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SRI LANKA STANDARD 379 : 1976

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GENERAL REQUIREMENTS AND TECHNICAL SUPPLY CONDITIONS FOR BOLTS, SCREWS AND NUTS

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BUREAU OF CEYLON STANDARDS

GENERAL REQUIREMENTS AND TECHNICAL SUPPLY CONDITIONS FOR BOLTS, SCREWS AND NUTS

SLS 379 : 1976

Gr. 16

BUREAU OF CEYLON STANDARDS
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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract.

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SRI LANKA STANDARD
GENERAL REQUIREMENTS AND TECHNICAL SUPPLY CONDITIONS FOR BOLTS, SCREWS AND NUTS

FOREWORD

This Sri Lanka Standard has been prepared by the Drafting Committee on Bolts, Screws and Nuts. It was approved by the Mechanical Engineering Divisional Committee of the Bureau of Ceylon Standards and was authorised for adoption and publication by the Council of the Bureau on 1976-05-05.

This standard which lays down the technical supply conditions for Threaded Fasteners, covers the technical requirements which are common to Bolts, Screws and Nuts, and is intended for use as a supplementary standard for the other standard specifications covering various types of Bolts, Screws and Nuts. For details as applicable to the different types reference should be made to the appropriate standards.

In the preparation of this standard, due weightage has been given to the agreements reached at international level, specially the work done by ISO/TC 2 - Technical Committee on Bolts, Nuts and Accessories. The mechanical properties, designation system and the methods of tests are based on the recommendations of ISO/TC 2.

The three grades of fasteners covered in this standard are expected to meet most of the requirements of the Mechanical Engineering Industry in Sri Lanka and covers both production methods prevalent in the industry at present.

The dimensions and other requirements specified in this standard are in SI units. Equivalents in the metric system or the imperial system are given in a few instances, where necessary. The symbols used to indicate the tolerances and inaccuracies in the relevant figures (Figs. 1 to 25) are in line with the current practices adopted internationally. In this connection reference should be made to ISO/R 1101:1969 — " Tolerances of Form and Position ", issued by the International Organisation for Standardisation.

This standard makes reference to the following Sri Lanka Standards :

CS 12 : 1968 — Method for tensile testing of steel products other than sheet, strip wire and tube.

CS 145 : 1972	—	Method for Rockwell Hardness test.
CS 146 : 1972	—	Method for Brinell Hardness test.
SLS 268 : 1974	—	ISO Metric Screw Threads.
SLS 355 : 1974	—	Method of Charpy Impact test (U-notch) for Steel.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with CS 102 : 1971.* The number of figures to be retained in the rounded off values shall be the same as that of the specified value in this standard.

1. SCOPE

This standard deals with technical supply conditions for Bolts, Screws and Nuts and covers general and specific requirements for different grades, mechanical properties and methods of test for the same. Mechanical properties specified are applicable to threaded fasteners upto and including 39 mm thread diameter. It also prescribes the methods of sampling under normal inspection and criteria for conformity for Bolts, Screws and Nuts. The requirements specified in this standard may also be applied, with due care, to products for which no standards are yet formulated.

2. TERMINOLOGY

For the purpose of this standard, the following definitions shall apply :

2.1 Acceptance Number — The maximum permissible number of defectives in the samples for acceptance of a lot (denoted by AC).

2.2 Acceptable Quality Level (AQL) — A designated value of maximum per cent defectives in a lot that will be accepted most of the times (approximately 95 times out of 100) by operation of this sampling plan.

Note — The risk (chance) of rejecting lots of quality better than or equal to AQL is 5 per cent which is known as the ' producer's risk '.

* CS 102 : 1971 — Presentation of numerical values.

2.3 Bolt and Nut — All fasteners having external threads are referred to as "Bolts" and those having internal threads as 'Nuts', unless otherwise specified.

2.4 Burst — A burst is an open break in metal.

2.5 Crack — A crack is a clean (crystalline) fracture passing through or across the grain boundaries without inclusion of foreign elements. Cracks are usually caused by overstressing the metal during forging or other forming operations. Where parts are subjected to significant reheating, cracks usually are discoloured by scale.

2.6 Defect — Failure to meet the requirement imposed on a fastener with respect to a single characteristic.

2.6.1 Major Defect — A defect that could result in failure or materially reduce the usability of the product for its intended purpose.

