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Specification for

Procurement of corrosion and heat-resisting steel bolts with strength classification 1100 MPa and MJ threads

Committees responsible for this British Standard

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Civil Aviation Authority (Airworthiness Division)

Electronic Engineering Association

Ministry of Defence

Society of British Aerospace Companies Limited

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National foreword

This British Standard, which has been prepared under the direction of the Aerospace Standards Policy Committee, is identical with ISO 8168:1988 "*Aerospace — Corrosion- and heat-resisting steel bolts with strength classification 1 100 MPa and MJ threads — Procurement specification*" published by the International Organization for Standardization (ISO).

Cross-references

International Standard	Corresponding British Standard
ISO 2859-1:1974	BS 6001 *Sampling procedures for inspection by attributes* Part 1:1972 *Specification for sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection* (Technically equivalent)
ISO 3534:1977	BS 5532 *Statistical terminology* Part 1:1978 *Glossary of terms relating to probability and general terms relating to statistics* (Identical)
ISO 5855-2:1981	BS 6293 *MJ threads for aerospace construction* Part 2:1982 *Specification for dimensions for bolts and nuts* (Identical)

The Technical Committee has reviewed the provisions of ISO 3452, ISO 3453 and ASTM E 112-84 to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. It is envisaged that a British Standard corresponding to ISO 7961 will be published.

A British Standard does not purport to include all the 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 and ii, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope and field of application

This International Standard specifies the characteristics and quality assurance requirements for bolts with normal heads, made of corrosion- and heat-resisting steel, having a tensile strength classification of 1 100 MPa and MJ threads, and intended for use in aerospace construction.

This International Standard applies to bolts as defined above, provided that reference is made to this International Standard in the product standard or definition document.

2 References

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*[1].

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

ISO 3453, *Non-destructive testing — Liquid penetrant inspection — Means of verification.*

ISO 3534, *Statistics — Vocabulary and symbols.*

ISO 5855-2, *Aerospace construction — MJ threads — Part 2: Dimensions for bolts and nuts.*

ISO 7961, *Aerospace — Bolts — Test methods*[2].

ASTM E 112-84, *Standard methods for determining average grain size.*

3 Definitions

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 basic part number and diameter, 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 with the same part number which completely defines the bolt

3.3 Discontinuities

3.3.1
crack

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

3.3.2
seam

open surface defect resulting from extension of the material

3.3.3
lap

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

3.3.4
inclusions

non-metallic particles originating from the material manufacturing process. These particles may be isolated or arranged in strings

[1] At present at the stage of draft. (Revision, in part, of ISO 2859:1974.)
[2] At present at the stage of draft.

3.4
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)]

3.5
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)]

3.6
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)]

3.7
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)]

3.8
sampling plan

a plan according to which one or more samples are taken in order to obtain information and possibly to reach a decision[3)]

3.9
limiting quality (LQ)

in a sampling plan, a quality level which corresponds to a specified and relatively low probability of acceptance: for the purposes of this International Standard, a 10 % probability of acceptance (LQ_{10}). 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[3)]

3.10
acceptable quality level (AQL)

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

it is the 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[3)]

4 Quality assurance

4.1 General

4.1.1 *Approval of manufacturers*

The manufacturer shall conform to the quality assurance and approval procedures in effect in the purchaser's country: 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.

The granting of an approval of the manufacturer is a function of the Certification Authorities, or their appointed representative, who may be the prime contractor.

4.1.2 *Qualification of bolts*

The purpose of qualification inspections and tests of bolts is to check that the design and manufacturing conditions of a bolt allow it to satisfy the requirements of this International Standard.

The granting of qualification of a bolt is a function of the Certification Authorities in the purchaser's country, or their appointed representative, who may be the prime contractor.

[3)] Definition taken from ISO 3534:1977. (ISO 3534 is currently being revised by ISO/TC 69, *Application of statistical methods.*)

4.1.3 *Acceptance of bolts*

The purpose of acceptance inspections and tests of bolts is to check, as simply as possible, using a method which is inexpensive and representative of actual conditions of use, with the uncertainty inherent in statistical sampling, that the bolts satisfy the requirements of this International Standard.

Acceptance inspections and tests 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 and test conditions

Qualification inspections and tests (requirements, methods, numbers of bolts) are specified in Table 1. They 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 of a bolt be granted, without inspection or testing: 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 and tests shall be repeated on any bolt if the manufacturing conditions have changed.

