
**Aerospace — Bolts, with MJ threads, made
of heat-resistant nickel-based alloy,
strength class 1 550 MPa — Procurement
specification**

*Aéronautique et espace — Vis à filetage MJ, en alliage résistant à chaud à
base de nickel, classe de résistance 1 550 MPa — Spécification
d'approvisionnement*

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Printed in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9154 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 4, *Aerospace fastener systems*.

Annex A forms a normative part of this International Standard. Annexes B and C are for information only.

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Aerospace — Bolts, with MJ threads, made of heat-resistant nickel-based alloy, strength class 1 550 MPa — Procurement specification

1 Scope

This International Standard specifies the characteristics and quality assurance requirements for MJ threads bolts made of heat-resisting nickel-base alloy, of strength class 1 550 MPa, for aerospace construction.

It is applicable whenever it is referenced in a definition document.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2859-1:1999, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.*

ISO 3452:1984, *Non-destructive testing — Penetrant inspection — General principles.*

ISO 4288:1996, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Rules and procedures for the assessment of surface texture.*

ISO 5855-2:1999, *Aerospace — MJ threads — Part 2: Limit dimensions for bolts and nuts.*

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test method.*

ISO 6508-1:1999, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T).*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

ISO 7870:1993, *Control charts — General guide and introduction.*

ISO 7961:1994, *Aerospace — Bolts — Test methods.*

ISO 7966:1993, *Acceptance control charts.*

ISO 8258:1991, *Shewhart control charts.*

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing.*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests*.

ISO/TR 13425:1995, *Guide for the selection of statistical methods in standardization and specification*.

3 Terms and definitions

For the purpose of this International Standard, the following terms and definitions apply.

3.1

production batch

quantity of finished bolts, manufactured using the same process, from a single material cast (single heat of alloy), having the same number of definition document, same thread and diameter code, heat-treated together to the same specified condition and produced as one continuous run

3.2

inspection lot

quantity of bolts from a single production batch having the same number of definition document

3.3

definition document

document specifying directly or indirectly all the requirements for bolts

NOTE

The definition document may be an International Standard, an in-house standard or a drawing.

3.4

crack

rupture in the material which may extend in any direction and which may be intercrystalline or transcrystalline in character

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3.5

seam

open surface defect

3.6

lap

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

3.7

crevice

hollow area at thread crest

3.8

inclusions

non-metallic particles originating from the material manufacturing process

NOTE

These particles may be isolated or arranged in strings.

3.9

microstructural shearing

shear banding

V- or U-shaped rippled grain structure immediately below the thread root, or chevron shaped rippled grain structure within the thread crest

3.10**sampling plan**

plan according to which one or more samples are taken in order to obtain information and possibly to reach a decision, if possible

NOTE In this International Standard, each sampling plan specifies the number of bolts to be inspected as a function of the size of the batch and the acceptance number [number of defective items acceptable (Ac)]¹⁾.

3.11**simple random sampling**

sampling 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

3.12**critical defect**

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 (bolt), or that is likely to prevent performance of the function of a major end item

3.13**major defect**

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

3.14**minor defect**

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

3.15**limiting quality****LQ**

(sampling plan) a quality level which corresponds to a specified and relatively low probability of acceptance

NOTE 1 It is the limiting lot quality characteristic that the consumer is willing to accept with a low probability that a lot of this quality would occur.

NOTE 2 For the purposes of this International Standard, the limiting quality quoted in Table 4 corresponds to a probability of acceptance of 10 %.

3.16**acceptance quality limit****AQL**

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

NOTE Variant: quality limit which in a sampling plan corresponds to a specified but relatively high probability of acceptance.

1) Supplementary information taken from ISO 2859-1.

4 Quality assurance

4.1 General

4.1.1 Approval of manufacturers

The manufacturer shall conform to the quality assurance and approval procedures defined by ISO 9002. The purpose of these procedures is to ensure that a manufacturer has a quality system and the capability for continuous production of bolts complying with the specified quality requirements.