2.6.2 Minor Defect — A defect other than major defect that does not materially reduce the usability of the product for its intended purpose.

2.6.3 Duds — An incomplete, mutilated fastener or foreign part.

Note — For classification of defects for various types of fasteners, reference should be made to the appropriate standard specification.

2.7 Defective — A fastener which has one or more defects.

2.8 Fold — A fold is a doubling over of metal.

2.9 Lot Tolerance Per cent Defective (LTPD) — The percentage of defective fasteners in a lot that will render it liable for rejection most of the times (approximately 90 times out of 100) by operation of this sampling plan.

Note — The risk (chance) of accepting lots of quality worse than or equal to LTPD is 10 per cent which is known as 'consumer's risk'.

2.10 Lap — A lap is a fold over of metal in the threads of fasteners. If laps occur, they generally show a pattern of consistency between the product; that is laps will be identically located and with the same direction of traverse between all products.

2.11 Nick or Gouge — A nick or gouge is an indentation on the surface of a fastener, produced by forceful abrasion on the impact of product coming into contact with other products or manufacturing equipment.

2.12 Purchaser — The party purchasing the material. The term purchaser shall also cover person or persons expressly authorised in writing by the purchaser to act on his behalf for inspection of the material.

2.13 Rejection Number — The minimum number of defectives in the samples for the rejection of the lots (denoted by **Re**).

2.14 Seam — A seam is a narrow continuous discontinuity in the metal. Seams are generally inherent in the raw material from which the fastener is made. Seams generally run parallel to the product axis.

2.15 Shear Failure — A shear failure is an open break in the metal due to overstressing of the metal during forging. Shear failures occur mostly with flange products.

2.16 Supplier — The party supplying the material. The supplier may or may not be the actual manufacturer of the material.

2.17 Tool Mark — Tool marks are longitudinal or circumferential grooves of shallow depths produced by manufacturing tools.

2.18 Void — A void is a shallow pocket or hollow on the surface of the fastener due to non-filling of metal during forging or upsetting.

3. GRADES

3.1 The fasteners shall be of the following grades.

a) Precision (P)
b) Semi-precision (S)
c) Commercial (C)

3.2 The grades are specified without any reference to the method of manufacture and the fasteners are not required to exhibit any particular appearance.

4. GENERAL REQUIREMENTS (WORKMANSHIP)

4.1 The fasteners shall be cleanly finished, sound and free from defects which may affect their serviceability, consistent with the grade of the product.

4.2 The fasteners shall have full surfaces and edges in keeping with the method of manufacture used. These shall be free from burrs, although barely perceptible thin burrs which result, for example, from slotting and trimming operations, may be left out. The commercial grade bolts may have reasonable die seams on the shank ; in no case the shank diameter with such seams shall exceed the maximum permissible diameter.

4.3 All nuts of ' P ' and ' S ' grades shall be countersunk on the bearing face at an included angle of 120° ; the diameter of the countersink shall not exceed the nominal major diameter of the thread. With the exception of slotted nuts, all double chamfered hexagonal nuts of grades ' P ' and ' S ' shall have a countersink as above on both faces.

Commercial grade nuts may also be countersunk at the option of the manufacturer.

4.4 Unless otherwise specified, centre holes in bolts, and screws in all grades may be allowed to remain.

5. DIMENSIONAL REQUIREMENTS

5.1 Dimensional Accuracy

5.1.1 The tolerances on various grades of Bolts, Screws and Nuts shall be as indicated in the respective figures (see Figs. 1 to 25) and applied on the basic sizes given in the relevant dimensional standards. For ready reference, the values of basic tolerances and tolerance zones are given in Tables 1 to 8.

5.1.2 The diameter of the chamfer circle on the Bolt and Screw heads, and nut and the washer face diameters of bolt and nut, where applicable, shall be controlled to a minimum of 90 per cent of the nominal across flat dimension of the bolt and screw heads and the nuts.