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

Qualification inspections and tests are summarized in Table 3.

4.3 Acceptance inspection and test conditions

Acceptance inspections and tests (requirements, methods, numbers of bolts) are specified in Table 1; they shall be carried out on each production batch or inspection lot. Bolts from the batch or lot to be tested shall be selected by simple random sampling.

Each bolt may be submitted to several inspections or tests.

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

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

Production batches or inspection lots declared unacceptable after the acceptance inspections and tests shall be submitted for re-inspection or re-testing only after all defective units have been removed and/or defects have been corrected.

Twice the normal sample size shall be used for re-inspecting or re-testing the attributes causing initial rejection; the same acceptance level shall be used.

Acceptance inspections and tests are summarized in Table 3.

5 Requirements

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

Table 1 — Technical requirements and test methods

Clause No.	Characteristic	Technical requirement	Inspection and test method	Q/A[a]	Sample size
5.1	**Materials**	In accordance with the product standard or definition document.	As stated in the material specification.		
5.2	**Dimensions**	In accordance with the requirements of the product standard or definition document.	Standard gauging.	Q A	22 Table 8 and Table 9
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. In the case of hot forging, the equipment shall be such 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 product standard or definition document. No blank shall be heat treated more than twice. The heat treatment media or atmosphere shall not cause any surface contamination except as permitted by **5.5.3**			
5.3.3	***Machining***	The amount of material removed from the bearing surface of the head and the shank of the heat-treated blanks shall be as little as practicable consistent with the removal of surface contamination, production of a smooth surface and maintenance of optimum grain flow around the under-head fillet radius as shown in Figure 1.	See **5.5.1**.		
5.3.4	***Cold rolling***	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; this may cause distortion which shall not exceed the values shown in Figure 2; this requirement is not applicable to fully threaded screws or bolts with a nominal diameter less than MJ5.	See **5.5.1**.		
5.3.5	***Threads***	To be formed by a single rolling process after all heat treatment.			
5.3.6	***Surface roughness***	In accordance with the product standard or definition document.	Visual comparison method or thumbnail comparison method.	Q A	3 Table 8 and Table 9

[a] Q = qualification inspection and test conditions (see **4.2**)
A = production acceptance test conditions (see **4.3**)

Table 1 — Technical requirements and test methods

Clause No.	Characteristic	Technical requirement	Inspection and test method	Q/A	Sample size
5.3.7	***Surface coating***	In accordance with the product standard or definition document.	See applicable coating specification.	Q A	3 Table 8 and Table 9
5.4	**Mechanical properties**				
5.4.1	***Tensile strength***	In accordance with the minimum tensile loads specified in Table 5. Tensile tests are not applicable to the following: a) protruding head bolts of grip length less than 2*D*; b) countersunk head bolts of grip length less than 2,5*D*; c) threaded-to-head bolts of overall length less than 3*D* or bolts having an overall length less than 18 mm. In such cases, acceptance shall be based on the results from tests bars of the same material, heat-treated with the same process cycle.	See ISO 7961.	Q A	5 Table 10, column B, or Table 11
5.4.2	***Double shear strength***	In accordance with the values specified in Table 5. The grip length shall not be shorter than twice the nominal shank diameter for protruding head bolts or shorter than 2,5 times the nominal shank diameter for countersunk heads.	See ISO 7961.	Q A	5 Table 10, column B or Table 11
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 Loads: see Table 6 Unbroken bolts shall be rendered unusable. Unless otherwise specified, fatigue tests shall not be carried out on the following: a) bolts with drilled shanks; b) bolts of thread size smaller than 5 mm; c) bolts having a grip length of less than twice the diameter.	See ISO 7961.	Q A	10 Table 10, column B
5.5	**Metallurgical properties**				

