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Aerospace — Bolts, with MJ threads, made of heat and corrosion resisting steel, strength class 1 100 MPa — Procurement specification

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National foreword

This British Standard is the UK implementation of ISO 8168:2016. It supersedes BS ISO 8168:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/12, Aerospace fasteners and fastening systems.

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 4, *Aerospace fastener systems*.

This third edition cancels and replaces the second edition (ISO 8168:2008), which has been technically revised and includes the following changes:

— updated normative references;

— updated terminology; and

— editorial modifications.

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Aerospace — Bolts, with MJ threads, made of heat and corrosion resisting steel, strength class 1 100 MPa — Procurement specification

1 Scope

This document specifies the characteristics and quality assurance requirements for MJ thread bolts made of heat and corrosion resisting steel, of strength class 1 100 MPa, for aerospace construction.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

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 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

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

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

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7870-1, *Control charts — Part 1: General guidelines*

ISO 7870-2, *Control charts — Part 2: Shewhart control charts*

ISO 7870-3, *Control charts — Part 3: Acceptance control charts*

ISO 7961, *Aerospace — Bolts — Test methods*

ASTM E112:2004, *Standard Test Methods for Determining Average Grain Size*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
batch
quantity of finished parts, manufactured using the same process, from a single material cast (single heat of alloy), having the same definition document number, diameter, heat-treated together to the same specified condition and produced as one continuous run

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3.2
inspection lot
quantity of bolts from a single production batch having the same definition document number

3.3
definition document
document specifying directly or indirectly all the requirements for products

Note 1 to entry: 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

3.5
seam
longitudinal open surface defect

3.6
lap
surface defect caused by folding over metal fins or sharp corners and then forming 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 1 to entry: These particles may be isolated or arranged in strings.

3.9
sampling plan
plan according to which one or more samples are taken in order to obtain information and possibly reach a decision

Note 1 to entry: In this document, 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)].

Note 2 to entry: Ac = acceptance number (supplementary information taken from ISO 2859-1).

3.10
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

3.11
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, or that is likely to prevent performance of the function of a major end item

3.12
major defect
defect other than critical, that is likely to result in failure or to reduce materially the usability of the considered product for its intended purpose

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3.13
minor defect
defect that is not likely to reduce materially the usability of the considered product for its intended purpose, or that is a departure from the established specifications having little bearing on the effective use or operation of this product

3.14
limiting quality
LQ
<sampling plan> quality limit which corresponds to a specified and relatively low probability of acceptance

Note 1 to entry: 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 to entry: For the purposes of this document, the limiting quality quoted in Table 4 corresponds to a probability of acceptance of 10 %.

3.15
acceptable quality level
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 1 to entry: Variant: quality level, which in a sampling plan, corresponds to a specified but relatively high probability of acceptance.

4 Quality assurance

4.1 General

The manufacturer shall be capable of providing a continuous production of bolts complying with the quality requirements specified in this document. It is recommended that the manufacturer implement a recognized quality management system.

The purpose of qualification inspections[1)] of bolts is to check that the design and manufacturing conditions of a bolt allow it to satisfy the requirements of this document.

Quality documentation for parts produced in accordance with this document shall be maintained for a minimum period of 10 years.

The purpose of a production acceptance inspection of a bolt is to check, as simply as possible, using a method which is inexpensive but representative of the actual conditions of use, with the uncertainty inherent in statistical sampling, that the bolt satisfies the requirements of this document.

Production acceptance inspections shall be carried out by the manufacturer or under his responsibility.

4.2 Qualification inspection conditions

Unless otherwise specified, the inspection shall be carried out on:

— each type and diameter of bolt;

— 25 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.

1) In order to simplify the text, the term “inspections” used in this document also refers to “inspections and tests”.

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

Table 2 indicates the allocation of bolt samples 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.

