BRITISH STANDARD

BS 2A 173:
1962+A7:2012

Specification for

100° Countersunk head steel bolts (Unified threads), cadmium plated, for aircraft

ICS 49.030.20

This British Standard, having been approved by the Aircraft Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution on 4 June 1962

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Foreword

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution.

This revision of BS A 173:1956 has been prepared to relate the standard to the relevant requirements of BS A 100. Additionally, provision has been made for the use of alternative materials for forged bolts, the use of BS S 96 material for machined bolts, and for closer limits on head protrusion, the values now shown being the same as those given in the American specification NAS. 517.

BS 2A 173:1962+A7:2012 supersedes BS 2A 173:1962 (incorporating Amendments Nos. 1:1962, 2:1962, 3:1964, 4: 1967, 5: 1976 and 6: 1988), which is withdrawn.

Text introduced or altered by Amendment No. 7(and No. 3) is indicated in the text by tags 〈A7〉 and 〈A7〉. Previous amendments are not indicated.

This British Standard marks a departure from the traditional method of dimensioning countersunk head bolts by means of toleranced dimensions for head diameter, head thickness, land and angle. The method now adopted is known as the "flushness tolerance" method and was first used in a British Standard for countersunk fasteners in BS 1981, "*Unified machine screws and machine screw units*." Its basic principles and advantages are outlined in Appendix A to this standard, together with suggested methods of gauging.

Reference is made in the standard to the following British Standards:

BS A 100, *Bolts and nuts for aircraft (general clauses).*

BS EN 2133 *Aerospace series. Cadmium plating of steels with specified tensile strength≤ 1450 MPa, copper, copper alloys and nickel alloys.*

BS S 95, *55 ton, 1½ per cent nickel-chromium-molybdenum steel.*

BS S 102, *Carbon-molybdenum steel.*

BS S 105, *Carbon steel.*

BS S 114, *55 ton manganese-molybdenum steel.*

BS S 116, *55 ton carbon steel.*

BS S 117, *55 ton 1 per cent chromium steel.*

BS S 147, *Nickel-chromium-molybdenum steel (bar for the manufacture of forged bolts only).*

BS S 148, *Low nickel-chromium steel (bar for the manufacture of forged bolts only).*

BS S 149, *1.75 per cent nickel-chromium-molybdenum steel.*

BS S 154, *2½ % nickel-chromium-molybdenum steel billets, bars, forgings and parts (880 – 1 080 MPa: limiting ruling section 150 mm).*

BS S 158, *1 % chromium-molybdenum steel bars for the manufacture of forged bolts and forged nuts.*

Reference is also made to:

Def Stan, 03-19 *Electro-deposition of cadmium*

NOTE 1 The values in British units are to be regarded as the standard. A table is given in Appendix B to provide a ready means of calculating the approximate millimetre equivalents of the inch dimensions. More accurate conversions should be based on the tables in BS 350.

NOTE 2 In place of the customary, but incorrect, use of the ton as a unit of force, the unit called a ton force (abbreviation tonf) has been used in this standard. It is the force which, when acting on a body of mass one ton, gives an acceleration equal to that of standard gravity.

CAUTION. BS A 173 bolts have cadmium as a plating material which has been restricted and/or banned for use in many countries owing to environmental and health concerns; they should not be used in new product designs. Local officials should be consulted about any concerns on the use of cadmium-plated parts.

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.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies the materials, dimensions, finish and inspection requirements for steel bolts with 100° countersunk heads and Unified threads [A7], cadmium plated,〈A7〉 for aircraft.

2 General requirements

The bolts shall comply with the relevant requirements of [A7] BS 4A 100:2003 〈A7〉 in respect of manufacture, screw threads, and [A7] protective finish 〈A7〉.

3 Material and manufacture

a) The bolts shall be manufactured by either of the following methods:

[A7] i) Machined from bright drawn alloy steel bars that conform to the latest issue of one of the following British Standards: 〈A7〉

BS S 95

or BS S 114

or BS S 116 — bolts up to and including ⅜ inch diameter;

or BS S 117

or BS S 154.

NOTE BS S 96 material may be used until stock are exhausted.

[A7] ii) Forged from alloy steel that conforms to the latest issue of one of the following British Standards: 〈A7〉

BS S 102

or BS S 105

or BS S 147

or BS S 148

or BS S 149

or BS S 158

b) In the finally heat-treated condition the mechanical properties of the material used for forged bolts shall be as follows:

0.1 per cent proof stress	not less than 43 tonf/in^2 (664 MPa)
Tensile strength	not less than 55 tonf/in^2 (850 MPa)
	not more than 65 tonf/in^2 (1 003 MPa)
Elongation on 4 $\sqrt{}$ area	not less than 18 per cent
Izod impact value	not less than 40 ft lbf (54 J)

4 Dimensions

a) All finished bolts, after the application of the [A7] protective finish〈A7〉 shall conform to the dimensions and tolerances given in Table 1 and Table 2.

b) The clamping length of the bolt shall conform to the dimensions and tolerances given in Table 2, and shall be such that, when a standard nut without countersink or a ring gauge without countersink has been screwed on as far as possible by hand, its leading face is within the distance M from the upper surface of the bolt head. The runout of thread shall not exceed twice the pitch.

c) The nominal length of the bolt shall be the minimum bearing length *L*, which is determined by the minimum clamping length *M*, less two thread pitches.