Table 1 — Technical requirements and test methods

Clause No.	Characteristic	Technical requirement	Inspection and test method	Q/A	Sample size
5.5.1	***Head-to-shank grain flow and fillet work effect***	Flow lines in the fillet area immediately below the surface shall closely conform to the fillet contour (see Figure 1). See Figure 1 for breaks in flow lines. If there is doubt about the acceptability of the grain flow or fillet work effect, the acceptability shall be decided by the results of the acceptance fatigue test.	Specimens shall be taken from the finished bolt (see Figure 6). The sections to be examined shall be subjected to an appropriate macroscopic etchant. Macroscopic examination of a longitudinal section at a suitable magnification (X10 to X20).	Q A	A Table 10, column B
5.5.2	***Thread grain flow and work effect***	The 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).	Macroscopic examination.	Q A	4 Table 10, column B
5.5.3	***Microstructure***	The microstructure shall be free from overheating and alloy segregation which is likely to affect the mechanical or physical properties of the bolt.	The sections to be examined shall be subjected to an appropriate microscopic etchant. Microscopic examination at a magnification of X100.	Q A	4 Table 10, column B
5.5.4	***Grain size***	The grain size of the finished bolts when compared with plate II in ASTM E 112-84 shall not be coarser than 5. Isolated grains not exceeding a mean diameter[a] of 0,23 mm are acceptable.	Microscopic examination at a magnification of X100.	Q A	4 Table 10, column B
5.5.5	***Surface contamination***	See Table 4.	Microscopic examination at a magnification of X100.	Q A	4 Table 10, column B
5.5.6	***Discontinuities***	The bolts shall not show any discontinuity equal to or greater than the limitations specified in this International Standard (see Table 4). Care shall be exercised to avoid confusing cracks with other discontinuities. Cracked bolts and those having discontinuities transverse to the axis (i.e. at an angle of more than 10° to the longitudinal axis) shall be rejected and destroyed.	Penetrant flaw detection in accordance with ISO 3452 and ISO 3453. In cases of doubt, microscopic examination at a magnification of X100 shall be carried out.	Q A	25 Penetrant: Table 8 and Table 9 Microscopic examination: Table 10, column B

[a] Mean diameter = average of the major and minor axes of an individual grain.

Table 1 — Technical requirements and test methods

Clause No.	Characteristic	Technical requirement	Inspection and test method	Q/A	Sample size
5.5.6.1	*Head and shank*	See Table 4 for the limits of acceptance.			
5.5.6.2	*Thread*	Acceptance limits (see Figure 4 and Figure 5): — in the unloaded part of the fillet, above the pitch diameter, see Table 7; — at the crest of the threads, see Table 7 — values to be increased by half the difference between the actual measured diameter and the minimum external thread diameter (see ISO 5855-2); — a slight irregularity in the form of the crests in relation to the basic profile is acceptable (see Figure 5).			
5.6	**Product identification**	Marking in accordance with the product standard or definition document. Bolts to be "package-marked" shall be packed and identified in accordance with **5.7.1** and **5.7.2**	Visual inspection.	Q A	25 Table 8 and Table 9
5.7	**Delivery**				
5.7.1	***Packaging***	The bolts shall be packed in such a way as to prevent any damage or corrosion occurring in the course of handling, transportation and storage. Each basic package shall only contain bolts with the same part number and the same inspection lot number.	Visual inspection.	A	100 %
5.7.2	***Labelling***	Each basic package shall carry a label on which the complete part number, quantity, production batch number and inspector's stamp have been legibly recorded.	Visual inspection.	A	100 %

Table 2 — Qualification testing requirements for bolt samples

Type of test	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
		Uncoated			Coated																					
Non-destructive																										
Dimensions	**5.2**				×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Surface roughness	**5.3.6**	×	×	×																						
Surface coating	**5.3.7**				×	×	×																			
Discontinuities	**5.5.6**	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Product identification	**5.6**	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Destructive																										
Tensile strength	**5.4.1**				×	×	×	×	×																	
Double shear strength	**5.4.2**	×	×	×								×	×													
Tension fatigue strength	**5.4.3**																×	×	×	×	×	×	×	×	×	×
Head-to-shank grain flow and fillet work effect	**5.5.1**									×	×	×	×													
Thread grain flow and work effect	**5.5.2**									×	×	×	×													
Microstructure	**5.5.3**									×	×	×	×													
Grain size	**5.5.4**									×	×	×	×													
Surface contamination	**5.5.5**									×	×	×	×													

