2.1 as a minimum but the purchaser may also request a 2.2 or 3.1 certificate at their option.

Table 2 Temperature/pressure ratings for carbon steel flanges [see Annex B]

Table	Temperature °C										Maximum hydraulic test pressure (lbf/in ²)
	–17.8 to 121.1	–17.8 to 232.2	260.0	287.8	315.6	343.3	371.1	399	427		
	Temperature °F										
	0 to 250	0 to 450	500	550	600	650	700	750	800		
	Pressure (lbf/in ²)										
A	50 ^{A)}	25 ^{B)}	—	—	—	—	—	—	—	75	
D	—	100	95	85	80	70	65	55	50	150	
E	—	200	185	170	155	140	130	115	100	300	
F	—	300	280	255	235	215	195	170	150	450	
H	—	500	465	430	395	355	320	285	250	750	
J	—	700	650	600	550	500	450	400	350	1 050	
K	—	900	835	770	705	645	580	515	450	1 350	
R	—	1 200	1 115	1 030	945	855	770	685	600	1 800	
S	—	1 800	1 670	1 545	1 415	1 285	1 155	1 030	900	2 700	
T	—	2 800	2 600	2 400	2 200	2 000	1 800	1 600	1 400	4 200	

NOTE Intermediate values above 450°F (232.2°C) may be obtained by linear interpolation.

^{A)} It is customary in the gas industry to limit the use of Table A flanges to working gas pressures not exceeding 30 lbf/in². It is recommended that this limitation be also applied to compressed air.

^{B)} This rating applies to temperatures above 121.1 °C (250 °F) up to and including 232.2 °C (450 °F) and does not apply to flange sizes above 36 in.

10 Low temperature flanges and bolting

COMMENTARY ON CLAUSE 10

Alternative materials may be used provided that the mechanical properties at operating temperature are not inferior to those given in the specifications referred to below.

Flanges and bolting for low temperature duty shall conform to the following minimum requirements.

- a) Steel flanges either plate, stamped, forged or cast and bolting material intended for use with pipes in accordance with BS 3603. Pressure ratings for these shall be stated by the purchaser.
- b) Where copper alloy flanges to this standard are used for temperatures down to $-200\text{ }^{\circ}\text{C}$ ($-328\text{ }^{\circ}\text{F}$), pressure ratings for these flanges shall be stated by the purchaser. Guidance is provided in Table B.3 or Table B.4, temperature range $-17.8\text{ }^{\circ}\text{C}$ to $121.1\text{ }^{\circ}\text{C}$ ($0\text{ }^{\circ}\text{F}$ to $250\text{ }^{\circ}\text{F}$), and is based on historical data contained in previous revisions of this standard.

NOTE 9% aluminium bronze to BS 2032 is a suitable bolting material for the above low temperature range, but other copper alloys may be used by agreement between the purchaser and the supplier.

Table A Dimensions of plain, boss, integrally cast or forged flanges (for ratings see Table 2 and Annex B)