Quality documentation, as specified by ISO 9002, for parts produced in accordance to this International Standard, shall be maintained for a minimum period of 10 years.

The approval of the manufacturer shall be granted by the Certification Authorities, or their appointed representative, who may be the prime contractor.

4.1.2 Qualification of bolts

The purpose of inspections²⁾ is to verify that the design and manufacturing conditions of a bolt enable it to satisfy the requirements of this International Standard.

The qualification shall be granted by the Certification Authorities in the purchaser's country, or their appointed representative, who may be the prime contractor.

4.1.3 Acceptance of bolts

The purpose of inspections is to verify, as simply as possible, using a method which is inexpensive, with the uncertainty inherent in statistical sampling, that the bolts satisfy the requirements of this International Standard.

They shall be carried out by the manufacturer, or under his responsibility.

The manufacturer is responsible for the quality of the bolts manufactured.

4.2 Qualification inspection conditions

Unless otherwise specified the inspection shall be carried out on:

- each type and diameter of bolt;
- 28 bolts selected from a single inspection lot by simple random sampling.

The test programme may possibly be reduced, or the qualification granted, without inspection: any such decision shall be based on the results obtained on similar types and diameters of bolts provided that the design and manufacturing conditions are identical.

The inspections shall be repeated on any bolt if the manufacturing conditions have modified.

Table 2 indicates the allocation of bolt sample for the inspections.

4.3 Acceptance inspection conditions

Inspections shall be carried out on each production batch or inspection lot. Bolts from the batch or lot to be inspected shall be selected by simple random sampling.

2) In order to simplify the text the term "inspections" used in this International Standard also refers to "inspections and tests".

Each bolt may be submitted to several inspections, provided that none of characteristics to be verified has been previously altered during any of these inspections.

The bolts to be subjected to destructive inspections may be those on which non-destructive inspections have been carried out.

If a more stringent inspection is deemed necessary, all or part of the qualification inspections may be performed during the acceptance inspections. In this case, the number of bolts submitted is the same as that submitted for qualification inspection.

Production batches or inspection lots declared unacceptable after the production acceptance inspections shall be submitted for re-inspection only after all the defective units have been removed and/or defects have been corrected. In this case, the attribute(s) which caused the rejection shall be verified using a sample of twice the normal size with the same number of defective items acceptable.

4.4 Use of "Statistical process control (SPC)"

When a characteristic is obtained by a controlled statistical process, the manufacturer has the possibility, in order to declare conformity of the characteristic, of refraining from the final systematic sampling provided for in this International Standard, if he is capable of **formally justifying** this choice by using ISO/TR 13425 and the standards quoted in it as a basis.

This justification will include the following phases:

- analysis of the key characteristics of the product;
- analysis of the risks for each implemented process;
- determination of the parameters and/or characteristics to be respected under SPC;
- determination of the capabilities of each process;
- drawing up an inspection plan and integration in the manufacturing process;
- drawing up of routes and control charts (ISO 7966, ISO 7870, ISO 8258);
- use of control charts for data consolidation;
- determination of the audits to be run and the control to be carried out to ensure reliability of the device.

To be usable in production, this process shall or should be validated beforehand by the qualifying body, either during the qualification phase, or *a posteriori* according to the case, by analysing the justificatory file and the results of the qualification inspections such as provided for in clause 5. **Such SPC process is not applicable to destructive tests** apart from the measurement of the hydrogen content.

5 Requirements

The requirements of this International Standard are given in Table 1 and, unless otherwise specified, they apply to bolts ready for use. The test temperature, unless otherwise specified, shall be the ambient temperature. These requirements complement the requirements of all other standards or specifications referenced in the definition document.