Table 3 — Summary of qualification and acceptance tests

Type of test	Defined in	Sample size for	
		qualification tests	acceptance tests
Dimensions	**5.2**	22	Table 8 and Table 9
Surface roughness	**5.3.6**	3	Table 8 and Table 9
Surface coating	**5.3.7**	3	Table 8 and Table 9
Tensile strength	**5.4.1**	5	Table 10, column B or Table 11
Double shear strength	**5.4.2**	5	Table 10, column B or Table 11
Tension fatigue strength	**5.4.3**	10	Table 10, column B
Head-to-shank grain flow and fillet work effect	**5.5.1**	4	Table 10, column B
Thread grain flow and work effect	**5.5.2**	4	Table 10, column B
Microstructure	**5.5.3**	4	Table 10, column B
Grain size	**5.5.4**	4	Table 10, column B
Surface contamination	**5.5.5**	4	Table 10, column B
Discontinuities	**5.5.6**	25	Penetrant: Table 8 and Table 9 Microscopic examination: Table 10, column B
Product identification	**5.6**	25	Table 8 and Table 9
Packaging	**5.7.1**	—	100 %
Labelling	**5.7.2**	—	100 %

Table 4 — Surface discontinuities and contamination

Dimensions in millimetres

Location	Permissible discontinuity	Maximum depth normal to surface for bolts having a nominal diameter	
		up to 16 mm	18 mm and above
Heat-to-shank fillet and root of thread	No discontinuities		
	No surface contamination		
Shank diameter and bearing surface of head	Seams not extending into head to shank fillet or root of thread	0,12	0,15
	No surface contamination		
Non-bearing surface of head	Laps, seams and inclusions	0,25	0,3
	Surface contamination	0,025	0,025
Any other location	Surface contamination	0,025	0,025

Table 5 — Minimum tensile and double shear loads for qualification and acceptance tests

Thread		Tensile strength test			Double shear strength test	
Diameter mm	Pitch mm	Load, min. Protruding head kN	Load, min. Countersunk head kN	Cross-sectional area mm²	Load min. kN	Cross-sectional area mm²
3	0,5	5,98	4,78	5,439	9,33	7,069
4	0,7	10,47	8,38	9,517	16,59	12,566
5	0,8	16,83	13,46	15,296	25,92	19,635
6	1	23,93	19,14	21,753	37,32	28,274
7	1	34,02	27,22	30,93	50,8	38,484
8	1	45,85	36,68	41,682	66,4	50,265
10	1,25	71,65	57,32	65,136	104,3	78,54
12	1,25	107	85,6	97,128	149	113,1
14	1,5	145	116	131,562	203	153,9
16	1,5	193	154	175,613	266	201,1
18	1,5	249	199	225,949	337	254,5
20	1,5	311	249	282,571	415	314,2
22	1,5	380	304	345,478	502	380,1
24	2	442	354	401,68	597	452,4

Table 6 — Qualification and acceptance values for tension fatigue test

Thread		Protruding head		Countersunk head	
Diameter mm	Pitch mm	High load ± 2 % kN	Low load ± 2 % kN	High load ± 2 % kN	Low load ± 2 % kN
5	0,8	7,74	0,77	6,19	0,62
6	1	11,01	1,1	8,8	0,88
7	1	15,65	1,56	12,52	1,25
8	1	21,09	2,11	16,87	1,69
10	1,25	32,96	3,3	26,37	2,64
12	1,25	49,22	4,92	39,38	3,94
14	1,5	66,7	6,67	53,36	5,34
16	1,5	88,78	8,88	70,84	7,08
18	1,5	114,5	11,45	91,54	9,15
20	1,5	143	14,3	114,5	11,45
22	1,5	174,8	17,48	139,8	13,98
24	2	203,3	20,33	162,8	16,28

Table 7 — Thread discontinuities — Maximum depth of permissible faults (see **5.5.5.2**)

Dimensions in millimetres

Thread pitch	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

Table 8 — Classification of defects

Category of defect	Acceptable quality level (AQL)	Characteristics
Major “A”	0,065 %	Magnetic flaw detection
Major “B”	1 %	Thread size Shank diameter Grip length Fillet radius: distortion and dimensions Drilled holes missing when required Surface roughness Burrs and tool marks Surface coating Identification Depth of lightening hole in head Thread form Incomplete threads Squareness between head-bearing surface and shank Straightness of shank
Minor “A”	2,5 %	Overall length Head diameter Head angle (countersunk head) Lightening hole diameter Drilled hole location and diameter Wrenching configuration Concentricity of head and shank Coaxiality of shank and thread pitch diameter
Minor “B”	4 %	Chamfer on thread end Hexagon head: chamfer and washer face Collar height Head height

Table 9 — Sampling plans for visual inspection and inspection of dimensional characteristics