Each bolt may be submitted to several inspections, provided that none of the 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 the 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) that 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 option, in order to declare conformity of the characteristic, to forgo the final systematic sampling provided in this document, 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 of an inspection plan and integration in the manufacturing process;

— drawing up of routes and control charts (ISO 7870-3, ISO 7870-1, ISO 7870-2);

— 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 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 an SPC process is not applicable to destructive tests apart from the stress durability test.

5 Requirements

The requirements of this document are given in Table 1 and, unless otherwise specified, they apply to bolts that are 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.

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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 hot or cold forging process before heat treatment.	According to the manufacturing route	Q	
			In the case of hot forging, the equipment shall ensure that a constant temperature of less than 1 090 °C is guaranteed throughout the production batch.	The equipment used shall be approved.		
	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	Threads	Formed by a single rolling process after full heat treatment	According to the manufacturing route	Q	
	5.3.5	Surface roughness	In accordance with the definition document	ISO 4288 Visual examination	Q	5
					A	Tables 3 and 4
	5.3.6	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	See Table 5.	On bolts: ISO 7961	Q	5

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Table 1 *(continued)*

Clause		Characteristic	Requirement	Inspection and test method	Designation[a]	Sample size
		strength	The requirements apply to bolts except 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 threaded to head 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. In such a case, acceptance shall be based on the results from test bars of the same material, heat-treated with the same process cycle.	On test specimen (when tests do not apply to bolts as indicated in "Requirement" column): ISO 6892-1 The test specimens are to be produced from the same material batch as the bolts and treated with them.	A for bolts, not for specimens	Table 6 or Table 7
	5.4.2	Double shear strength	See Table 5. The requirements apply to bolts except 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) bolts threaded to head.	ISO 7961	Q	5
					A	Table 6 or Table 7
	5.4.3	Recess removal torque	The recess of the finished bolt shall withstand the torque values specified in the product standard or definition document. During the test, the driving feature shall show no cam-out and the recess no excessive distortion.	With the bolt fixed in rotation, submit the driving feature to an end load of (45 ± 2,5) N while applying the required removal torque.	Q	5

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Table 1 *(continued)*

Clause		Characteristic	Requirement	Inspection and test method	Designation[a]	Sample size
5.5		Metallurgical properties				
	5.5.1	Head-to-shank grain flow	Flow lines shall closely conform to the contour indicated in Figure 1. For breaks in flow lines, see Figure 1.	Macroscopic examination at a magnification of 10× to 2× (see Figure 2), after appropriate etching	Q	5
					A	Table 6
	5.5.2	Thread grain flow	Shall be continuous and shall follow the general thread contour with the maximum density at the bottom of the root radius (see Figure 3).	See 5.5.1.	Q	5
					A	Table 6
	5.5.3	Microstructure and overheating	Shall not: — have microporosity or major segregation; — show evidence of overheating, decarburization, carburization, nitrogenization or intergranular oxidation in excess of the limits specified in Table 9. Overheating of the head, except for the bearing surface, is permitted provided that its maximum depth, measured normal to the surface of the head, does not exceed: — 1,5 mm for diameters ≤ 16 mm; — 2,8 mm for diameters > 16 mm.	Microscopic examination at a magnification of 100× (see Figure 2), after appropriate etching	Q	5
					A	Table 6
	5.5.4	Grain size	The grain size of the finished bolts when compared with plate II in ASTM E112:2004 shall not be coarser than 5. Isolated grains not exceeding a mean diameter of 0,23 mm are acceptable.	Microscopic examination at a magnification of 100×	Q	5
					A	Table 6
	5.5.5	Discontinuities (before coating)	See Table 9. Care shall be exercised to avoid confusing cracks with other discontinuities.	Fluorescent penetrant inspection according to ISO 3452-1	Q	5
					A	Penetrant Tables 3 and 4 Microscopic examination Table 6
				In case of doubt, submit suspect bolts to a microscopic examination at a magnification of 100× (see Figure 2), after appropriate etching.		
5.6		Marking	In accordance with the definition document	Visual inspection	Q	25
					A	Tables 3 and 4