5 Screw threads

The bolts shall have Unified threads of the form and class of fit specified in the relevant requirements of [A7] BS 4A 100:2003. After coating, the bolt threads shall not exceed the basic size (maximum material condition) for the thread size and class of fit. 〈A7〉

6 [A7] Protective finish 〈A7〉

All finished bolts shall be coated with cadmium [A7] in accordance with Def-Stan 03-19 or BS EN 2133. 〈A7〉

7 Identification

The British Standard number and part number shall not be applied on the bolts, but shall be clearly marked on the labels of parcels of bolts.

8 Inspection procedure

The bolts shall be inspected in accordance with the relevant requirements of [A7] BS 4A 100:2003. 〈A7〉

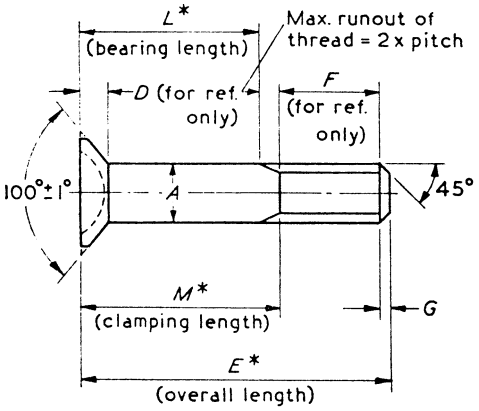
9 Gauging

a) The method of head dimensioning shown in Table 1 defines maximum and minimum head envelopes which control flushness in the manner defined in Appendix A.

b) The type of gauge shown in Figure 4 and Figure 5 is recommended as being suitable for flushness measurement, but the type of gauge to be used is not a mandatory requirement of this standard. The gauge shown in Figure 4 and Figure 5 does not control the head angle, which will require to be checked at intervals during production. An additional gauge will be necessary for the absolute minimum head diameter.

Table 1 — Dimensions

(Third Angle Project)



* For bearing length *L*, clamping length *M* and overall length *E*, see Table 2.

Figure 1

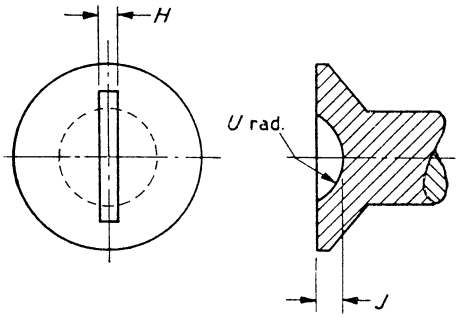


Figure 1b — Details of slots

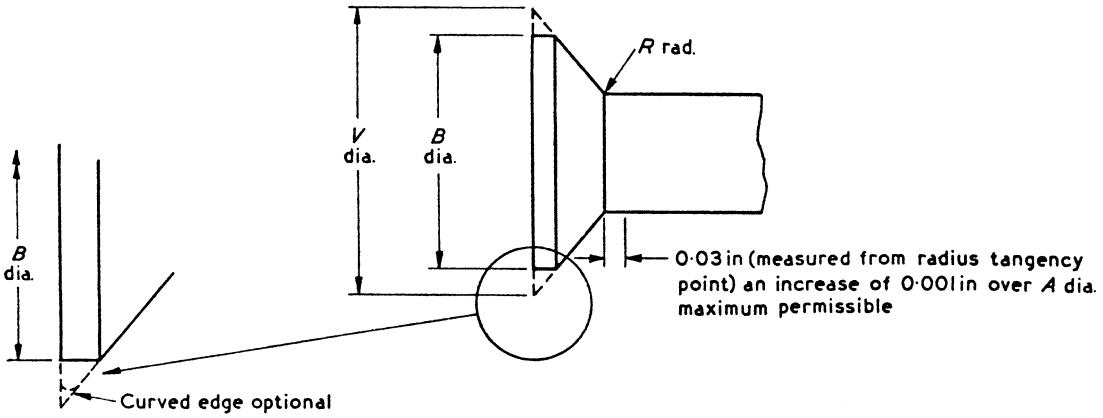
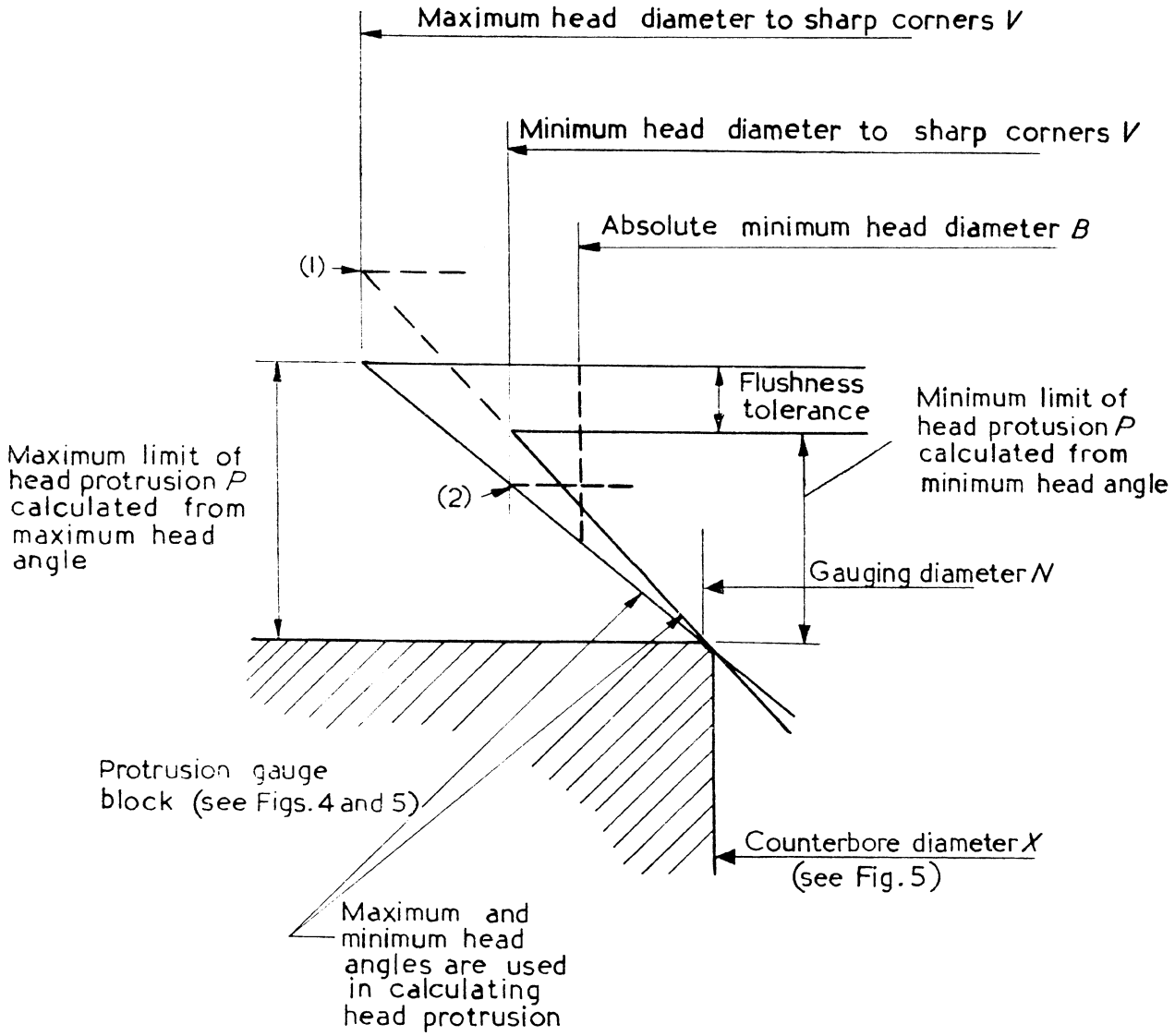


