

TECHNICAL SPECIFICATION

No. TS22™

MANUFACTURING SPECIFICATION

FOR BOLTS

**1100 MPa (159,000 lbf/in²) ULTIMATE TENSILE STRENGTH
MINIMUM AT ROOM TEMPERATURE**



Aerospace Standards Part Qualification Program

A Program of SAE ITC

RATIONALE

Eleventh issue of this Technical Spec.

The inspection requirement for billet cleanliness of BS S159 has been included in paragraph 5.1 to allow the use of ASTM E45 as this is considered to be a more stringent methodology.

For full details of changes, refer to supplementary SAE ITC Amendment Record document TS22-AR.

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**SAE INDUSTRY TECHNOLOGIES CONSORTIA
AEROSPACE STANDARDS AND PART QUALIFICATION PROGRAM**

FOREWORD

On the 1st January 2015 the SAE Industry Technologies Consortia (SAE ITC) acquired the ADS Aerospace Standards, previously known as the Society of British Aerospace Companies (SAE ITC) Aerospace Standards. The SAE ITC established in 2003 operates as a trade association as part of the SAE International Enterprise, providing a unique framework serving the automotive, aerospace and commercial vehicle sectors. Clients include private companies, government agencies, individuals and trade associations. Building consensus and breakthrough barriers to achieve solutions, and the ways by which those solutions take shape are tailored to each client's individual needs.

The legal obligations and copyright authority of all Aerospace Standards that were issued by the ADS Group Limited are therefore assigned / transferred to the SAE ITC.

These Standards are produced by the SAE ITC with the assistance of, and for the benefit of the Aerospace Industry, as part of a continuous programme of Standardisation for Aerospace application under the control of the Technical Standards Committee (TSC) of the SAE ITC.

SAE ITC Standards are published as part of the series of SAE ITC Aerospace Industry Standards, and where appropriate, additional manufacturing and inspection requirements are issued as Reference Sheets (RS) or Technical Specifications (TS). It is the responsibility of those using or specifying a Standard to ensure the product, process, or manufacturer so used or specified, is appropriate for the task or role in question. The SAE ITC wishes to draw special attention to the fact Technical Specifications (TS) include testing and procedures by which a user or Design Authority can establish whether a particular manufacturer, *prima facie*, has the capability to produce hardware in accordance with the appropriate standards and related specifications.

The SAE ITC, its servants, or representatives accept no responsibility for the continued quality of hardware items produced against the relevant drawings and specifications; this responsibility remains with the user.

Whilst the SAE ITC takes all reasonable care in the preparation of its Standards, neither the SAE ITC, its officers, employees, servants, agents or representatives, shall have any responsibility or liability whatsoever with respect to any act or omission (whether negligent or not) of whatsoever nature, or in connection with the preparation of the Standards or any part thereof. These responsibilities are those of the user or Design Authority. Users of SAE ITC Standards agree that any such liability on the part of the SAE ITC is excluded to the maximum extent permitted by law. SAE ITC Standards may be changed from time to time, and both users and manufacturers of these parts should ensure they are in possession of the latest issue of the Standards and supporting documentation before adoption or the commencement of production.

It is recommended that Technical Specification TS260, Metallic Materials List of Alternative Material Standards, be consulted prior to manufacture of SAE ITC products.

Each Standard is a facsimile or electronic reproduction of a master drawing, and therefore, any outline view scales stated are not necessarily reproduced accurately. A Master Index of all SAE ITC Aerospace Standards is published separately on the SAE ITC website.

All references to Standards include reference to RS and TS publications.

Details of this and any further information can be obtained from the SAE ITC.

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1. SCOPE

This specification covers the requirements for forged bolts in BS S159 material with rolled underhead radii. The bolts will develop a minimum ultimate tensile strength of 1100 MPa (159,000 lbf/in²) at room temperature and are suitable for use up to a temperature of 450°C.

2. ASSOCIATED SPECIFICATIONS

2.1 The following documents, in whole or in part, are normatively referenced in this Technical Specification & are indispensable for its application. For dated / revision listed references, only the issue cited applies. For undated / revision listed references, the latest issue of the referenced document (including any amendments) applies.

2.1.1 American Society for Testing and Materials (ASTM)

ASTM E1444 Standard practice for Magnetic Particle inspection.