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Table 1 *(continued)*

Clause		Characteristic	Requirement	Inspection and test method	Designation[a]	Sample size
5.7		Delivery				
	5.7.1	Packaging	To prevent all damage or corrosion occurring in the course of handling, transportation and storage Each basic package shall only contain bolts from the same inspection lot number.	Visual inspection	A	100 %
	5.7.2	Labelling	Each basic package shall carry a label which legibly indicates: — the designation as specified by the definition document; — the quantity; — the inspection lot number; — the inspector's stamp.	Visual inspection	A	100 %
	5.7.3	Certificate of conformity	At the demand of the customer, each delivery shall be accompanied by a certificate of conformity certifying that, without exception or dispensation, the bolts satisfy the requirements of this document.	Visual examination	A	100 %

[a] Q = Qualification, A = Acceptance.

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Table 2 — Summary of inspections for qualification and allocation of bolt samples

Characteristic	Defined in	Bolt sample number																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Non-destructive																										
Dimensions	5.2						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fillet between head and shank		X	X	X	X	X																				
Surface roughness	5.3.5[a]	X	X	X	X	X																				
Surface coating	5.3.6						X	X	X	X	X															
Recess removal torque	5.4.3																					X	X	X	X	X
Discontinuities (before coating)	5.5.5[a]	X	X	X	X	X																				
Marking	5.6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Destructive																										
Tensile strength	5.4.1						X	X	X	X	X															
Double shear strength	5.4.2											X	X	X	X	X										
Head-to-shank grain flow	5.5.1	X	X	X	X	X																				
Thread grain flow	5.5.2	X	X	X	X	X																				
Microstructure and overheating	5.5.3	X	X	X	X	X																				
Grain size	5.5.4	X	X	X																						

[a] Tests to be carried out prior to coating.

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Table 3 — Classification of defects

Category of defects	Acceptable quality level (AQL)	Characteristics
Major	0,065 %	Discontinuities
	1 %	Thread size Shank diameter Grip length Fillet radius: distortion and dimensions Drilled hole(s) missing when required Surface roughness Burrs and tool marks Surface coating Marking Depth of lightening hole Thread form Incomplete threads Head angle (countersunk head) Perpendicularity of head-bearing surface Straightness of shank
Minor	2,5 %	Overall length Head diameter Lightening hole diameter Drilled hole(s) position tolerance and diameter Wrenching configuration Run-out — Head external diameter to shank Run-out — Thread pitch diameter to shank Recess torque
	4 %	Chamfer of thread end Hexagon head: chamfer and washer face Collar height Head height

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Table 4 — Sampling plans for visual inspections and dimensional characteristics

Production batch size			Sample size	Acceptance number (Ac) and limiting quality (LQ) in accordance with the acceptable quality level (AQL)							
				AQL 0,065 %		AQL 1 %		AQL 2,5 %		AQL 4 %	
				Ac	LQ_{10} %	Ac	LQ_{10} %	Ac	LQ_{10} %	Ac	LQ_{10} %
2	to	8	2	↓	↓	↓	↓	↓	↓	↓	↓
9	to	15	3	↓	↓	↓	↓	↓	↓	0	53,6
16	to	25	5	↓	↓	↓	↓	0	36,9	↑	↑
26	to	50	8	↓	↓	↓	↓	↓	↑	↓	↓
51	to	90	13	↓	↓	0	16,2	↑	↓	1	26,8
91	to	150	20	↓	↓	↑	↑	1	18,1	2	24,5
151	to	280	32	↓	↓	↓	↓	2	15,8	3	19,7
281	to	500	50	↓	↓	1	7,56	3	12,9	5	17,8
501	to	1 200	80	↓	↓	2	6,52	5	11,3	7	14,3
1 201	to	3 200	125	↓	↓	3	5,27	7	9,24	10	12,1
3 201	to	10 000	200	0	1,14	5	4,59	10	7,60	14	9,81
10 001	to	35 000	315	↑	↑	7	3,71	14	6,33	21	8,84
35 001	to	150 000	500	↓	↓	10	3,06	21	5,60	↑	↑
150 001	to	500 000	800	1	0,485	14	2,51	↑	↑	↑	↑

↑ Use sampling plan above (sample size and Ac).