Figure 1a — Enlarged view of head

Table 1 — Dimensions



NOTE Gauges suitable for controlling flushness are described in Appendix A.

The limits on head protrusion do not permit the extreme limits on diameter to sharp corners and on head angle shown by 1) and 2) to occur in one and the same head. This is because the application of these countersunk heads demands a high degree of flushness.

1) Indicates the maximum head protrusion obtainable with the minimum head angle.

2) Indicates the minimum head protrusion obtainable with the maximum head angle.

Figure 2 — Diagram (part) showing maximum and minimum head conditions

Table 1 — Dimensions

1	2	3	4	5	6	7	8	9	10
Nominal [A7] thread [A7] size	**Decimal equivalent of nominal size**	**Diameter of plain portion of shank** *A*		**[A7]Thread runout[A7] 2 × pitch**	**Min. length of screwed portion of shank [A7] F[a] [A7]**	**Diameter of head**			**Nominal head depth[b]** *D* **(For reference only)**
						To sharp corners *V* **(For reference only)**		**Absolute minimum** *B*	
		max.	**min.**		**[A7]min. Ref[A7]**	**max.**	**min.**		
	in	in	in	in	in	in	in	in	in
No. 8-32 UNC	0.1640	0.1635	0.1605	0.063	0.327	0.334	0.323	0.287	0.068
No. 10-2 UNF	0.1900	0.1895	0.1865	0.063	0.377	0.387	0.375	0.337	0.080
1/4 in UNF	0.2500	0.2495	0.2465	0.071	0.459	0.510	0.496	0.452	0.106
5/16 in UNF	0.3125	0.3120	0.3090	0.083	0.497	0.638	0.622	0.572	0.133
3/8 in UNF	0.3750	0.3745	0.3715	0.083	0.597	0.766	0.748	0.692	0.159
7/16 in UNF	0.4375	0.4370	0.4335	0.100	0.670	0.894	0.874	0.812	0.186
1/2 in UNF	0.5000	0.4995	0.4960	0.100	0.770	1.022	1.000	0.932	0.213

1	11	12	13	14	15	16	17	18	19	20	21	22
Nominal [A7] thread [A7] size	**Gauging dia.** *N*	**Head protrusion**			**Radius under bolt head** *R*		**Depth of chamfer** *G*		**Slot**			
		Protrusion above gauging dia. *P*		**Flushness tolerance** *P* **max.** *– P min.)*					**Width** *H*		**Depth** *J*	**Rad.** *U*
		max.	**min.**		**max.**	**min.**	**max.**	**min.**	**min.**	**max.**	**–0.010 +0**	**± 0.010**
	in	in	in	in	in	in	in	in	in	in	in	in
No. 8-32 UNC	0.2671	0.0276	0.0238	0.0038	0.020	0.010	0.030	0.020	0.045	0.054	0.045	0.219
No. 10-32 UNF	0.3147	0.0299	0.0259	0.0040	0.020	0.010	0.030	0.020	0.050	0.060	0.060	0.219
1/4 in UNF	0.4245	0.0353	0.0307	0.0046	0.030	0.015	0.040	0.030	0.050	0.060	0.068	0.300
5/16 in UNF	0.5389	0.0409	0.0357	0.0052	0.030	0.015	0.040	0.030	0.050	0.060	0.087	0.300
3/8 in UNF	0.6532	0.0466	0.0407	0.0059	0.030	0.015	0.040	0.030	0.070	0.080	0.123	0.375
7/16 in UNF	0.7676	0.0522	0.0457	0.0065	0.030	0.015	0.050	0.040	0.070	0.080	0.134	0.375
1/2 in UNF	0.8820	0.0578	0.0507	0.0071	0.030	0.015	0.050	0.040	0.070	0.080	0.134	0.375