Production batch size	Sample size	Acceptance number (Ac) and limiting quality (LQ_{10}) 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} %
91 to 150	13	—	—	0	16	—	—	—	—
91 to 150	20	↓	↓	↑	↑	1	18	2	25
151 to 280	32	↓	↓	↓	↓	2	16	3	20
281 to 500	50	↓	↓	1	7,6	3	13	5	18
501 to 1 200	80	↓	↓	2	6,5	5	11	7	14
1 201 to 3 200	125	↓	↓	3	5,4	7	9,4	10	12
3 201 to 10 000	200	0	1,2	5	4,6	10	7,7	14	10
10 001 to 35 000	315	↑	↑	7	3,7	14	6,4	21	9
35 001 to 150 000	500	↓	↓	10	3,1	21	5,6	↑	↑
150 001 to 500 000	800	1	0,49	—	—	—	—	—	—

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

NOTE The data given in Table 9 are based on single sampling plans for a standard inspection, as specified in ISO 2859-1 (Table 2-A and Table 6-A).

A 100 % inspection should be performed when the sample size is as large as or larger 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 as way as to ensure an equivalent quality level.

As regards 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 level.

Table 10 — Sampling plans for the inspection of mechanical and metallurgical characteristics

Production batch size	Sample size		Acceptance number
	Non-destructive tests	Destructive tests	
	A	B	
Up to 500	8	3	0
501 to 3 200	13	5	0
3 201 to 35 000	20	5	0
Above 35 000	32	8	0

Table 11 — Variable sampling for tensile and shear tests (alternative method)

Production batch size	Sample number	Acceptable quality level approximately AQL 1 %				
		Sample size	Total	First sample		Combined sample
				K_a	K_r	K_t
Under 151	First	4	4	2,42	1,35	—
	Second	8	12	—	—	1,72
151 to 300	First	5	5	2,21	0,89	—
	Second	10	15	—	—	1,74
301 to 500	First	6	6	2,22	0,94	—
	Second	12	18	—	—	1,7
501 to 1 300	First	7	7	2,32	1,1	—
	Second	14	21	—	—	1,78
1 301 to 3 200	First	8	8	2,48	0,99	—
	Second	16	24	—	—	1,81
Above 3 200	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 $\bar{X}_1 - K_a S_1 \geqslant M$ Reject if $\bar{X}_1 - K_r S_1 < M$

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

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

Definition of terms:

$\bar{X}_1$ 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 which are used to determine acceptance or rejection of the batch represented by the sample;

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

where

N_1 is the number of parts in 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;

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

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

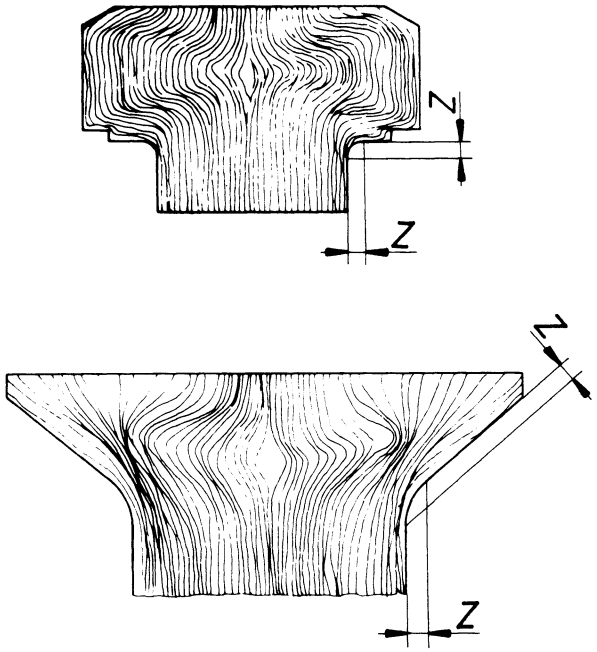
$$S_t = \sqrt{\frac{N_t \Sigma X_t^2 - (\Sigma X_t)^2}{N_t(N_t - 1)}}$$

where

N_t is the number of parts in the combined sample,

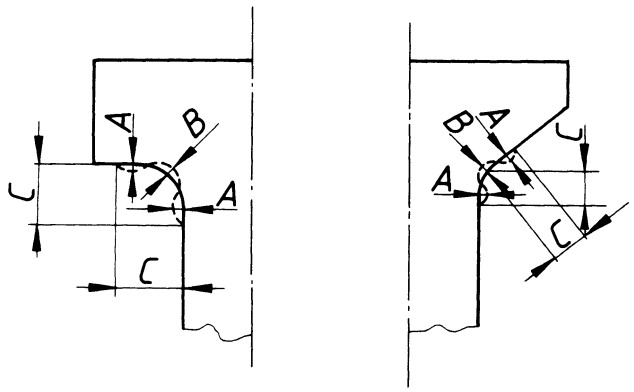
ΣX_t^2 is the sum of squares of X_t values,

