

General requirements for steel protruding- head bolts of tensile strength 1250 MPa (180 000 lbf/in²) or greater — Specification

ICS 49.030.20

Committees responsible for this British Standard

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- BSI Product Services
- Civil Aviation Authority — Airworthiness
- Energy Institute
- MoD — UK Defence Standardization
- AeroSpace Defence Security
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Foreword

This British Standard was prepared by Technical Committee ACE/12. BS 2A 241:2005+A2:2010 supersedes BS 2A 241:2005, which is withdrawn.

The start and finish of text introduced by Amendments No. 1 and No. 2 is indicated in the text by tags **A1** **A1** and **A2** **A2**. Minor editorial changes are not tagged.

This revision of BS A 241 incorporates amendments AMD 2143 (1976), AMD 3067 (1979) and AMD 3356 (1980) together with amendments agreed in 2001.

This British Standard is intended for use in conjunction with those “A” series British Standard Aerospace Specifications in which conformity with this standard is a specific requirement.

This standard may also be applicable to other aerospace threaded fasteners, if required by the relevant specification, drawing, contract or order and is a companion to BS 4A 100, *Specification for general requirements for free running bolts and nuts of tensile strength not exceeding 1 249 MPa*.

A1 Parts held in stock might not have been processed in accordance with the amended standard. Parts manufactured after the issue of Amendment No. 1 are to conform to this standard. A list of qualified manufacturers can be obtained from the BSI Product Services website (<http://www.bsi-global.com/en/ProductServices/About-Certification/Aerospace>). **A1**

This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

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 to iii, a blank page, pages 1 to 31 and a back cover.

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1 Scope

This British Standard specifies the general requirements for metric and inch protruding head steel aerospace bolts of tensile strength of 1 250 MPa (180 000 lbf/in²) or greater.

The requirements related to nominal size are presented in individual tables A1 *Text deleted* A1 for use as appropriate to the relevant bolt specification. The values quoted for metric and inch bolts have a proportional relationship and are not direct conversions.

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 1134 (all parts), *Assessment of surface texture*.

A2 BS 3643-1, *ISO metric screw threads — Part 1: Principles and basic data*.

BS 3643-2, *ISO metric screw threads — Part 2: Specification for selected limits of size*. A2

BS 6001 (all parts), *Sampling procedures for inspection by attributes*.

A2 BS A 346 (ISO 3161), *UNJ threads — General requirements and limit dimensions*.

BS A 358-1 (ISO 5855-1), *MJ threads — Part 1: General requirements*.

BS A 358-2 (ISO 5855-2), *MJ threads — Part 2: Limit dimensions for bolts and nuts*. A2

BS 2A 231, *Rolled threads for bolts. Lead and runout requirements*. (ISO 3353:1992).

BS 4A 4, *Test pieces and test methods for metallic materials for aircraft — Metric units*.

BS 4A 228, *Specification for steel double hexagon bolts — 1 250 MPa (180 000 lbf/in²) for aircraft*.

BS EN 9100, *Aerospace series — Quality management systems — Requirements (based on ISO 9001:2000) and Quality systems — Model for quality assurance in design, development, production, installation and servicing (based on ISO 9001:1994)*.

BS EN ISO 6507 (all parts), *Metallic materials — Vickers hardness test*.

A2 BS EN ISO 6508 (all parts), *Metallic hardness — Rockwell Hardness Test*.

BS EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles*. A2

A1 *Text deleted* A1

3 General

3.1 Material

3.1.1 The bolts shall be manufactured from the material specified in the relevant bolt standard.

3.1.2 Bolts shall be rejected at any time for faults in or revealed by manufacture, even if they have been made from material that previously conformed to the relevant material standard.

3.2 Manufacture

3.2.1 The heads of bolts shall be formed by forging before heat treatment.

The lightening hole of the double hexagon design may be machined or forged.

A1 Bolts shall be hot forged at a temperature of 1 100 °C ± 15 °C: the heating equipment shall be approved by the design authority and shall ensure consistent temperature throughout the part. A1

3.2.2 The forged blanks shall be heat treated in accordance with the requirements of the material standard to produce the properties required by the relevant bolt standard and this standard. No blank shall be submitted to the specified heat treatment more than three times.

3.2.3 The headed and heat-treated blanks shall have the shank, and bearing surface of the head, machined or wet ground. The amount of metal removed shall be as little as practicable; consistent with the production of a clean smooth surface and the maintenance of optimum grain flow around the underhead radii as specified in **4.6.2.2**. After machining or grinding and before thread and fillet rolling, the bolts shall be stress relieved at a temperature 25 °C to 50 °C below the actual tempering temperature used for not less than one hour.

3.2.4 Threads shall be formed by a single rolling process after final heat treatment unless otherwise permitted by individual customer specification.