Table 1 — Requirements and test methods

Clause	Characteristic	Requirement	Inspection and test method	Designation ^a	Sample size
5.1	Material	In accordance with the definition document	See material standard.		As required by semi-finished product
5.2	Dimensions	In accordance with the definition document	Standard gauging	Q	20
				A	Tables 3 and 4
5.3	Manufacturing				
5.3.1	Forging	The heads of the bolts shall be formed by a forging process before heat treatment. The equipment shall ensure an adequate and uniform temperature throughout the production batch.	According to the route of manufacture The equipment used shall be approved.	Q	
5.3.2	Heat treatment	The forged blanks shall be heat-treated to produce the properties required by the definition document. Blanks shall not be heat-treated more than twice.	According to the process route The equipment used shall be approved.	Q	
5.3.3	Removal of surface contamination (bearing face and shank)	If machining is required, it is necessary to respect the requirements of 5.5.1.			
5.3.4	Fillet between head and shank	The fillet radius shall be cold-rolled after heat treatment and machining so as to remove all visual signs of machining and to create superficial cold-working. The deformation shall not exceed the values in Figure 1. The requirements apply on bolts except on the following: a) threaded to head bolts; b) bolts with a nominal diameter < 5 mm.	Visual examination at a suitable magnification of × 10 to × 20 and dimensional check	Q	5
				A	Tables 3 and 4
5.3.5	Threads	Formed by a single rolling process after full heat treatment	According to the manufacturing route	Q	
5.3.6	Surface roughness	In accordance with the definition document	ISO 4288 Visual examination	Q	5
				A	Tables 3 and 4

Table 1 (continued)

Clause	Characteristic	Requirement	Inspection and test method	Designation ^a	Sample size
5.3.7	Passivation treatment	Uncoated finished bolts shall be passivated in accordance with annex A (normative) After 2 h of salt spray, bolts shall show no evidence of corrosion or staining.	ISO 9227 Visual examination.	Q	5
				A	100 %
5.3.8	Surface coating	In accordance with the definition document	See surface coating standard.	Q	5
				A	Tables 3 and 4
5.4	Mechanical properties				
5.4.1	Tensile strength	See Table 5. The requirements apply on bolts except on the following: a) protruding head bolts of grip length < twice the nominal shank diameter; b) countersunk head bolts of grip length < two and a half times the nominal shank diameter; c) threaded to head bolts of overall length < three times the nominal thread diameter or bolts having an overall length < 18 mm; d) bolts with a thread length < one and a half times the thread nominal diameter; e) bolts with a nominal diameter < 4 mm.	On bolts: ISO 7961 On test specimen: ISO 6892 The test specimens to be produced from the same material batch as the bolts and treated with them.		
5.4.1.1	— at ambient temperature			Q	5
				A	Table 6 or Table 7
5.4.1.2	— at elevated temperature	Applicable to protruding head only. Test temperature: 480 °C.		Q	2

Table 1 (continued)

Clause	Characteristic	Requirement	Inspection and test method	Designation ^a	Sample size
5.4.2	Double shear strength	See Table 5. The requirements apply on bolts except on the following: a) protruding head bolts of grip length < twice the nominal shank diameter; b) countersunk head bolts of grip length < two and a half times the nominal shank diameter; c) bolts with a nominal diameter < 4 mm; d) threaded to head bolts.	ISO 7961	Q	5
				A	Table 6 or Table 7
5.4.3	Tension fatigue strength	Life: — mean value: 65 000 cycles min. — individual value: 45 000 cycles min. 130 000 cycles max. Frequency: 140 Hz max. Loads: see Table 8. The requirements apply on bolts except on the following: a) protruding head bolts of grip length < twice the nominal shank diameter; b) countersunk head bolts of grip length < two and a half times the nominal shank diameter; c) bolts with a nominal diameter < 5 mm; d) drilled shank bolts; e) threaded to head bolts.	ISO 7961	Q	5
				A	Table 6
5.4.4	Hardness	Before surface coating is applied, the hardness when measured at the end of the bolt (thread end) shall be: — Rockwell: 44 HRC min., — Vickers: 434 HV 30 min.	ISO 6507-1 ISO 6508-1	Q	5
				A	Tables 3 and 4