[a] This dimension is an absolute minimum associated with maximum length *M* and minimum length *E*. It is not intended that it shall be used for manufacturing or inspection purposes.

[b] These dimensions have been calculated as the mean between maximum and minimum head depth, corresponding to maximum and minimum diameters to sharp corners, the head angle and shank diameter being taken as nominal.

Table 2 — Bearing length *L*, clamping length *M* and overall length *E*

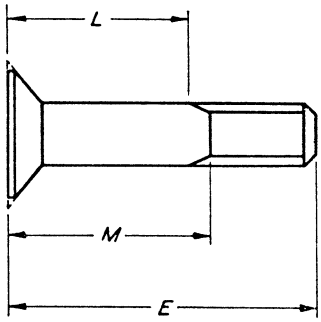


Figure 3

No. 8-32 UNC				No. 10-32 UNF			
Part No.	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**
	in	in	in		in	in	in
1C	0.1	0.193	0.55	1D	0.1	0.193	0.60
2C	0.2	0.293	0.65	2D	0.2	0.293	0.70
3C	0.3	0.393	0.75	3D	0.3	0.393	0.80
4C	0.4	0.493	0.85	4D	0.4	0.493	0.90
5C	0.5	0.593	0.95	5D	0.5	0.593	1.00
6C	0.6	0.693	1.05	6D	0.6	0.693	1.10
7C	0.7	0.793	1.15	7D	0.7	0.793	1.20
8C	0.8	0.893	1.25	8D	0.8	0.893	1.30
9C	0.9	0.993	1.35	9D	0.9	0.993	1.40
10C	1.0	1.093	1.45	10D	1.0	1.093	1.50
11C	1.1	1.193	1.55	11D	1.1	1.193	1.60
12C	1.2	1.293	1.65	12D	1.2	1.293	1.70
13C	1.3	1.393	1.75	13D	1.3	1.393	1.80
14C	1.4	1.493	1.85	14D	1.4	1.493	1.90
15C	1.5	1.593	1.95	15D	1.5	1.593	2.00
16C	1.6	1.693	2.05	16D	1.6	1.693	2.10
17C	1.7	1.793	2.15	17D	1.7	1.793	2.20
18C	1.8	1.893	2.25	18D	1.8	1.893	2.30
19C	1.9	1.993	2.35	19D	1.9	1.993	2.40
20C	2.0	2.093	2.45	20D	2.0	2.093	2.50
21C	2.1	2.193	2.55	21D	2.1	2.193	2.60
22C	2.2	2.293	2.65	22D	2.2	2.293	2.70
23C	2.3	2.393	2.75	23D	2.3	2.393	2.80
24C	2.4	2.493	2.85	24D	2.4	2.493	2.90
25C	2.5	2.593	2.95	25D	2.5	2.593	3.00
26C	2.6	2.693	3.05	26D	2.6	2.693	3.10
27C	2.7	2.793	3.15	27D	2.7	2.793	3.20
28C	2.8	2.893	3.25	28D	2.8	2.893	3.30
29C	2.9	2.993	3.35	29D	2.9	2.993	3.40
30C	3.0	3.093	3.45	30D	3.0	3.093	3.50
31C	3.1	3.193	3.55	31D	3.1	3.193	3.60
32C	3.2	3.293	3.65	32D	3.2	3.293	3.70
33C	3.3	3.393	3.75	33D	3.3	3.393	3.80

[a] See Clause **4** c).

Table 2 — Bearing length *L*, clamping length *M* and overall length *E*

No. 8-32 UNC				No. 10-32 UNF			
Part No.	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**
	in	in	in		in	in	in
34C	3.4	3.493	3.85	34D	3.4	3.493	3.90
35C	3.5	3.593	3.95	35D	3.5	3.593	4.00
36C	3.6	3.693	4.05	36D	3.6	3.693	4.10
37C	3.7	3.793	4.15	37D	3.7	3.793	4.20
38C	3.8	3.893	4.25	38D	3.8	3.893	4.30
39C	3.9	3.993	4.35	39D	3.9	3.993	4.40
40C	4.0	4.093	4.45	40D	4.0	4.093	4.50
41C	4.1	4.193	4.55	41D	4.1	4.193	4.60
42C	4.2	4.293	4.65	42D	4.2	4.293	4.70
43C	4.3	4.393	4.75	43D	4.3	4.393	4.80
44C	4.4	4.493	4.85	44D	4.4	4.493	4.90
45C	4.5	4.593	4.95	45D	4.5	4.593	5.00
46C	4.6	4.693	5.05	46D	4.6	4.693	5.10
47C	4.7	4.793	5.15	47D	4.7	4.793	5.20
48C	4.8	4.893	5.25	48D	4.8	4.893	5.30
49C	4.9	4.993	5.35	49D	4.9	4.993	5.40
50C	5.0	5.093	5.45	50D	5.0	5.093	5.50
51C	5.1	5.193	5.55	51D	5.1	5.193	5.60
52C	5.2	5.293	5.65	52D	5.2	5.293	5.70
53C	5.3	5.393	5.75	53D	5.3	5.393	5.80

[a] See Clause 4 c).