3.2.5 All processes of manufacture shall be to the satisfaction of the design authority.

3.2.6 **[A₁]** The head to shank fillet shall be rolled after final heat treatment. Radius R shall blend smoothly with face and shank, subject to the requirements of Annex A. **[A₁]**

The fillet radius, after rolling, shall conform to the requirements of the relevant bolt standard. The fillet area may be distorted as shown in Annex A. There shall be no machining of the fillet radius after rolling.

3.2.7 **[A₁]** After completion of all machining and grinding and prior to surface treatment, each batch of bolts shall be etch inspected as specified in Annex D in accordance with a process approved by the design authority. **[A₁]**

3.2.8 The bolts shall be visually examined by a suitably qualified person to determine if any machining or grinding abuse is present. Where present, all parts from the batch concerned shall be reworked to remove the abuse or be scrapped.

3.2.9 Within two hours after etch inspection, the bolts shall be de-embrittled for a minimum of one hour.

3.3 Dimensions

All bolts shall conform to the dimensions and tolerances specified in this standard and in the relevant bolt standard. The dimensions shall be controlled as specified in 4.3.

3.4 Run-out and lead thread of screw threads

The bolts shall have a run-out and lead thread conforming to BS 2A 231.

3.5 Surface treatment

3.5.1 All bolts shall be de-embrittled after surface treatment in accordance with the relevant standard.

NOTE It is recommended that the de-embrittlement temperature is not less than 190 °C and the de-embrittlement time not less than eight hours.

3.6 Identification marking

3.6.1 Bolts shall have the manufacturer's symbol applied to the upper face of the head.

3.6.2 **[A₂]** Bolts of thread size 0.190 inch, M5 or MJ5 **[A₂]** and larger shall have the complete part number (e.g. A... 3D) applied to the upper face of the head. Bi-hexagonal bolts shall have the complete part number applied either around the collar or on the top face at the manufacturer's option unless otherwise stated.

3.6.3 Bolts smaller than **[A₂]** thread size 0.190 inch, M5 or MJ5 **[A₂]** shall have the length and size number (e.g. 3B) applied to the upper face of the head.

3.6.4 Identification marking shall be by microprocessor "controlled dot peen" or forged raised or depressed characters, or another suitable alternative permitted by the design authority.

3.6.5 Controlled dot peening process shall use an indenting stylus with a hardness of not less than 54 Rockwell "C", a 0.005 inch (0.127 mm) minimum tip radius and an indentation depth not exceeding 0.002 inch (0.051 mm).

3.6.6 Forged markings shall be integrally forged with a character height that is not less than 0.025 inch (0.635 mm). The depth of the depressed characters shall not exceed 0.010 inch (0.254 mm).

3.6.7 All markings shall be clear and legible after surface treatment when viewed at a magnification not exceeding ×5.

3.7 Packaging

The bolts shall be packed so as to prevent damage during handling, transportation and storage. Each individual package of bolts shall have, as a minimum, the complete part number, batch identification and manufacturer's symbol clearly shown on the label.

4 Quality Assurance and product qualification testing approvals

4.1 General

4.1.1 *Quality Assurance approval*

The bolt manufacturers shall have a Quality Management System in accordance with the requirements of BS EN 9100.

NOTE 1 Product certification/inspection/testing. Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this British Standard. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

NOTE 2 The prime contractor, in the context of this British Standard, may also be the design authority.

4.1.2 *Definition of a batch*

A batch shall consist of finished bolts which are of the same type and diameter, fabricated by the same process from material of the same cast, heat treated as one lot and processed as one continuous run, and free from any interruption or changes that might be expected to result in a significant variation in the quality of the finished product.

4.1.3 *Product qualification testing approval*

4.1.3.1 Prior to production, each manufacturer shall perform product qualification testing in accordance with Annex B. A delegated representative acceptable to the design authority (who may be the prime contractor) shall independently witness product qualification testing. Records of this product qualification testing shall be retained by the manufacturer and form part of the Quality Assurance records (see 4.1.5).

4.1.3.2 Once qualified, the manufacturing route shall be sealed and not changed without the agreement of the qualification body, who might require re-qualification to re-establish manufacturing route compliance to specification. **[A]** Manufacturers who have previously supplied bolts conforming to this British Standard before its Amendment 1 may continue to do so until their manufacturing routes are changed. Notification of any changes shall be sent to the design authority.

NOTE Examples of change include changes to the company name, company identity, change in manufacturing location or changes to the existing facility. **[A]**

4.1.4 *Materials, surface treatments and testing*

The manufacturer shall satisfy the design authority that the procedures adopted by the manufacturer in respect of materials, surface treatments and testing conform with the relevant specifications and that the identity of all materials, surface treatments and testing is retained as part of the Quality Assurance batch record.

4.1.5 *Records*

4.1.5.1 The manufacturer shall establish and use a batch control record system to the satisfaction of the design authority. As a minimum, the batch control record system shall record the batch number and identity of the raw material used, the total batch quantity made, the number scrapped during manufacture, a record of all interstage processes and inspections and a record of all surface treatments (together with certification details where appropriate) and tests made in accordance with this specification.

