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ISO metric precision hexagon bolts, screws and nuts — Specification

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- Confederation of British Forgers
- Electricity Association
- Society of Motor Manufacturers and Traders Limited
- UK Steel Association

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Foreword

This new edition of the British Standard has been prepared by Sub-Committee FME/9/6, General purpose fasteners and accessories, on behalf of Technical Committee FME/9, Bolts, nuts and accessories. It supersedes BS 3692:1967, which is withdrawn. This new edition embodies the text of amendment No. 1 (AMD 1720) and amendment No. 2 (AMD 8227).

The need for bolts, screws and nuts covered by this British Standard has been reviewed and it has been decided, in the interests of safety, to delete BS 3692:1967 Tables 10 and 13 (mechanical properties for bolts and screws) and to produce a new edition. In this edition, BS EN ISO 898-1 has been referred to as it reflects current thinking and practice of the mechanical properties for such products. This edition cross-refers to tables for mechanical properties of bolts, and brings the specification into line with BS EN ISO 898-1.

Annex A and Annex B are normative. Annex C, Annex D, Annex E, and Annex F, are informative.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared.

A British Standard does not purport to include all necessary provisions of a contract. Users of British standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 32, an inside back cover and a back cover.

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1 Scope

This British Standard gives the general dimensions and tolerances of precision hexagon bolts, screws and nuts with ISO metric threads in diameters from 1.6 mm to 68 mm inclusive. Mechanical properties are given only in respect of carbon or alloy steel bolts, screws and nuts, which are not to be used for special applications, such as those requiring weldability, corrosion resistance or ability to withstand temperatures above 300 °C or below 50 °C.

NOTE Nuts with an effective height of less than $0.6d$ and/or with a width across flats or outside diameter of less than $1.45d$ are excluded from the mechanical requirements specified.

The dimensional requirements of this standard also apply to non-ferrous and stainless steel bolts, screws and nuts.

NOTE It is considered that the range of nominal sizes included in this standard is adequate for most of the applications for which this series is likely to be employed, but for the convenience of users requiring larger sizes, further information in relation to the derivation of tolerances is provided in Annex E.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 1916-1:1953, *Limits and fits for engineering — Part 1: Limits and tolerances*.

BS 1916-2:1953, *Limits and fits for engineering — Part 2: Guide to the selection of fits in BS 1916-1*.

BS 1916-3:1963, *Limits and fits for engineering — Part 3: Recommendations for tolerances, limits and fits for large diameters*.

BS 3580:1964, *Guide to design considerations on the strength of screw threads*.

BS 3643-1:1981, *ISO metric screw threads — Part 1: Thread data and standard thread series*.

BS 3643-2:1981, *ISO metric screw threads — Part 2: Limits and tolerances for coarse pitch series threads*.

BS EN 10045-1:1990, *Charpy impact test on metallic materials — Part 1: Test method (V- and U-notches)*.

BS EN 10109-1:1996, *Metallic materials — Hardness test — Part 1: Rockwell test (scales A, B, C, D, E, F, G, H, K) and Rockwell superficial test (scales 15 N, 30 N, 45 N, 15 T, 30 T and 45 T)*.

BS EN 10109-2:1996, *Metallic materials — Hardness test — Part 2: Verification of Rockwell hardness testing machines (scales A, B, C, D, E, F, G, H, K, N, T)*.

BS EN 10109-3:1996, *Metallic materials — Hardness test — Part 3: Calibration of standardized blocks to be used for Rockwell hardness testing machines (scales A, B, C, D, E, F, G, H, K, N, T)*.

BS EN 20286-1:1993, *ISO system of limits and fits — Part 1: Specification for uses of tolerances, deviations and fits*.

BS EN 20286-2:1993, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*.

BS EN 20898-2:1994, *Mechanical properties of fasteners — Nuts with specified proof load values — Coarse thread*.

BS EN ISO 898-1:1999, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*.

BS EN ISO 1234, *Split pins*.

BS EN ISO 4042:2000, *Fasteners — Electroplated coatings*.