2.1.2 British Standards Institution (bsi.)

BS S159 12% Chromium heat resisting steel.

BS A4 Test pieces and methods for aircraft materials.

BS M39 Penetrant inspection of aerospace materials and components.

BS 240 Method for Brinell hardness test.

BS 427 Method for Vickers hardness test.

BS 891 Method for Rockwell hardness test

BS 1134 Surface texture.

BS 1580 Unified screw threads.

BS 6072 Method for Magnetic particle inspection.

2.1.3 UK Defence Standardization

DEF STAN 03-2 Cleaning and preparation of metal surfaces.

2.1.4 International Standards Organisation (ISO)

ISO 3161 Unified screw threads of 'UNJ' basic profile.

2.1.5 SAE Industry Technologies Consortia (ITC)

RS 610 Identification marking of parts and assemblies.

RS 678 Rolled fastener thread, lead and run-out threads.

TS 200 Qualified manufacturers for SAE ITC aerospace industry standard parts.

TS 201 Method change approval for qualified parts.

TS 202 Qualification test requirements and procedures for aerospace industry standard parts.

3. DEFINITION OF TERMS

3.1 Authorities

3.1.1 Design Authority:

The Design Authority is the SAE ITC Technical Standards Committee (TSC).

3.1.2 Qualification testing authority:

The qualification testing authority shall be the SAE ITC Technical Standards Committee or other body nominated by the TSC to carry out the testing.

3.1.3 **Quality assurance authority**

The quality assurance authority will be as agreed by the TSC. Generally the quality assurance authority will be that of the design activity.

3.2 **Production Batch:**

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

3.3 **Inspection lot:**

An inspection lot consists of bolts from a single production batch of the same part number that completely defines the lot.

3.4 **Discontinuities**

3.4.1 **Crack:**

Rupture in a material, which may extend in any direction and which may be intercrystalline or transcrystalline in character.

3.4.2 **Seam:**

Open surface defect.

3.4.3 **Lap:**

Surface defect caused by folding over metal fins or sharp corners and then rolling or forging them into the surface.

3.4.4 **Inclusion:**

Non-metallic particles originating from the material making process. They may exist as discrete particles or strings of particles extending longitudinally.

3.5 **Test temperature:**

Ambient temperature, unless otherwise specified.

3.6 **Simple Random Sampling:**

The taking of n items from a population of N items in such a way that all possible combinations of n items have the same probability of being chosen.

3.7 **Critical defect:**

A defect that according to judgement and experience, is likely to result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the considered product, or that is likely to prevent performance of the function of a major end item.

3.8 **Major defect:**

A defect other than critical, that is likely to result in a failure or to reduce materially the usability of the considered product for its intended purpose.

3.9 **Minor defect:**

A defect that is not likely to reduce materially the usability of the considered product for its intended purpose, or that is a departure from established specification having little bearing on the effective use or operation of this product.

3.10 Sampling plan:

A plan according to which one or more samples in order to obtain information and to possibly reach a decision.

3.11 Limiting Quality LQ10:

In a sampling plan, a quality level which corresponds to a specific and relatively low probability of acceptance – in this case 10% probability of acceptance. It is the limiting lot quality characteristics that a lot of this quality would occur.

When expressed as a percent defective, it may be referred to as a lot tolerance percent defective.

3.12 Acceptance quality level:

3.12.1 A quality level which in a sampling plan corresponds to a specified but relatively high probability of acceptance.

3.12.2 It is the maximum percent defective (or the maximum number of defects per hundred units) that, for purpose of sampling inspection, can be considered satisfactory as a process average.

3.13 Product Standard:

A standard published by SAE ITC document bearing the prefix AS, AGS or ESC to define the requirements of parts. Available from any current SAE ITC Distributor.

3.14 Qualification Testing:

Tests performed or observed by the Mandated Body to determine that SAE ITC Standard Parts meet the requirements shown in the relevant Technical Specification and Product Standard.

3.15 Technical Standards Committee (TSC):

The SAE ITC committee who has authority over qualification and standards issues.

3.16 Technical Specification:

A document published by SAE ITC bearing the prefix TS that defines the Qualification Testing Requirements of an SAE ITC Product Standard.

3.17 Finished bolt:

A bolt ready for use, inclusive of any possible treatments and/or surface coatings, as specified on the relevant bolt drawing.