↓ Use sampling plan below (sample size and Ac).

The data given in this table are based on single sampling plans for a normal inspection, as specified in ISO 2859-1:1999, Tables 2-A and 6-A. A 100 % inspection should be performed when the sample size is equal to or greater than the batch size.

Other sampling plans specified in ISO 2859-1 may be used (double or multiple sampling), but these shall be chosen in such a way as to ensure an equivalent quality limit.

For those manufacturers who carry out an inspection during the manufacturing process (inspection on a machine and/or inspection between operations), the sampling plan for the final inspection shall be compiled in such a way that the overall inspection plan shall guarantee an equivalent quality limit.

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Table 5 — Minimum loads for tensile[a] and double shear[b] tests

Thread		Tensile strength test				Double shear strength test
			Countersunk head			
Diameter	Pitch	Protruding head	Normal head	Reduced head		
				No recess	Recessed	
mm	mm	kN	kN	kN	kN	kN
4	0,7	10,5	8,38	5,24	4,71	16,6
5	0,8	16,8	13,5	8,41	7,57	25,9
6	1	23,9	19,1	12	10,8	37,3
7		34	27,2	17	13,6	50,8
8		45,9	36,7	22,9	18,3	66,4
10	1,25	71,7	57,3	35,8	28,7	104
12		107	85,6	53,5	42,8	149
14	1,5	145	116	72,5	58	203
16		193	154	96,5	61,8	266
18		249	199	125	79,7	337
20		311	249	156	99,5	415
22		380	304	190	122	502
24	2	442	354	221	141	597

[a] See Annex A for areas and formulae.

[b] See Annex B for areas and formulae.

Table 6 — Sampling plans for the inspection of mechanical and metallurgical characteristics

Production batch size	Sample size destructive testing	Acceptance number (Ac)
≤500	3	0
501 to 3 200	5	0
3 201 to 35 000	5	0
≥35 001	8	0

Table 7 — Variable sampling for tensile and shear tests

Production batch size	Sample number	Acceptable quality level approximately AQL 1 %				
		Sample size	Total	First sample		Combined sample
				K_a	K_r	K_t
≤150	First	4	4	2,42	1,35	—
	Second	8	12	—	—	1,72
151 to 280	First	5	5	2,21	0,89	—
	Second	10	15	—	—	1,74
281 to 500	First	6	6	2,22	0,94	—
	Second	12	18	—	—	1,7
501 to 1 200	First	7	7	2,32	1,1	—
	Second	14	21	—	—	1,78
1 201 to 3 200	First	8	8	2,48	0,99	—
	Second	16	24	—	—	1,81

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Table 7 *(continued)*

Production batch size	Sample number	Acceptable quality level approximately AQL 1 %				
		Sample size	Total	First sample		Combined sample
				K_a	K_r	K_t
≥3 201	First	10	10	2,34	1,31	—
	Second	20	30	—	—	1,8

Evaluate each sample by tensile or shear tests as follows:

First sample: accept if $\bar{X}_1 - K_a S_1 \geq M$ Reject if $\bar{X}_1 - K_r S_1 < M$

Take a second sample if batch is doubtful; evaluate as follows:

Second sample: accept if $\bar{X}_t - K_t S_t \geq M$ Reject if $\bar{X}_t - K_t S_t < M$

Definition of symbols:

$\bar{X}_1$ is the average of X_1 individual values in the first sample;

K_a, K_r and K_t are coefficients of S, which is the best estimate of standard deviation, and are used to determine acceptance or rejection of the batch represented by the sample;

M is the minimum tensile or the minimum shear value according to Table 5;