Flange size designation (nominal bore of pipe)	Approximate outside diameter of steel pipe ^{A)}	Diameter of flange	Bolt circle diameter	No. of bolts	Diameter of bolts ^{B)}	Dimensions of boss (Fig 4) ^{C)}			Thickness of flange			
						Boss length	Diameter at small end of boss	Maximum diameter at root of boss	Grey cast iron integrally cast or screwed on with boss	Malleable cast iron screwed on with boss	Copper alloy cast or wrought integral or boss or plain (Fig. 3)	Wrought steel integral or plain (Fig. 3) or boss (Fig. 4)
	<i>H</i>	<i>D</i>	<i>P</i>	<i>N</i>	<i>O</i>	<i>A</i>	<i>B</i>	<i>E</i>	<i>T</i> ₁	<i>T</i> ₂	<i>T</i> ₃	<i>T</i> ₄
in	in	in	in		in	in	in	in	in	in	in	in
6 1/2 [5]	27/32	3 3/4	2 5/8	4	1/2	3/8	1 5/16	1 1/2	1/2	3/16	1/4	3/16 ^{D)}
3/4	1 1/16	4	2 7/8	4	1/2	7/16	1 1/2	1 3/4	1/2	3/16	1/4	3/16 ^{D)}
1	1 11/32	4 1/2	3 1/4	4	1/2	7/16	1 7/8	2 1/16	1/2	3/16	5/16	3/16 ^{D)}
1 1/4	1 11/16	4 3/4	3 7/16	4	1/2	7/16	2 3/16	2 9/32	5/8	1/4	5/16	1/4 ^{D)}
1 1/2	1 29/32	5 1/4	3 7/8	4	1/2	1/2	2 7/16	2 3/4	5/8	1/4	3/8	1/4 ^{D)}
2	2 3/8	6	4 1/2	4	5/8	1/2	2 15/16	3 1/8	5/8	5/16	3/8	5/16 ^{D)}
2 1/2	3	6 1/2	5	4	5/8	5/8	3 9/16	3 21/32	11/16	5/16	7/16	5/16 ^{D)}
3	3 1/2	7 1/4	5 3/4	4	5/8	5/8	4 3/16	4 13/32	11/16	3/8	1/2	3/8 ^{D)}
3 1/2	4	8	6 1/2	4	5/8	11/16	4 11/16	5 1/8	3/4	3/8	9/16	3/8 ^{D)}
4	4 1/2	8 1/2	7	4	5/8	3/4	5 1/4	5 1/2	3/4	3/8	5/8	3/8 ^{D)}
5	5 1/2	10	8 1/4	4	5/8	3/4	6 5/16	6 3/4	3/4	1/2	11/16	1/2
6	6 1/2	11	9 1/4	4	5/8	3/4	7 5/16	7 3/4	13/16	1/2	11/16	1/2
	6 5/8											
7	7 5/8	12	10 1/4	8	5/8	7/8	8 3/8	8 3/4	13/16	—	3/4	1/2
8	8 5/8	13 1/4	11 1/2	8	5/8	7/8	9 1/2	10	7/8	—	3/4	1/2
9	9 5/8	14 1/2	12 3/4	8	5/8	1	10 1/2	11 1/8	7/8	—	3/4	5/8
10	10 3/4	16	14	8	3/4	1 1/16	11 3/4	12 3/16	15/16	—	3/4	5/8
12	12 3/4	18	16	8	3/4	1 1/8	13 3/4	14 3/16	15/16	—	7/8	3/4
13	14	19 1/4	17 1/4	8	3/4	—	—	—	15/16	—	7/8	3/4
14	15 ^{E)}	20 3/4	18 1/2	8	7/8	—	—	—	1	—	1	7/8
15	16	21 3/4	19 1/2	8	7/8	—	—	—	1	—	1	7/8
16	—	22 3/4	20 1/2	12	7/8	—	—	—	1 1/16	—	1	7/8
17	18	24	21 3/4	12	7/8	—	—	—	1 1/16	—	1 1/16	7/8
18	—	25 1/4	23	12	7/8	—	—	—	1 1/16	—	1 1/16	7/8
19	20	26 1/2	24	12	7/8	—	—	—	1 1/8	—	1 1/8	7/8
20	—	27 3/4	25 1/4	12	7/8	—	—	—	1 1/8	—	1 1/8	1
21	22	29	26 1/2	12	7/8	—	—	—	1 1/8	—	1 1/8	1

Table A Dimensions of plain, boss, integrally cast or forged flanges (for ratings see Table 2 and Annex B) (continued)