4.1.5.2 The manufacturer shall establish a record retention system to the satisfaction of the design authority that, as a minimum, ensures that records are retained for not less than 10 years (or other period as specified by the design authority) after the date of last sale of any individual batch or lot.

4.1.6 *Sampling*

Except where 100 % inspection is specified, sampling procedures shall satisfy the requirements of the design authority and demonstrate by use of the sample procedures specified in 4.1.7 for dimensional and 4.2 for non-destructive inspection and as specified in Annexes C and D for destructive tests on finished products that the procedures adopted by the manufacturer **[A]** provide **[A]** conforming product.

4.1.7 *Sample size for dimensional inspection*

Samples for dimensional testing inspection shall be taken from each batch in accordance with BS 6001, at the acceptance quality limit (AQL) level shown in Table 1 of this standard. The acceptance or rejection shall depend upon the accept/reject criteria of the appropriate AQL listed in BS 6001.

Table 1 — AQL for use with BS 6001 Inspection level II

AQL	Characteristics
1.0	Incomplete threads Thread size and form Thread run out Shank diameter Grip length Radius under head Drilled holes in head missing (when required) Squareness between head bearing surface and shank Straightness of shank Surface texture Burrs and tool marks Surface treatment Identification Lightening hole depth
2.5	Overall length Head diameter Head height Width across flats Concentricity of shank and thread pitch diameter Concentricity of head and shank Drilled holes diameters and location Lightening hole diameter
4.0	Chamfer on thread end Collar height Collar diameter

4.2 Sample size for non-destructive testing

Samples for non-destructive testing shall be taken from each batch in accordance with BS 6001 at 0.065 AQL Inspection level II. The acceptance or rejection shall depend upon the accept/reject criteria of the AQL.

4.3 Control of dimensions

4.3.1 All dimensions shall be controlled by a system of gauging.

4.3.2 A gauge recording and control system shall be established to the satisfaction of the design authority for each gauge and other measuring and test equipment used by the manufacturer. As a minimum, the system shall provide for each piece of equipment to be uniquely identified and calibrated at known intervals to ensure conformance with the requirements of the appropriate equipment specification.

4.4 Surface texture

The surface texture shall be determined in accordance with BS 1134 and shall be as specified in Table 2.

Table 2 — Surface texture

Feature	Maximum surface roughness R_a (see BS 1134) μm (μin)
Head to shank fillet, thread root, thread flanks, and run out	0.8 (32)
Shank diameter and bearing, surface of head	0.8 (32)
All other features	3.2 (125)

4.5 Geometric tolerances

The tolerances of the bolt's geometric features shall be as shown in Figure 1 and Table 3.

[A₁] Text deleted **[A₁]**

Table 3 — Straightness tolerance bolts

Inch series bolts		Metric series bolts	
[A₂] Thread inch [A₂]	Straightness tolerance	[A₂] Thread ISO metric and MJ mm [A₂]	Straightness tolerance
0.164 and 0.190	0.15% of bolt length plus an additional 0.001 inch	[A₂] 4 and 5 [A₂]	0.15% of bolt length plus an additional 0.025 mm
0.250	[A₂] 0.12% [A₂] of bolt length plus an additional 0.001 inch	[A₂] 6 and 8 [A₂]	[A₂] 0.12% [A₂] of bolt length plus an additional 0.025 mm
0.3125 and 0.375	[A₂] 0.10% [A₂] of bolt length plus an additional 0.001 inch	[A₂] 10 [A₂]	[A₂] 0.10% [A₂] of bolt length plus an additional 0.025 mm
0.4375	[A₂] 0.07% [A₂] of bolt length plus an additional 0.001 inch	[A₂] 12 [A₂]	[A₂] 0.07% [A₂] of bolt length plus an additional 0.025 mm
0.500 and larger	[A₂] 0.05% [A₂] of bolt length plus an additional 0.001 inch	[A₂] 14 and larger [A₂]	[A₂] 0.05% [A₂] of bolt length plus an additional 0.025 mm

4.6 Freedom from material defects

4.6.1 Magnetic flaw detection

4.6.1.1 All bolts shall be subjected to magnetic flaw detection for both longitudinal and transverse defects. During the examination, unless otherwise agreed by the design authority, the bolts shall be in their finished condition.

4.6.1.2 The flaw detection shall be in accordance with **[A₂]** BS EN ISO 9934-1 **[A₂]** or a recognized alternative process as required by the design authority. It shall be undertaken by personnel accredited to a non-destructive testing scheme recognized by the design authority.

4.6.1.3 The flaw detection scheme shall have access to, and use techniques approved by, an accredited level 3 person.

4.6.1.4 After flaw detection, all bolts shall be demagnetized.

4.6.1.5 No cracks (defined as clean crystalline break passing through the grain or grain boundary) are permitted in any location. Any bolt showing a transverse indication or an indication extending at an angle of more than 10° to the longitudinal axis shall be rejected. Other discontinuities shall only be permitted as specified in Annex D.