BS EN ISO 4759-1, *Tolerances for fasteners — Part 1: Bolts, screws, studs and nuts — Product grades A, B and C*.

BS EN ISO 6506-1:1999, *Metallic materials — Brinell hardness test — Part 1: Test method*.

BS EN ISO 6506-2:1999, *Metallic materials — Brinell hardness test — Part 2: Verification of Brinell hardness testing machines*.

BS EN ISO 6506-3:1995, *Metallic material — Brinell hardness test — Part 3: Calibration of reference blocks*.

BS EN ISO 6507-1:1998, *Metallic materials — Vickers hardness test — Part 1: Test method.*

BS EN ISO 6507-2:1998, *Metallic materials — Vickers hardness test — Part 2: Verification of testing machines.*

BS EN ISO 6507-3:1998, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks.*

3 Finishes

Steel precision bolts, screws and nuts are supplied with the following finishes:

- *Heat-treated bolts and screws.* Components heat-treated after manufacture are customarily dull black, although the manufacturer may machine some of the surfaces of the larger size bolts and screws after heat treatment.
- *Bright finished bolts and screws.* This term is used to describe bolts and screws which are finished bright on all surfaces or which have a finish on the hexagon, produced by bright drawing.
- *Nuts.* These may be bright on all surfaces or dull black when heat-treated.
- *Other finishes.* If the purchaser requires bolts, screws or nuts of steel (or other material) to be coated, they should state the type of coating required in their enquiry and order and it is recommended that reference be made to BS EN ISO 4042, in this respect.

If steel bolts, screws or nuts are required finished bright all over, the purchaser should state this in their enquiry and order.

4 General dimensions

The bolts, screws and nuts shall conform to the general dimensions given in Table 1, Table 5, Table 6, Table 7 and Table 8, and in clauses 5 to 10 inclusive.

5 Length of bolts and screws

5.1 Nominal length

The nominal length of a bolt or screw is the distance from the underside of the head to the extreme end of the shank including any chamfer or radius. The standard nominal lengths shall be as given in Table 8.

NOTE Preferred nominal lengths of bolts and screws, in association with diameters, are given in Annex D.

5.2 Tolerance on length

The tolerance on the nominal length shall be as given in Table 8.

6 Ends of bolts and screws

The ends of bolts and screws may, at the option of the manufacturer, be finished with either a 45° chamfer to a depth slightly exceeding the depths of thread or a radius approximately equal to one and a quarter times the nominal diameter of the shank. When bolts and screws are made with rolled threads, the lead formed at the end of the bolt by the rolling operation may be regarded as providing the necessary chamfer to the end with no other machining operation being necessary, and the end shall be reasonably square with the centre line of the shank. (See Figure 5 and Figure 6.)

7 Screw threads

7.1 General

The form of thread and diameters and associated pitches of standard ISO metric bolts, screws and nuts shall be in accordance with BS 3643-1.

7.2 Tolerances

The screw threads shall be made to the tolerances for the medium class of fit (6H/6g) as specified in BS 3643-2, unless a purchaser requires other classes of fit or fine pitch threads when this shall be the subject of agreement between the purchaser and the manufacturer.

8 Length of thread on bolts and screws

8.1 Bolts

8.1.1 The length of thread on bolts shall be the distance from the end of the bolt (including any chamfer or radius) to the leading face of a screw ring gauge, which has been screwed as far as possible on to the bolt by hand.

8.1.2 The standard thread lengths, as given in Table D.2, are based on the formulae given in Table 1.

Table 1 — Basis for standard thread lengths

Nominal length of bolt l	Length of thread b
Up to and including 125 mm	$2d + 6$ mm
Over 125 mm up to and including 200 mm	$2d + 12$ mm
Over 200 mm	$2d + 25$ mm

8.1.3 The length of thread runout shall not exceed the values given in column 3 of Table 5.

8.1.4 Bolts that are too short for minimum thread lengths shall be threaded as screws and shall be designated screws. Guidance in this respect is given in Annex D.