Flange size designation (nominal bore of pipe)	Approximate outside diameter of steel pipe ^{A)}	Diameter of flange	Bolt circle diameter	No. of bolts	Diameter of bolts ^{B)}	Dimensions of boss (Fig 4) ^{C)}			Thickness of flange			
						Boss length	Diameter at small end of boss	Maximum diameter at root of boss	Grey cast iron integrally cast or screwed on with boss	Malleable cast iron screwed on with boss	Copper alloy cast or wrought integral or boss or plain (Fig. 3)	Wrought steel integral or plain (Fig. 3) or boss (Fig. 4)
	<i>H</i>	<i>D</i>	<i>P</i>	<i>N</i>	<i>O</i>	<i>A</i>	<i>B</i>	<i>E</i>	<i>T</i> ₁	<i>T</i> ₂	<i>T</i> ₃	<i>T</i> ₄
in	in	in	in		in	in	in	in	in	in	in	in
22	—	30	27 1/2	12	1	—	—	—	1 3/16	—	1 3/16	1
23	24	31	28 1/2	12	1	—	—	—	1 3/16	—	1 3/16	1
24	—	32 1/2	29 3/4	12	1	—	—	—	1 3/16	—	1 3/16	1
26	26	33 1/4	30 3/4	16	1	—	—	—	1 1/4	—	—	1
27	28	34 1/4	31 3/4	16	1	—	—	—	1 1/4	—	—	1
29	30	36 1/4	33 3/4	20	1	—	—	—	1 1/4	—	—	1
30	—	37 1/4	34 3/4	20	1	—	—	—	1 1/4	—	—	1
33	34	40 1/2	38	20	1	—	—	—	1 1/4	—	—	1 1/8
35	36	42 1/2	40	24	1	—	—	—	1 1/4	—	—	1 1/8
36	—	43 1/2	41	24	1	—	—	—	1 3/8	—	—	1 1/8
39	40	46 1/2	44	24	1	—	—	—	1 3/8	—	—	1 1/8
42	43	49 1/2	47	28	1	—	—	—	1 3/8	—	—	1 1/4
45	—	52 3/4	50 1/4	28	1	—	—	—	1 1/2	—	—	1 1/4
48	49	55 3/4	53 1/4	28	1	—	—	—	1 1/2	—	—	1 1/4
54	55	63 1/4	60 1/4	32	1 1/4	—	—	—	1 3/4	—	—	1 3/8
60	61	70 1/4	67	32	1 1/4	—	—	—	1 7/8	—	—	1 1/2
66	67 1/4	76 1/2	73 1/4	32	1 1/4	—	—	—	2 1/8	—	—	1 5/8
72	73 1/4	83	79 1/2	36	1 3/8	—	—	—	2 3/8	—	—	1 3/4

^{A)} (H) For availability of steel pipe sizes, refer to BS EN 10216, BS EN 10217. See BS 4622 and BS 4722 for outside diameters of cast iron pipes. See BS EN 12449 for the sizes of copper pipes for use with copper alloy flanges up to 8 in bore.

^{B)} (O) For 1/2 in and 3/8 in bolts, the diameters of the holes shall be 1/16 in larger than the bolts and for 3/4 in bolts and sizes above, the diameters shall be not more than 1/8 in larger than the bolts. For cast iron flanges the diameters of the bolt holes may be 1/8 in larger than the bolts of sizes 5/8 in and above. For 7/8 in bolts and sizes above, the diameters shall be not more than 1/4 in larger than the bolts.

(A, B and E) Tapers are not specified but shall be such that the maximum diameters at root of boss are not exceeded.

(T₄) It may be impracticable to use thicknesses less than 1/2 in except for boss and integral flanges.

(H) It is recommended that this size for steel pipes should be avoided wherever possible. $\langle C_1 \rangle$

Table D Dimensions of plain, boss, integrally cast or forged and welding neck flanges (for ratings see Table 2 and Annex B)