5.1.3 The permissible variation on the nominal length of fasteners shall, unless otherwise specified, be as follows :

Nominal Length, mm		Precision (P) mm	Semi-Precision (S) and Commercial (C) mm
Over	Up to and including		
3	6	± 0·38	± 0·60
6	10	± 0·45	± 0·75
10	18	± 0·55	± 0·90
18	30	± 0·65	± 1·05
30	50	± 0·80	± 1·25
50	80	± 0·95	± 1·50
80	120	± 1·10	± 1·75
120	180	± 1·25	± 2·00
180	250	± 1·45	± 2·30
250	315	± 1·60	± 2·60
315	400	± 1·80	± 2·85
400	500	± 2·00	± 3·15

5.2 Screw Threads

5.2.1 The form of thread, diameters and associated pitches of Bolts, Screws and Nuts shall be in accordance with SLS 268* as indicated in Clause 5.2.2.

5.2.2 Threads shall conform to the following tolerance classes in accordance with SLS 268 *.

Grade	*Tolerance Class*	
	Bolts	*Nuts*
Precision (P)	6 g	6H
Semi-Precision (S)	6 g	6H, 6H7H
Commercial (C)	8 g	7H

5.2.3 The permissible variation on the length of thread for bolts shall be plus 2 pitches or 5 mm whichever is greater. Unless otherwise specified the screws shall be threaded to within a distance from the underside of the head not exceeding 2 pitches for diameters up to and including 24 mm and 3 pitches for diameters over 24 mm.

5.3 Eccentricity — The eccentricity of various elements of Bolts, Screws and Nuts shall be within the limits specified in respective figures (Figs. 1 to 25) and as detailed in Table 4.

5.4 Angularity Error — The angularity error for various fasteners shall not exceed the limits shown in respective figures (Figs. 1 to 25).