$\bar{X}_t$ is the average of X_t individual values in the combined samples;

$$S_1 = \sqrt{\frac{N_1 \sum X_1^2 - \left(\sum X_1\right)^2}{N_1 \left(N_1 - 1\right)}}$$

where

N_1 is the sample size of the first sample;

ΣX_1^2 is the sum of squares of X_1 values;

$(\Sigma X_1)^2$ is the square of the sum of X_1 values;

$$S_t = \sqrt{\frac{N_t \sum X_t^2 - \left(\sum X_t\right)^2}{N_t \left(N_t - 1\right)}}$$

where

N_t is the sample size of the combined sample;

ΣX_t^2 is the sum of squares of X_t values;

$(\Sigma X_t)^2$ is the square of the sum of X_t values.

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Table 8 — Discontinuities

Type	Location	Maximum depth, normal to surface mm		
		Bolts threaded to head (all diameters) and other bolts $D < 5$ mm	**Bolts** 5 mm ≤ D ≤ 16 mm	**Bolts** $D > 16$ mm
Cracks	All zones	0	0	0
Laps, seams, inclusions	Head-to-shank fillet	0	0	0
	Root of thread[a]	0	0	0
	Non-bearing surface of head	0,3	0,25	0,3
Seams	Shank and bearing face	0,15	0,12	0,15
Laps and seams, forming an angle of more than 10° with the longitudinal axis	Shank	0,1	0	0
Laps	Unload flank of threads	See Table 9 and Figures 4 and 5.		
Laps and/or crevices	Crest of thread[b]	See Table 9 and Figures 5 and 7. NOTE Values increased by half the difference between the actual measured diameter and the minimum external diameter (see ISO 5855-2).		

[a] See Figure 4.

[b] See Figure 6.

Table 9 — Thread discontinuities[a]

Dimensions in millimetres

Thread pitch	Maximum depth
0,5	0,06
0,7	0,08
0,8	0,09
1	0,12
1,25	0,15
1,5	0,18
2	0,24

[a] Nature and position.

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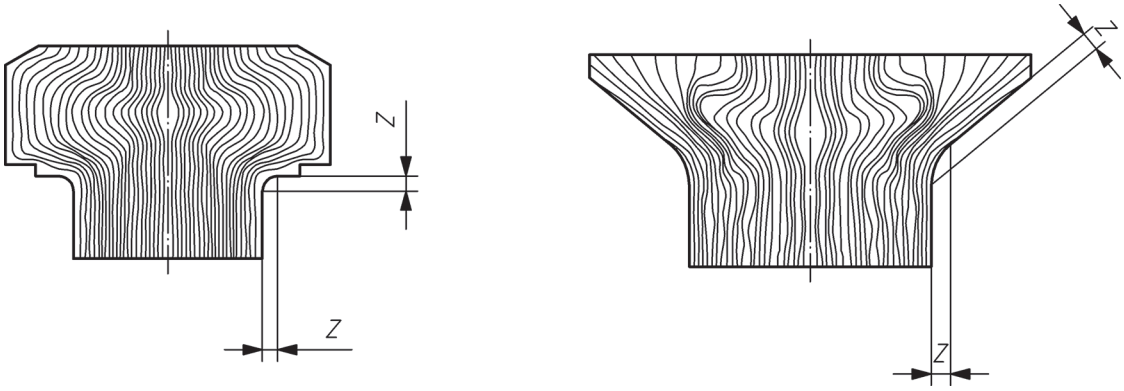
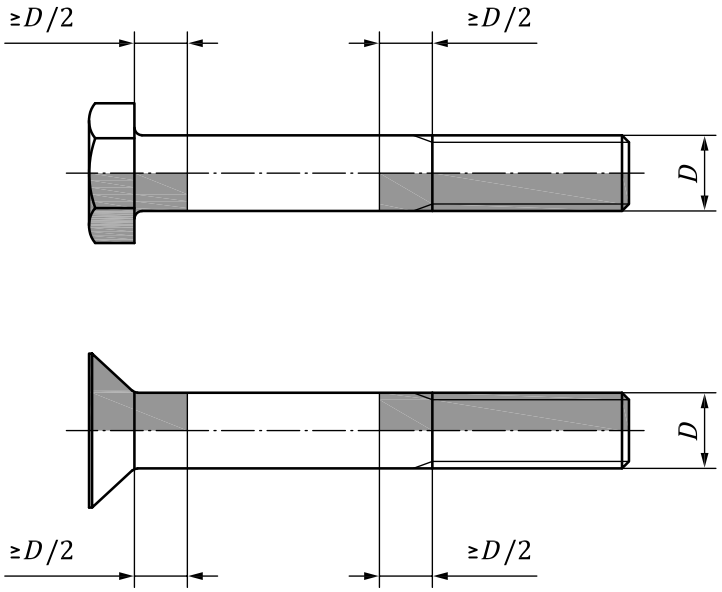