Table 2 — Bearing length *L*, clamping length *M* and overall length *E*

1/4 in UNF				5/16 in UNF				3/8 in UNF			
Part No.	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**
	in	in	in		in	in	in		in	in	in
2E	0.2	0.301	0.80	2G	0.2	0.313	0.85	2J	0.2	0.313	0.95
3E	0.3	0.401	0.90	3G	0.3	0.413	0.95	3J	0.3	0.413	1.05
4E	0.4	0.501	1.00	4G	0.4	0.513	1.05	4J	0.4	0.513	1.15
5E	0.5	0.601	1.10	5G	0.5	0.613	1.15	5J	0.5	0.613	1.25
6E	0.6	0.701	1.20	6G	0.6	0.713	1.25	6J	0.6	0.713	1.35
7E	0.7	0.801	1.30	7G	0.7	0.813	1.35	7J	0.7	0.813	1.45
8E	0.8	0.901	1.40	8G	0.8	0.913	1.45	8J	0.8	0.913	1.55
9E	0.9	1.001	1.50	9G	0.9	1.013	1.55	9J	0.9	1.013	1.65
10E	1.0	1.101	1.60	10G	1.0	1.113	1.65	10J	1.0	1.113	1.75
11E	1.1	1.201	1.70	11G	1.1	1.213	1.75	11J	1.1	1.213	1.85
12E	1.2	1.301	1.80	12G	1.2	1.313	1.85	12J	1.2	1.313	1.95
13E	1.3	1.401	1.90	13G	1.3	1.413	1.95	13J	1.3	1.413	2.05
14E	1.4	1.501	2.00	14G	1.4	1.513	2.05	14J	1.4	1.513	2.15
15E	1.5	1.601	2.10	15G	1.5	1.613	2.15	15J	1.5	1.613	2.25
16E	1.6	1.701	2.20	16G	1.6	1.713	2.25	16J	1.6	1.713	2.35
17E	1.7	1.801	2.30	17G	1.7	1.813	2.35	17J	1.7	1.813	2.45
18E	1.8	1.901	2.40	18G	1.8	1.913	2.45	18J	1.8	1.913	2.55
19E	1.9	2.001	2.50	19G	1.9	2.013	2.55	19J	1.9	2.013	2.65
20E	2.0	2.101	2.60	20G	2.0	2.113	2.65	20J	2.0	2.113	2.75
21E	2.1	2.201	2.70	21G	2.1	2.213	2.75	21J	2.1	2.213	2.85
22E	2.2	2.301	2.80	22G	2.2	2.313	2.85	22J	2.2	2.313	2.95
23E	2.3	2.401	2.90	23G	2.3	2.413	2.95	23J	2.3	2.413	3.05
24E	2.4	2.501	3.00	24G	2.4	2.513	3.05	24J	2.4	2.513	3.15
25E	2.5	2.601	3.10	25G	2.5	2.613	3.15	25J	2.5	2.613	3.25
26E	2.6	2.701	3.20	26G	2.6	2.713	3.25	26J	2.6	2.713	3.35
27E	2.7	2.801	3.30	27G	2.7	2.813	3.35	27J	2.7	2.813	3.45
28E	2.8	2.901	3.40	28G	2.8	2.913	3.45	28J	2.8	2.913	3.55
29E	2.9	3.001	3.50	29G	2.9	3.013	3.55	29J	2.9	3.013	3.65
30E	3.0	3.101	3.60	30G	3.0	3.113	3.65	30J	3.0	3.113	3.75
31E	3.1	3.201	3.70	31G	3.1	3.213	3.75	31J	3.1	3.213	3.85
32E	3.2	3.301	3.80	32G	3.2	3.313	3.85	32J	3.2	3.313	3.95
33E	3.3	3.401	3.90	33G	3.3	3.413	3.95	33J	3.3	3.413	4.05
34E	3.4	3.501	4.00	34G	3.4	3.513	4.05	34J	3.4	3.513	4.15
35E	3.5	3.601	4.10	35G	3.5	3.613	4.15	35J	3.5	3.613	4.25
36E	3.6	3.701	4.20	36G	3.6	3.713	4.25	36J	3.6	3.713	4.35
37E	3.7	3.801	4.30	37G	3.7	3.813	4.35	37J	3.7	3.813	4.45
38E	3.8	3.901	4.40	38G	3.8	3.913	4.45	38J	3.8	3.913	4.55
39E	3.9	4.001	4.50	39G	3.9	4.103	4.55	39J	3.9	4.103	4.65
40E	4.0	4.101	4.60	40G	4.0	4.113	4.65	40J	4.0	4.113	4.75
41E	4.1	4.201	4.70	41G	4.1	4.213	4.75	41J	4.1	4.213	4.85
42E	4.2	4.301	4.80	42G	4.2	4.313	4.85	42J	4.2	4.313	4.95
43E	4.3	4.401	4.90	43G	4.3	4.413	4.95	43J	4.3	4.413	5.05
44E	4.4	4.501	5.00	44G	4.4	4.513	5.05	44J	4.4	4.513	5.15
45E	4.5	4.601	5.10	45G	4.5	4.613	5.15	45J	4.5	4.613	5.25

[a] See Clause **4** c).