Flange size designation (nominal bore of pipe)	Approximate outside diameter of steel pipe ^{A)}	Diameter of flange	Bolt circle diameter	No. of bolts	Diameter of bolts ^{B)}	Dimensions of boss (Fig 4) ^{C)}			Dimensions of cast iron necks for cast iron (Fig. 7)			Dimensions of steel welding necks (Fig. 6)				Thickness of flange				
						Boss length	Diameter at small end of boss	Maximum diameter at root of boss	Diameter at large end of neck	Length of taper	Diameter at large end of neck	Diameter at small end of neck ^{D)}	Total length of neck	Length of taper	Grey cast iron integrally cast or screwed on with boss	Copper alloy cast or wrought integral or boss or plain (Fig. 3)	Wrought steel integral or plain (Fig. 3) or boss or neck welding neck (except for valves) (Fig. 6)	Cast steel integral or plain (Fig. 3) or boss or welding neck (Fig. 6) (except for valves)	Forged steel or cast steel integral (Fig. 5) or valves (for valves only)	
in	H	D	P	N	O	A	B	E	C	G	J	K	L	M	T ₁	T ₃	T ₅	T ₆	T ₉	
1/2	27/32	3 3/4	2 5/8	4	1/2	3/8	1 5/16	1 1/2	—	—	1 1/16	7/8	7/8	—	5/8	1/2	1/4	3/16 E)	3/8 E)	3/8
3/4	1 1/16	4	2 7/8	4	1/2	7/16	1 1/2	1 3/4	—	—	1 5/16	1 3/32	7/8	5/8	1/2	1/4	3/16 E)	3/8 E)	3/8	
1	1 11/32	4 1/2	3 1/4	4	1/2	7/16	1 7/8	2 1/16	—	—	1 11/16	1 3/8	7/8	5/8	1/2	5/16	3/16 E)	3/8 E)	3/8	
1 1/4	1 11/16	4 3/4	3 7/16	4	1/2	7/16	2 3/16	2 9/32	—	—	1 15/16	1 23/32	1	5/8	5/8	5/16	1/4 E)	1/2	1/2	
1 1/2	1 29/32	5 1/4	3 7/8	4	1/2	1/2	2 7/16	2 3/4	—	—	2 5/16	1 15/16	1 1/8	3/4	5/8	3/8	1/4 E)	1/2	1/2	
2	2 3/8	6	4 1/2	4	5/8	1/2	2 15/16	3 1/8	—	—	2 3/4	2 13/32	1 1/8	3/4	11/16	3/8	5/16 E)	9/16	9/16	
2 1/2	3	6 1/2	5	4	5/8	5/8	3 9/16	3 21/32	—	—	3 1/4	3 1/32	1 1/4	7/8	11/16	7/16	5/16 E)	9/16	9/16	
3	3 1/2	7 1/4	5 3/4	4	5/8	5/8	4 3/16	4 13/32	—	—	4	3 17/32	1 3/8	1	3/4	1/2	3/8 E)	9/16	9/16	
3 1/2	4	8	6 1/2	4	5/8	11/16	4 11/16	5 1/8	—	—	4 1/2	4 1/16	1 3/8	1	3/4	9/16	3/8 E)	9/16	9/16	
4	4 1/2	8 1/2	7	4	5/8	3/4	5 1/4	5 1/2	—	—	5 1/8	4 9/16	1 5/8	1 1/4	3/4	5/8	3/8 E)	11/16	11/16	
5	5 1/2	10	8 1/4	8	5/8	3/4	6 5/16	6 3/4	—	—	6	5 9/16	1 3/4	1 1/4	13/16	11/16	1/2	11/16	11/16	
6	6 1/2	11	9 1/4	8	5/8	3/4	7 5/16	7 3/4	—	—	7 1/4	6 9/16	1 7/8	1 1/4	13/16	11/16	1/2	11/16	11/16	
	6 23/32																			
7	7 5/8	12	10 1/4	8	5/8	7/8	8 3/4	8 3/4	—	—	8 1/4	7 23/32	2	1 3/8	7/8	3/4	1/2	3/4	3/4	
8	8 5/8	13 1/4	11 1/2	8	5/8	7/8	9 1/2	10	—	—	9 1/2	8 23/32	2	1 3/8	7/8	3/4	1/2	3/4	3/4	
9	9 5/8	14 1/2	12 3/4	8	5/8	1	10 1/2	11 1/8	—	—	10 5/8	9 3/4	2 1/4	1 1/2	7/8	3/4	5/8	3/4	3/4	
10	10 3/4	16	14	8	3/4	1 1/16	11 3/4	12 3/16	—	—	11 1/2	10 7/8	2 1/2	1 3/4	1	3/4	5/8	3/4	3/4	
12	12 3/4	18	16	12	3/4	1 1/8	13 3/4	14 3/16	—	—	13 1/2	12 29/32	2 3/4	2	1	7/8	3/4	7/8	7/8	
13	14	19 1/4	17 1/4	12	3/4	—	—	—	—	—	15	14 5/32	2 7/8	2 1/8	1	7/8	3/4	7/8	7/8	
14	15 ^{F)}	20 3/4	18 1/2	12	7/8	—	—	—	—	—	16	15 5/32	2 7/8	2 1/8	1 1/8	1	7/8	1	1	
15	16	21 3/4	19 1/2	12	7/8	—	—	—	—	—	17	16 3/16	3	2 1/4	1 1/8	1	7/8	1	1	