*SLS 268 ISO Metric Screw Threads

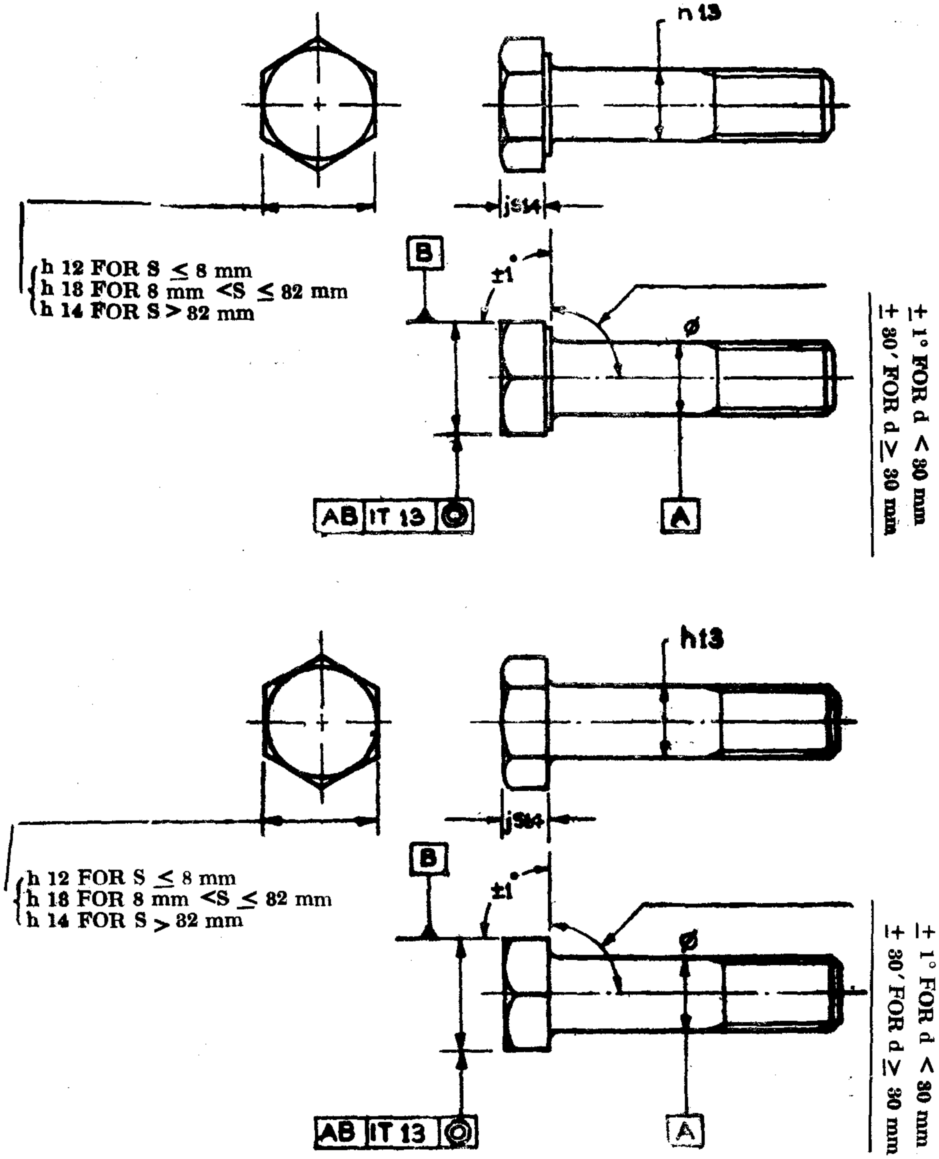


Fig. 1 — Hexagon Bolt ('P' Grade)

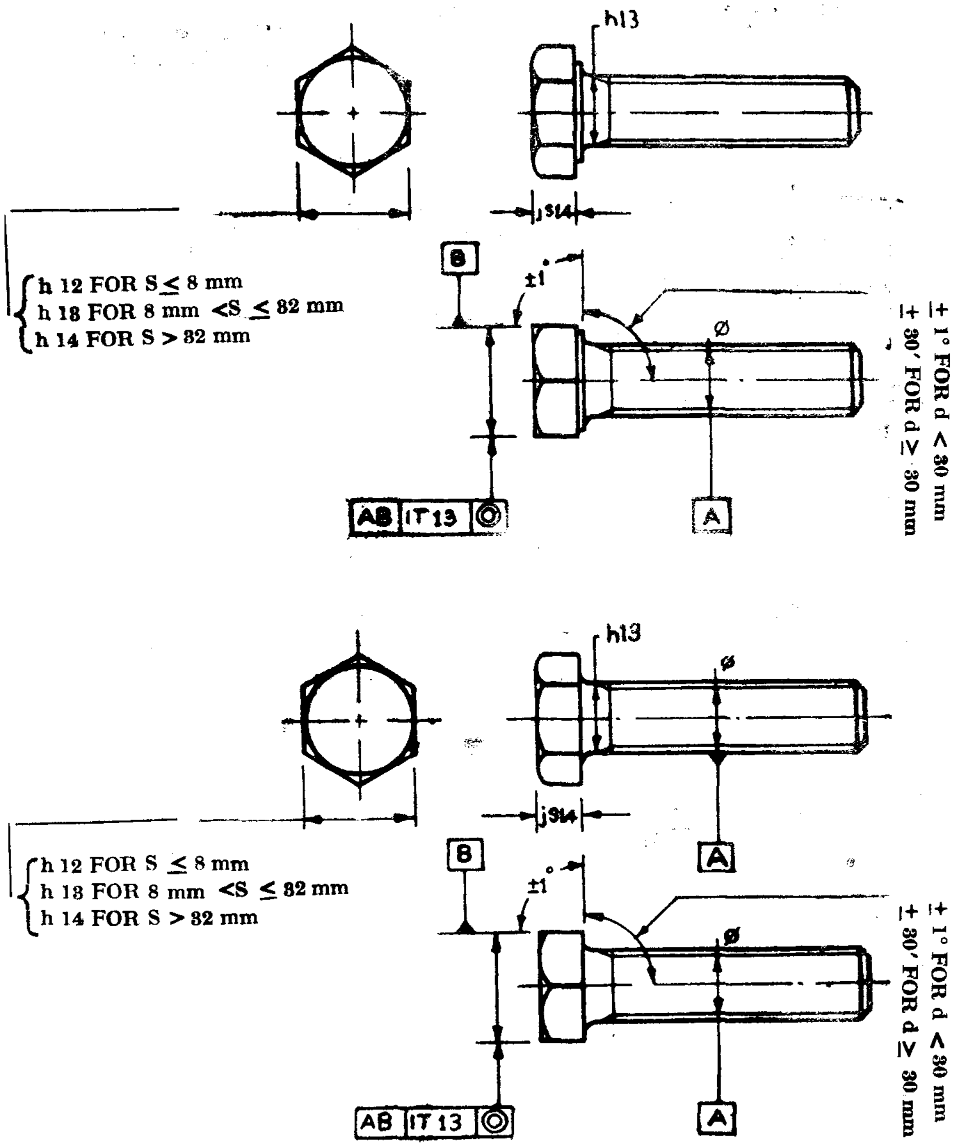


Fig. 2 — Hexagon Screw ('P' Grade)