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



NOTE Cut grain acceptable in the zone defined by *Z* dimensions [*Z* max. = *R* max. (where *R* max. is the minimum fillet radius specified in the product standard)].

Figure 1 — Head structure and grain flow (see **5.5.1**)



Dimensions in millimetres

Bolt nominal diameter	*A* max.	*B* max.	*C* max.
5	0,03	0,025	1,5
6			1,5
7			1,5
8			2,5
10			2,5
12			3,5
14			3,5
16			3,5
18			4,5
20			4,5
22			4,5
24			4,5

Figure 2 — Distortion in fillet area (see **5.3.4**)

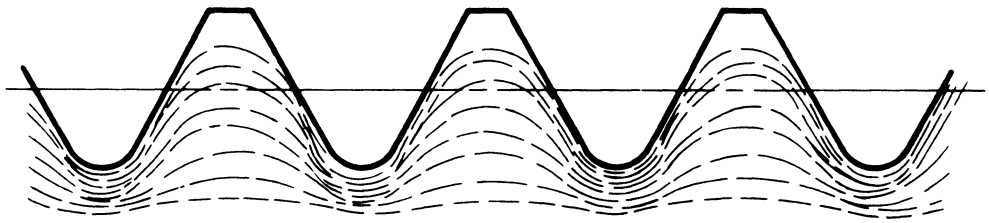


Figure 3 — Grain flow in thread (see **5.5.2**)

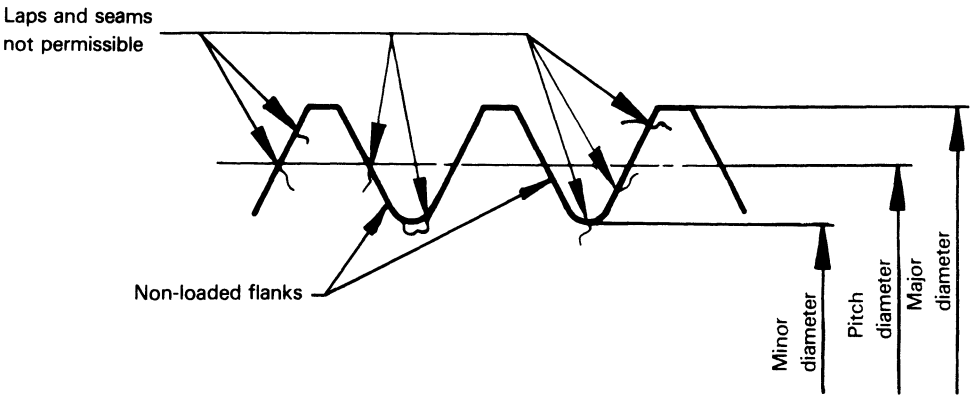


Figure 4 — Non-permissible laps, seams and surface irregularities (see **5.5.5.2**)