Table 2 — Bearing length *L*, clamping length *M* and overall length *E*

1/4 in UNF				5/16 in UNF				3/8 in UNF			
Part No.	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**
	in	in	in		in	in	in		in	in	in
46E	4.6	4.701	5.20	46G	4.6	4.713	5.25	46J	4.6	4.713	5.35
47E	4.7	4.801	5.30	47G	4.7	4.813	5.35	47J	4.7	4.813	5.45
48E	4.8	4.901	5.40	48G	4.8	4.913	5.45	48J	4.8	4.913	5.55
49E	4.9	5.001	5.50	49G	4.9	5.013	5.55	49J	4.9	5.013	5.65
50E	5.0	5.101	5.60	50G	5.0	5.113	5.65	50J	5.0	5.113	5.75
51E	5.1	5.201	5.70	51G	5.1	5.213	5.75	51J	5.1	5.213	5.85
52E	5.2	5.301	5.80	52G	5.2	5.313	5.85	52J	5.2	5.313	5.95
53E	5.3	5.401	5.90	53G	5.3	5.413	5.95	53J	5.3	5.413	6.05
54E	5.4	5.501	6.00	54G	5.4	5.513	6.05	54J	5.4	5.513	6.15

7/16 in UNF				1/2 in UNF			
2L	0.2	0.330	1.05				
3L	0.3	0.430	1.15	3N	0.3	0.430	1.25
4L	0.4	0.530	1.25	4N	0.4	0.530	1.35
5L	0.5	0.630	1.35	5N	0.5	0.630	1.45
6L	0.6	0.730	1.45	6N	0.6	0.730	1.55
7L	0.7	0.830	1.55	7N	0.7	0.830	1.65
8L	0.8	0.930	1.65	8N	0.8	0.930	1.75
9L	0.9	1.030	1.75	9N	0.9	1.030	1.85
10L	1.0	1.130	1.85	10N	1.0	1.130	1.95
11L	1.1	1.230	1.95	11N	1.1	1.230	2.05
12L	1.2	1.330	2.05	12N	1.2	1.330	2.15
13L	1.3	1.430	2.15	13N	1.3	1.430	2.25
14L	1.4	1.530	2.25	14N	1.4	1.530	2.35
15L	1.5	1.630	2.35	15N	1.5	1.630	2.45
16L	1.6	1.730	2.45	16N	1.6	1.730	2.55
17L	1.7	1.830	2.55	17N	1.7	1.830	2.65
18L	1.8	1.930	2.65	18N	1.8	1.930	2.75
19L	1.9	2.030	2.75	19N	1.9	2.030	2.85
20L	2.0	2.130	2.85	20N	2.0	2.130	2.95
21L	2.1	2.230	2.95	21N	2.1	2.230	3.05
22L	2.2	2.330	3.05	22N	2.2	2.330	3.15
23L	2.3	2.430	3.15	23N	2.3	2.430	3.25
24L	2.4	2.530	3.25	24N	2.4	2.530	3.35
25L	2.5	2.630	3.35	25N	2.5	2.630	3.45
26L	2.6	2.730	3.45	26N	2.6	2.730	3.55
27L	2.7	2.830	3.55	27N	2.7	2.830	3.65
28L	2.8	2.930	3.65	28N	2.8	2.930	3.75
29L	2.9	3.030	3.75	29N	2.9	3.030	3.85
30L	3.0	3.130	3.85	30N	3.0	3.130	3.95

[a] See Clause **4** c).

Table 2 — Bearing length *L*, clamping length *M* and overall length *E*

$^{7}/_{16}$ in UNF				$^{1}/_{2}$ in UNF			
Part No.	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**	**Part No.**	[a] ***L*** **min.**	***M*** **+0 −0.03**	***E*** **+0.04 −0**
	in	in	in		in	in	in
31L	3.1	3.230	3.95	31N	3.1	3.230	4.05
32L	3.2	3.330	4.05	32N	3.2	3.330	4.15
33L	3.3	3.430	4.15	33N	3.3	3.430	4.25
34L	3.4	3.530	4.25	34N	3.4	3.530	4.35
35L	3.5	3.630	4.35	35N	3.5	3.630	4.45
36L	3.6	3.730	4.45	36N	3.6	3.730	4.55
37L	3.7	3.830	4.55	37N	3.7	3.830	4.65
38L	3.8	3.930	4.65	38N	3.8	3.930	4.75
39L	3.9	4.030	4.75	39N	3.9	4.030	4.85
40L	4.0	4.130	4.85	40N	4.0	4.130	4.95
41L	4.1	4.230	4.95	41N	4.1	4.230	5.05
42L	4.2	4.330	5.05	42N	4.2	4.330	5.15
43L	4.3	4.430	5.15	43N	4.3	4.430	5.25
44L	4.4	4.530	5.25	44N	4.4	4.530	5.35
45L	4.5	4.630	5.35	45N	4.5	4.630	5.45
46L	4.6	4.730	5.45	46N	4.6	4.730	5.55
47L	4.7	4.830	5.55	47N	4.7	4.830	5.65
48L	4.8	4.930	5.65	48N	4.8	4.930	5.75
49L	4.9	5.030	5.75	49N	4.9	5.030	5.85
50L	5.0	5.130	5.85	50N	5.0	5.130	5.95
51L	5.1	5.230	5.95	51N	5.1	5.230	6.05
52L	5.2	5.330	6.05	52N	5.2	5.330	6.15
53L	5.3	5.430	6.15	53N	5.3	5.430	6.25
54L	5.4	5.530	6.25	54N	5.4	5.530	6.35

[a] See Clause **4** c).