NOTE Cut grain acceptable in the zone identified by *Z* dimensions (where *R* max. is the maximum fillet radius specified in the definition document).

Figure 1 — Head-to-shank grain flow (see 5.5.1)



Key

▭ Cut here for test pieces to be subjected to micro- or macroscopic examination.

Figure 2 — Metallurgical test pieces (see 5.5.1 to 5.5.4)

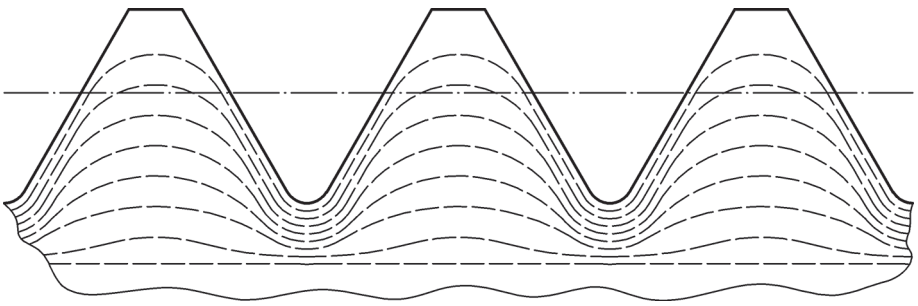


Figure 3 — Grain flow in threads (see 5.5.2)

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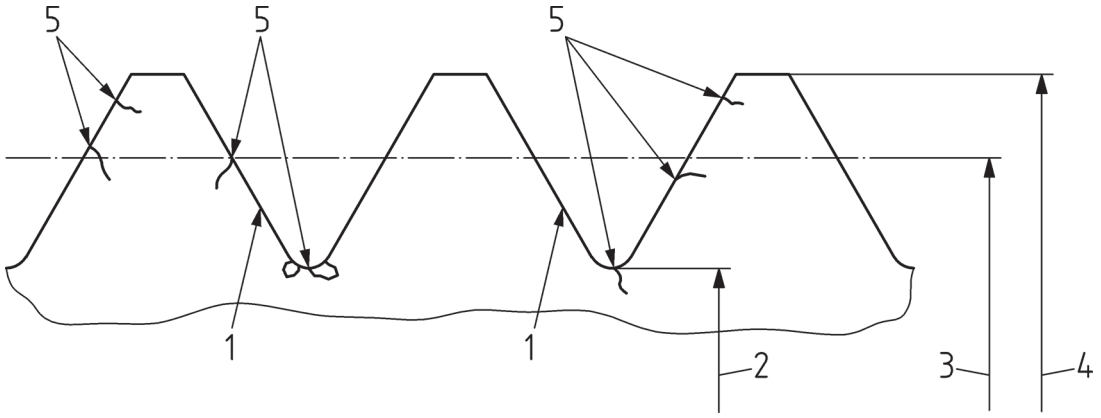
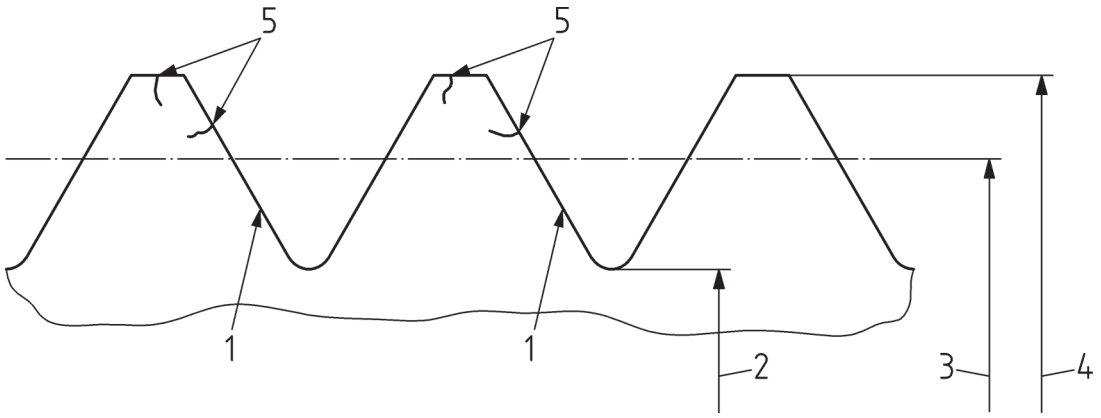