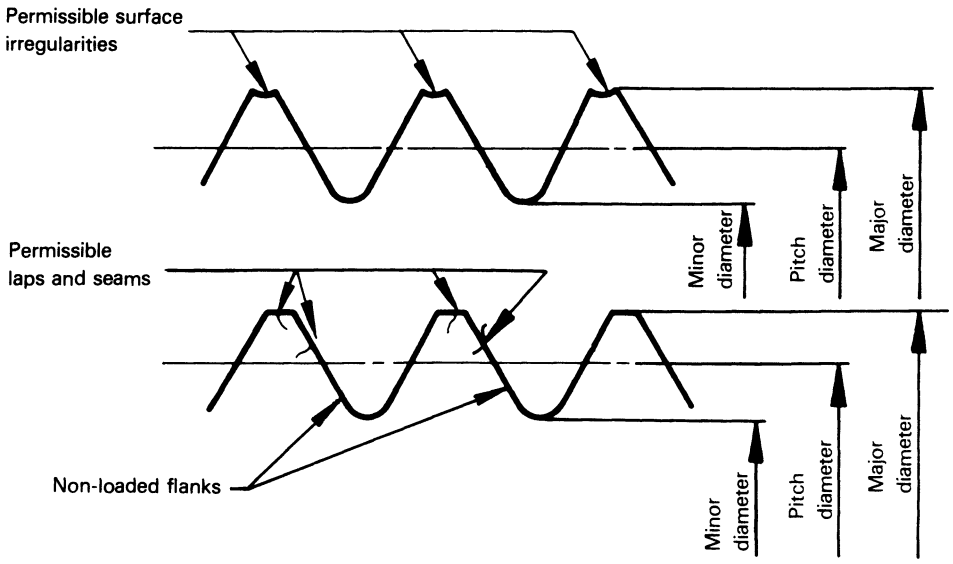


Figure 5 — Permissible laps, seams and surface irregularities (see **5.5.5.2**)

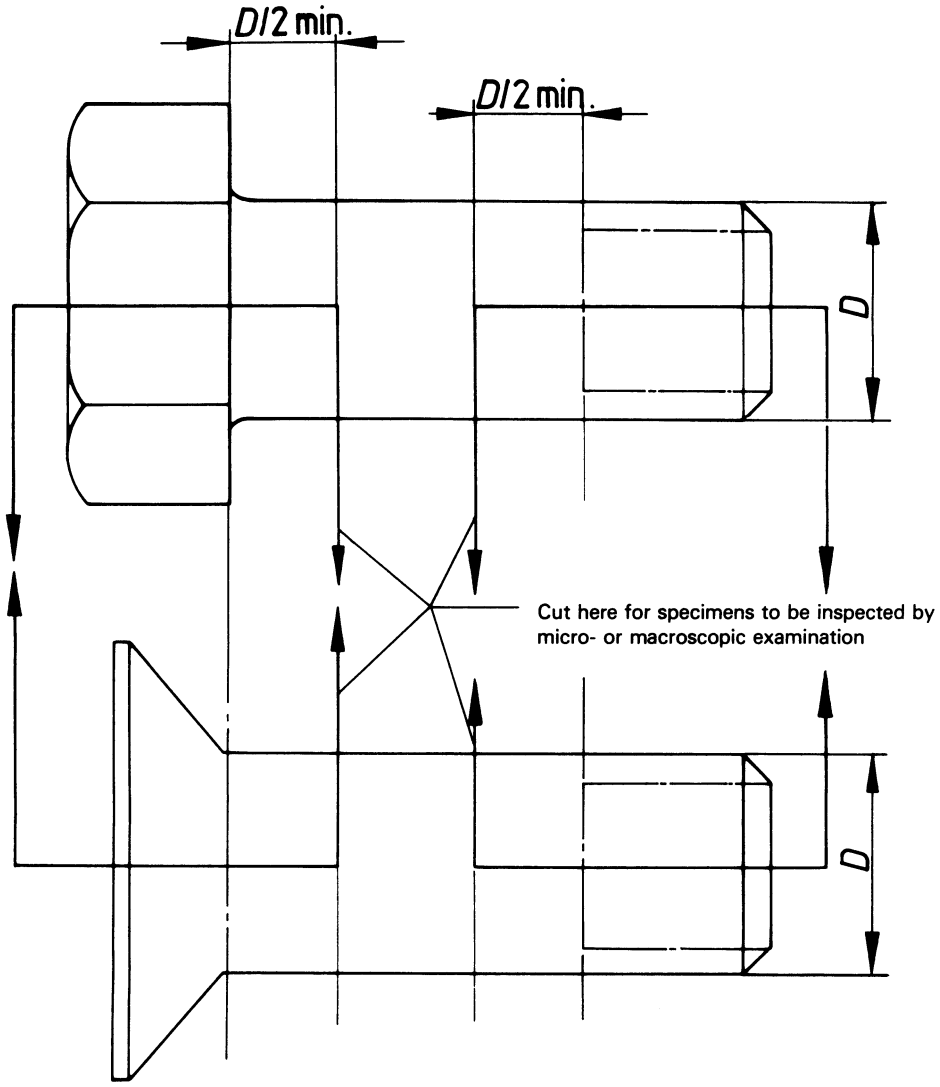


Figure 6 — Metallurgical specimens (see **5.5.1** to **5.5.3**)

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See national foreword.

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