8.2 Tolerances

8.2.1 The tolerances on bolt thread lengths shall be plus two pitches for all diameters, as given in Table D.2.

8.2.2 The eccentricity of the thread relative to the shank of bolts shall not exceed the values given in column 19 of Table 5.

8.3 Screws

Screws shall be threaded to permit a screw ring gauge being screwed by hand to within a distance from the underside of the head not exceeding two and a half times the pitch for diameters up to and including 52 mm and three and a half times the pitch for diameters over 52 mm, in accordance with column 3 of Table 5.

9 Angularity and eccentricity of bolts, screws and nuts

9.1 The axis of the thread of the nut shall be square to the face of the nut subject to the “squareness tolerance” given in column 9 of Table 6, which is equivalent to an out of squareness of $\pm 1^\circ$.

The nut shall be screwed by hand on to a gauge having a truncated taper thread until the thread of the nut is tight on the thread of the gauge. A sleeve sliding on a parallel extension of the gauge, and which has a face of diameter equal to the minimum distance across flats of the nut and at exactly 90° to the axis of the gauge, shall be brought into contact with the leading face of the nut.

The sleeve shall be in such a position so that it shall not be possible for a feeler gauge of thickness equal to the squareness tolerance to enter anywhere between the leading face of the nut and the face of the sleeve (see Annex A).

9.2 The hexagon flats of bolts, screws and nuts shall be square to the bearing face, and the angularity of the head shall be within the limits of $90^\circ \pm 1^\circ$ (see Annex E).

9.3 The eccentricity of the hexagon flats of nuts relative to the thread diameter shall not exceed the values given in column 10 of Table 6.

9.4 The eccentricity of the head relative to the width across flats and eccentricity between the shank and thread of bolts and screws shall not exceed the values given in columns 18 and 19, respectively, of Table 5.

10 Chamfering, washer facing and countersinking

10.1 Bolts and screws

10.1.1 Bolt and screw heads shall have a chamfer of approximately 30° on their upper faces and, at the option of the manufacturer, a washer face or full bearing face on the underside unless the purchaser in his enquiry or order specifically states that he requires one of the alternatives available.

NOTE Attention is drawn to the fact that these alternative methods of finishing the underside of bolt and screw heads are associated with both the nominal size and the particular method of manufacture. A request by the purchaser for a specific type of finish limits the manufacturing processes available and it is therefore recommended that the purchaser avoids making such a request unless circumstances fully justify it.

10.2 Nuts

10.2.1 Nuts shall have a chamfer of approximately 30° on both faces.

10.2.2 Nuts shall be countersunk at an included angle of $120^\circ \pm 10^\circ$ at both ends of the thread. The diameter of the countersink shall conform to the requirements of ISO/FDIS 4759-1:2000 Figure 69 as follows:

$$d \leq 5 \text{ mm}: d_{\text{amax}} = 1.15d$$

$$5 \text{ mm} < d \leq 8 \text{ mm}: d_{\text{amax}} = d + 0.75$$

$$d > 8 \text{ mm}: d_{\text{amax}} = 1.08d$$

$$\text{for all sizes: } d_{\text{amin}} = d$$

Requirements apply to both sides of symmetrical parts.

11 Strength grade designation system for steel bolts and screws

Being in accordance with BS EN ISO 898-1, the strength grade designation system (property class symbol) for steel bolts and screws consists of two figures. The first is one hundredth of the minimum tensile strength in N/mm², and the second is one hundredth of the ratio between the minimum yield stress (or stress at permanent set limit, $R_{0.2}$) and the minimum tensile strength, expressed as a percentage, as illustrated below, for strength grade designation 8.8, in accordance with Table 2.

Table 2 — Strength grade designations of steel bolts and screws

Strength grade designation	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
Tensile strength R_m min. N/mm ²	400	400	500	500	600	800	1 000	1 200
Yield stress R_e min. N/mm ²	240	320	300	400	480	—	—	—
Stress at permanent set limit $R_{0.2}$ N/mm ²	—	—	—	—	—	640	900	1 080

12 Material and manufacture of steel bolts and screws

12.1 Method of production

Steel bolts and screws may be produced by cold forging, hot forging or by turning from bar. The choice of method shall be left to the manufacturer.