Key

1 non-loaded flanks
2 minor diameter
3 pitch diameter
4 major diameter
5 non-permissible laps and seams

Figure 4 — Non-permissible laps, seams and surface irregularities in threads



Key

1 non-loaded flanks
2 minor diameter
3 pitch diameter
4 major diameter
5 permissible laps and seams

Figure 5 — Permissible laps and seams in threads

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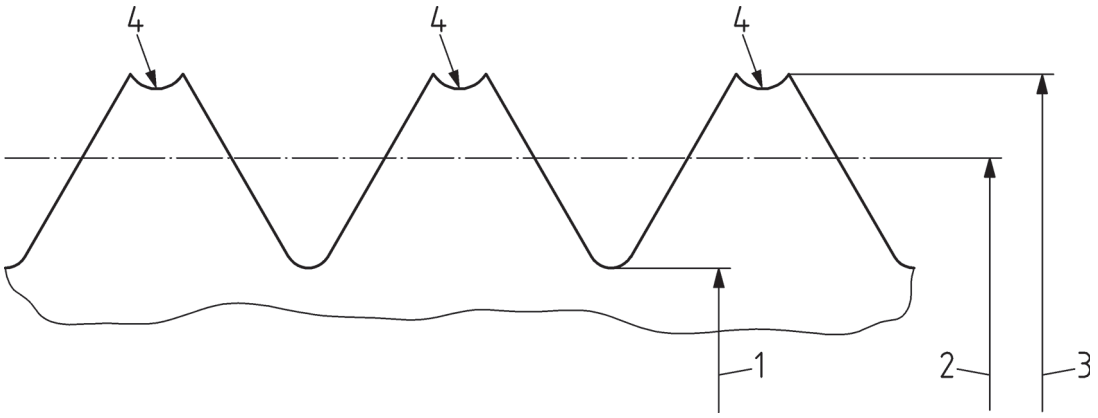
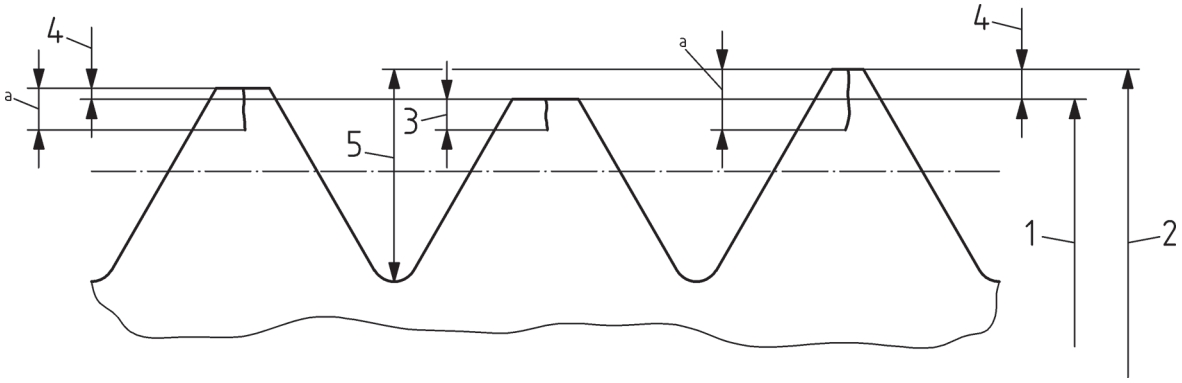