Appendix A Principles of flushness control and recommended gauging practice

A.1 The major requirement of the user of a countersunk head bolt is that the upper surface of the head should fit with as great a degree of flushness as possible with the surface into which it is inserted. This flushness is dependent upon both the tolerance on the head of the bolt and that on the countersunk hole into which the head is fitted. The method of dimensioning adopted in this standard directly controls the flushness accuracy of the bolt in relation to the countersink, the result in an actual assembly being dependent upon the tolerance applied to the countersink, which is outside the scope of this standard.

A.2 In the traditional method of dimensioning countersunk head bolts, the limits on the bolt head thickness are affected by the tolerance on the shank diameter. This however is of no consequence in the matter of flushness and it would be necessary for any degree of flushness to exercise a closer control on head thickness and/or shank diameter if the traditional dimensioning methods were used.

A.3 The recommended methods of gauging flushness are simple and do not call for any measurement of difficult or dubious dimensions.

A.4 The most important aspect of the bolt head in the attainment of flushness is the position of the flat upper surface of the head in relation to the conical under surface. The gauging dimension by which this is controlled is that between the flat upper surface and a plane which cuts the conical surface normal to its axis at a specified diameter known as the gauging diameter (see Figure 2). The dimension measured is known as the "head protrusion" and its tolerance as the "flushness tolerance".

A.5 The variables which affect the flushness tolerance are:

a) The diameter to sharp corners (the hypothetical intersection of the flat upper surface and the conical under surface of the head) and

b) The included angle of the head.

The gauging diameter is at approximately one-third of the head depth from the upper surface.

A.6 The elements which define the bolt head and which are required to be controlled by inspection are:

a) head protrusion, the limits of which define the flushness tolerance;

b) diameter of head to sharp corners; this is controlled indirectly by the inspection of a and d.

c) actual diameter of head for which a minimum is specified and which is the diameter at the land;

d) included angle of the conical under surface;

e) radius between conical surface and shank.

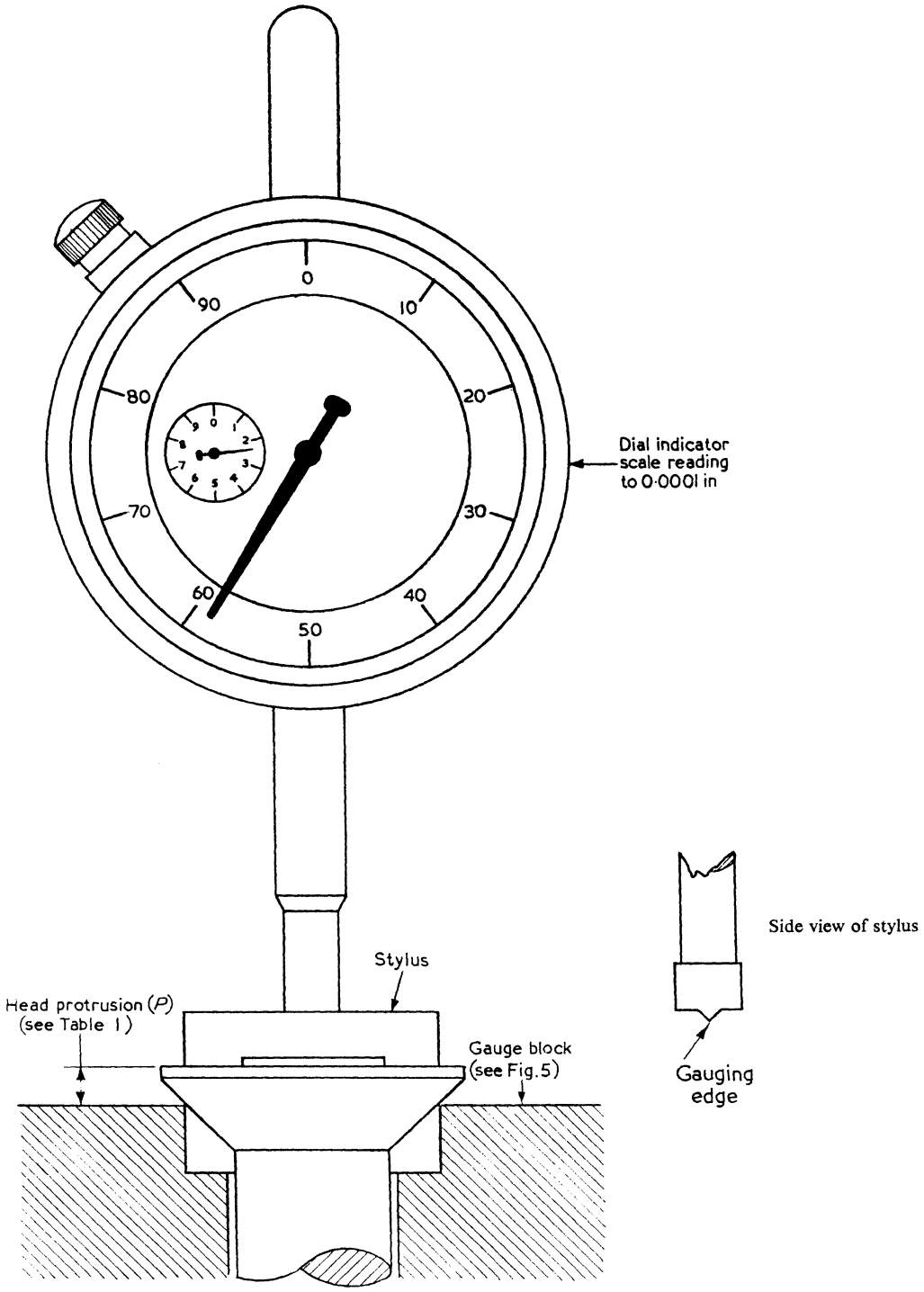
It is not a requirement of this standard that a particular method of inspection shall be employed. Head protrusion may be checked by means of a gauge of the type shown in Figure 4, by a GO — NOT GO gauge, by optical projection, or by any other suitable means. The actual diameter may be checked by direct measurement or by a GO — NOT GO gauge. The head angle and radius at shank may be checked by optical projection.