12.2 Chemical composition

The chemical compositions of steels, given in Table 2 of BS EN ISO 898-1, are for guidance only. The choice of steels shall be at the discretion of the manufacturer. The steel used shall be such that the finished product possesses the mechanical properties appropriate to the strength grade quoted.

12.3 Heat treatment

12.3.1 Grades designated 8.8, 10.9 and 12.9 shall be heat-treated to give the mechanical properties given in BS EN ISO 898-1.

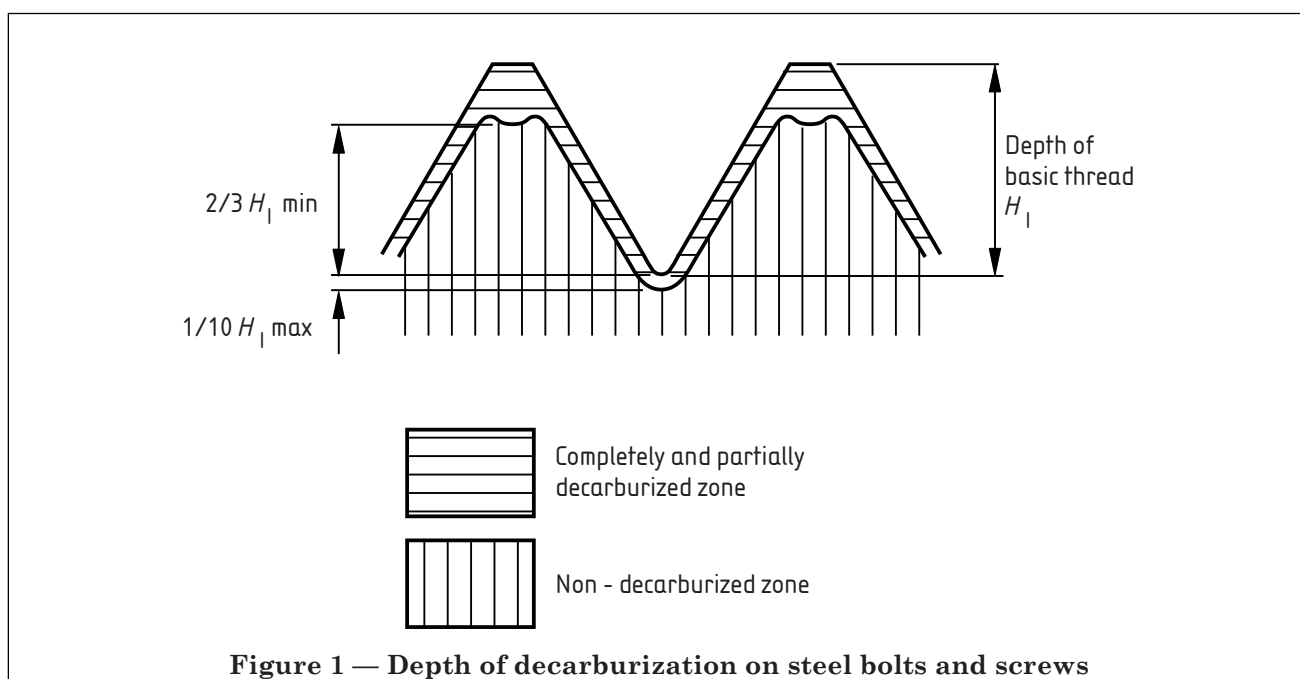
12.3.2 Other grades may be heat-treated if this is necessary to obtain the mechanical properties given in BS EN ISO 898-1.

12.4 Decarburization

12.4.1 Decarburization of the thread surface shall not be greater than stipulated below for bolts and screws of grade designations 8.8, 10.9, and 12.9.

12.4.2 The depth of the non-decarburized zone shall be not less than two thirds of the depth of the basic thread. In the root of the thread, the decarburization shall not exceed one tenth of the depth of the basic thread.