Key

1 minor diameter
2 pitch diameter
3 major diameter
4 permissible surface irregularities (see Table 8)

Figure 6 — Permissible surface irregularities in threads



Key

1 minimum major diameter
2 maximum major diameter
3 maximum permissible discontinuity: 20 % of basic thread depth (see Table 9)
4 difference between actual major diameter and minimum major diameter
5 basic thread depth
a See Tables 8 and 9.

Figure 7 — Thread discontinuities

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Annex A
(informative)

Cross-sectional areas and formulae for tensile loads

A.1 Cross-sectional area values

See Table A.1.

Table A.1

Thread		Cross-sectional area
Diameter mm	Pitch mm	mm^2
3	0,5	5,439
4	0,7	9,517
5	0,8	15,296
6	1	21,753
7		30,93
8		41,682
10	1,25	65,136
12		97,128
14	1,5	131,562
16		175,613
18		225,949
20		282,571
22		345,478
24	2	401,68

A.2 Formulae

A.2.1 Cross-sectional area, A_t

$$A_t = \frac{\pi}{4} \left(d_3\right)^2 \left[2 - \left(\frac{d_3}{d_2} \right)^2 \right] \quad \text{(A.1)}$$

where

d_2 is the maximum pitch diameter (according to ISO 5855-2), in millimetres;

d_3 is the maximum root diameter (according to ISO 5855-2), in millimetres.

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A.2.2 Tensile test load, L_t

$$L_t = \frac{A_t \times k \times R_m}{1\,000} \text{ kN} \quad \text{(A.2)}$$

where

k for protruding head bolts = 1

k for normal countersunk head bolts = 0,8

k for reduced countersunk head bolts without drive recess in head = 0,5

k for reduced countersunk head bolts with drive recess in head:

— for diameters ≤ 6 mm = 0,45

— for diameters 7 mm ≤ D ≤ 14 mm = 0,4

— for diameters ≥ 16 mm = 0,32

R_m = 1 250 MPa

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Annex B
(informative)

Cross-sectional areas and formulae for double shear loads

B.1 Cross-sectional area values (single section)

See Table B.1.

Table B.1

Nominal shank diameter mm	Cross-sectional area mm^2
3	7,069
4	12,566
5	19,635
6	28,274
7	38,485
8	50,265
10	78,54
12	113,1
14	153,9
16	201,1
18	254,5
20	314,2
22	380,1
24	452,4

B.2 Formulae

B.2.1 Shear strength cross-sectional area, A_S (single section)

$$A_s = \frac{\pi}{4} d^2 \tag{B.1}$$

where d is the nominal shank diameter.

B.2.2 Double shear strength test load, L_S

$$L_s = \frac{2 A_s R_c}{1\,000} \text{ kN} \tag{B.2}$$

where

R_c = 750 MPa

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Bibliography

[1] ISO/TR 13425[2)], *Guidelines for the selection of statistical methods in standardization and specification*

2) Withdrawn.

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