4. QUALITY ASSURANCE**4.1 General****4.1.1 Material and surface treatment**

The bolt manufacturer shall provide evidence to the quality assurance authority that the controls for the bolt material and surface treatment process complies with the relevant specifications, and shall also show that the identity of the bolt material has been maintained throughout all stages of manufacture.

4.1.2 Records

The manufacturer shall establish a batch record chart (or card) to the satisfaction of the quality assurance authority. The record shall show the batch quantity and the serial numbers of certificates covering approval of the material. The results of the inspections and tests made to the requirements of this specification shall be recorded and correlated with the batch numbers, and batch chart (or card) shall show the serial numbers of those records to the satisfaction of the quality assurance authority.

4.1.3 Dimensional control during manufacture

The manufacturer shall satisfy the quality assurance authorities that the frequency and results of inspections made at each operation during manufacture of each part are adequate.

4.1.4 Dimensions and Gauging

4.1.4.1 All dimensions shall be controlled by a system of gauging, which, with the type and quality of all gauges, projection apparatus, diagrams and inspection techniques, shall be to the satisfaction of the quality assurance authority. In cases of dispute: -

- a) The full threads shall be checked with fixed limit gauges.
- b) Notwithstanding the reaction of the threads to the gauges, the overall profile must be acceptable when checked with an optical projector and line limit diagrams.

4.1.4.2 Each gauge and projection diagram shall be marked with its reference number (serial number) and in the case of non-adjustable gauges, marked with the gauging dimensions. Each gauge shall further be certified initially, and thereafter the standard of accuracy of each gauge shall be maintained by regular certification, either at an approved gauge test house or, if agreed with the quality assurance authority, at the manufacturers own test room. The accuracy of each projection diagram shall be to the satisfaction of the quality assurance authority.

4.1.4.3 A record card shall be maintained for each gauge showing the initial dimensions of each gauging element, the frequency of the maintenance checks and the gauge dimensions resulting there from, to the satisfaction of the quality assurance authority.

4.2 Qualification

4.2.1 A minimum of 25 finished bolts of each diameter for which qualification is required, manufactured in accordance with the requirements of this specification and by a technique which is to be used for future deliveries, shall be supplied by the bolt manufacturer for evaluation in accordance with TS202 "SAE ITC qualification test requirements and procedures for aerospace industry standard parts."

4.2.2 The qualification inspections and tests (requirements, methods, numbers of bolts) are specified in Table 1.

4.2.3 Table 2 indicates the allocation of bolt specimens for the inspections and tests.

4.2.4 Re-qualification may be called for from time to time at the discretion of the Design Authority.

4.2.5 If there is any purpose change in manufacturing source or method, the procedures specified in TS201 "Method change approval for qualified parts" shall be initiated.

4.3 Acceptance

4.3.1 The purpose of acceptance inspections and tests is to check, as simply as possible, using methods representative of actual conditions of use, with the uncertainty inherent in statistical sampling, that the bolts satisfy the requirements of TS22.

4.3.2 Acceptance inspections and tests are specified in Table 1. They shall be carried out on each production batch or inspection lot. Sampling shall meet the requirement of Tables 3, 4 and 5 unless more stringent requirements are agreed between the manufacturer and purchaser. Bolts from the batch to be tested shall be selected by simple random selection.

4.3.3 Each bolt may be submitted to several inspections or tests, and the bolts to be subjected to destructive inspections or tests may be those on which non-destructive inspections or tests have been carried out.

4.3.4 If a more stringent inspection (see 4.3.2) is deemed necessary, all or part of the qualification inspections or tests may be performed during the acceptance inspection and testing. In this case, the number of bolts submitted to these inspections or tests is the same as that submitted for qualification inspections and tests.

4.3.5 Acceptance inspections and tests shall be carried out by the manufacturer, or under his responsibility.

4.4 Inspection and test report

4.4.1 A test report showing actual numerical values for the mechanical test results shall be provided.

4.4.2 The test report shall include a statement that dimensional inspection has been carried out to the latest issue of TS22, and that all results conform to the drawing.

4.5 Qualified manufacturers of BS S159 forged bolts

4.5.1 A list of qualified manufacturers of BS S159 forged bolts is contained in TS200.

5. MANUFACTURING AND TEST REQUIREMENTS

See Table 1.