12.4.3 The method of measuring the amount of decarburization shall be as specified in BS EN ISO 898-1.



12.5 Rolling laps

NOTE When threads are produced by rolling, small laps are commonly present at the crests and are generally of a magnitude which is not detrimental to the performance of the bolt.

12.5.1 A lap formed at the crest of the thread perpendicular to the axis of the bolt shall not be considered a cause for rejection if the depth of the lap does not exceed 33 % of the depth of the thread.

12.5.2 Bolts of grades designated 10.9 and 12.9 shall be free from laps in the thread flank below the effective diameter. Laps in the flanks above the effective diameter shall not have a depth greater than 33 % of the thread depth.

13 Mechanical properties of steel bolts and screws

Steel bolts and screws shall meet the requirements for mechanical properties given in BS EN ISO 898-1.

14 Strength grade designation system for steel nuts

14.1 The strength grade designation system for steel nuts shall be a number that is one hundredth of the specified proof load stress in N/mm². The proof load stress corresponds to the minimum tensile strength of the highest grade of bolt or screw with which the nut can be used (see Table 3).

Table 3 — Strength grade designations of steel nuts

Strength grade designation	4	5	6	8	10	12
Proof load stress N/mm ²	400	500	600	800	1 000	1 200

14.2 The mechanical properties of steel nuts are given in Table 9.

14.3 It is recommended that the grades of nut to be used with each grade of bolt and screw should be as shown in Table 4.

Table 4 — Recommended bolt and nut combinations

Grade of bolt	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
Recommended grade of nut	4	4	5	5	6	8	10	12

NOTE Nuts of a higher strength grade may be substituted for nuts of a lower strength grade.

15 Material and manufacture of steel nuts

15.1 Method of production

Steel nuts may be produced by cold forging, hot forging or by turning from bar. The choice of method shall be left to the manufacturer.

15.2 Chemical composition

The chemical compositions of the steels from which nuts are made shall conform to those given in Annex B.

NOTE The use of free-cutting steels at temperatures above 250 °C is not recommended. Free-cutting steel may be used where permitted in Annex B, or otherwise by special agreement between the purchaser and the supplier.

15.3 Heat treatment

Nuts shall be heat-treated where this is necessary to obtain the mechanical properties given in clause 14.

16 Mechanical properties of steel nuts (excluding thin nuts)

Steel nuts (excluding thin nuts) shall meet the requirements for mechanical properties given in Table 9. The nuts shall withstand the proof load stress given in Table 9 when tested in accordance with Annex C. Nuts that are proof load tested shall have a hardness not in excess of the maximum given in Table 9. Nuts which are not proof load tested shall have a hardness not less than the minimum agreed between the purchaser and the supplier and not more than the maximum given in Table 9. The tests shall be in accordance with Annex C.

17 Drilled bolts with split pin holes

17.1 Bolts with split pin holes will be supplied only when specially ordered. The purchaser should state, in his enquiry and order, dimension l_p , as illustrated in Figure 2. A tolerance of $-0 + 0.8$ mm shall be permissible on the specified dimension l_p .

17.2 The split pin holes shall be drilled through the centre of the bolt as specified in BS EN ISO 1234.

18 Marking and identification (see also Annex E)

18.1 General

The marking and identification requirements of this standard are only mandatory for steel bolts, screws and nuts of 6 mm diameter and larger; manufactured to strength grade designations 8.8 (for bolts or screws) and 8 (for nuts) or higher.

18.2 Bolts and screws

Marking of bolts and screws shall be as specified in clause 9 of BS EN 20898-2:1994.

19 Inspection and testing

19.1 The manufacturer shall take the necessary steps to ensure that the requirements of this standard are fulfilled but if, in addition the purchaser desires the manufacturer to certify or demonstrate that the bolts, screws and nuts conform to this standard, the details and cost of any further inspection shall be the subject of agreement between the purchaser and the manufacturer.

19.2 Tests for mechanical properties shall be in accordance with Annex C and BS EN ISO 898-1.