A.7 Figure 4 illustrates a type of gauge which has achieved some popularity for use with aircraft countersunk head bolts and rivets in the U.S.A. Details of a suitable gauge block are given in Figure 5.

The intersection of the hole X with the top surface of the gauge block forms the diameter on which the cone of the bolt head rests. The diameter of the hole X is slightly less than the gauging diameter N to permit the edge of the hole to be broken to form a land approximately 0.003 inch wide by lapping with a hardened steel ball until the dimension Z is within the stated limits. The dimension Z is calculated from the formula:

$$Z = \tfrac{1}{2}\ (Y + \sqrt{Y^2 - N^2})$$

When the bolt is inserted in the block, the dial indicator is used to give a direct reading of head protrusion which is the amount by which the top surface of the bolt head protrudes above the top surface of the gauge block.



Gauging edge of stylus and top surface of gauge block to be parallel within 0·0001 in. Indicator to be perpendicular to gauge block

Figure 4 — Method of measurement of head protrusion

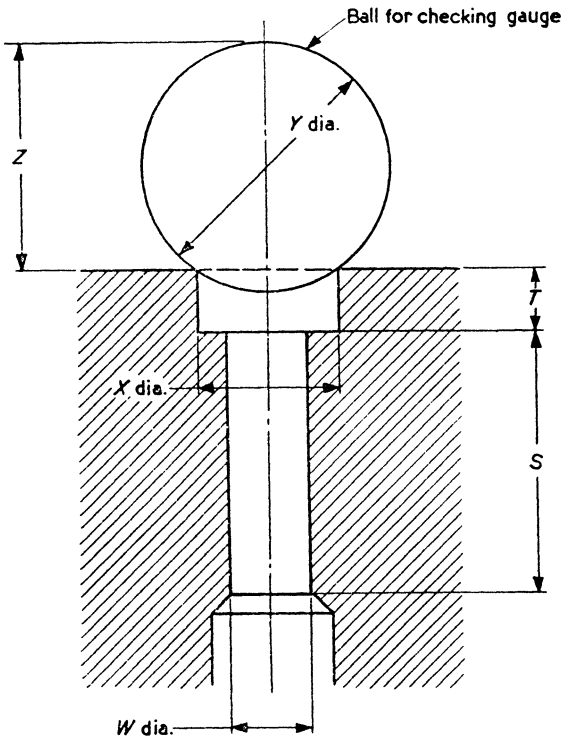


Figure 5 — Protrusion gauge block (see Figure 4 and Appendix **A.7**)

Nominal size of bolt	Ball dia. *Y*	Counter bore Dia. *X*	Ball protrusion *Z*[a]	Depth of counter bore *T*	Dia. of guide *W*	Length of guide *S*
	Nominal	+0 −0.001	+0.0002 −0	+0.010 −0	+0.001 −0	± 0.010
		in	in	in	in	in
No. 8-32 UNC	0.40625 ($^{13}/_{32}$)	0.263	0.3562	0.120	0.1665	0.25
No. 10-32 UNF	0.46875 ($^{15}/_{32}$)	0.311	0.4081	0.120	0.1935	0.30
$^{1}/_{4}$ in UNF	0.65625 ($^{21}/_{32}$)	0.420	0.5783	0.120	0.2535	0.40
$^{5}/_{16}$ in UNF	0.81250 ($^{13}/_{16}$)	0.535	0.7103	0.150	0.3160	0.50
$^{3}/_{8}$ in UNF	1.00000 (1)	0.649	0.8786	0.170	0.3785	0.60
$^{7}/_{16}$ in UNF	1.18750 ($1^{3}/_{16}$)	0.764	1.0468	0.200	0.4420	0.70
$^{1}/_{2}$ in UNF	1.31250 ($1^{5}/_{16}$)	0.878	1.1422	0.230	0.5045	0.80

[a] For the basis of calculation of this dimension see Appendix **A.7**.

Appendix B Table for conversion of inches to approximate millimetre equivalents

in	mm	in	mm
1/4	6.4	1	25.4
5/16	7.9	2	50.8
3/8	9.5	3	76.2
7/16	11.1	4	101.6
1/2	12.7	5	127.0
9/16	14.3	6	152.4
5/8	15.9	7	177.8
3/4	19.1	8	203.2
7/8	22.2	9	228.6
		10	254.0

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