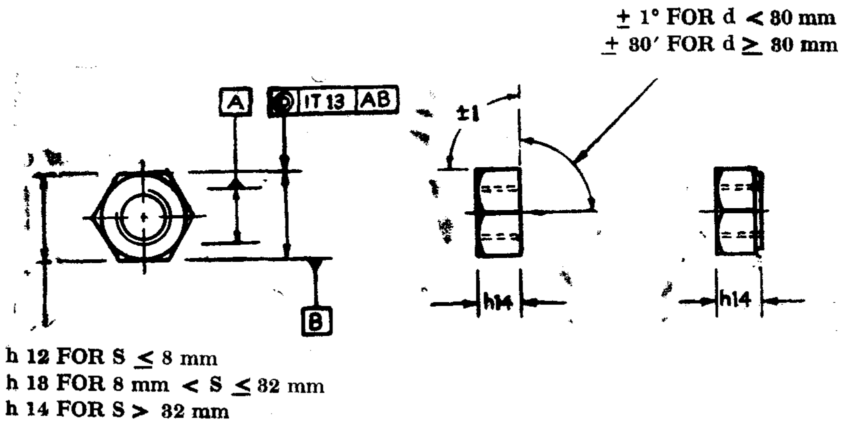


Fig. 3 — Hexagon Nut ('P' Grade)

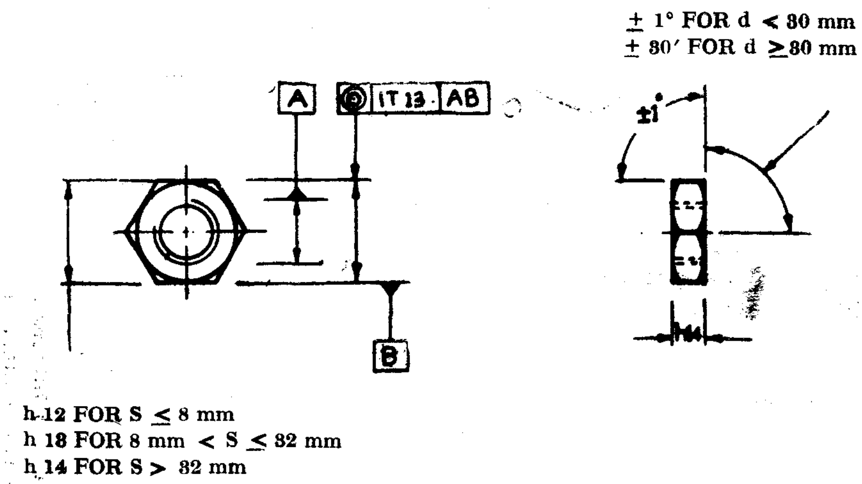


Fig. 4 — Hexagon Lock Nut ('P' Grade)

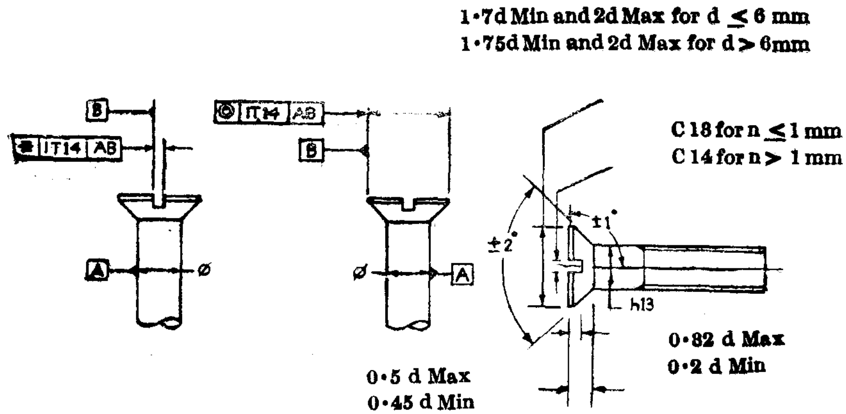


Fig. 5—Slotted or Recessed Counter Sunk Head Screws ('P' Grade)

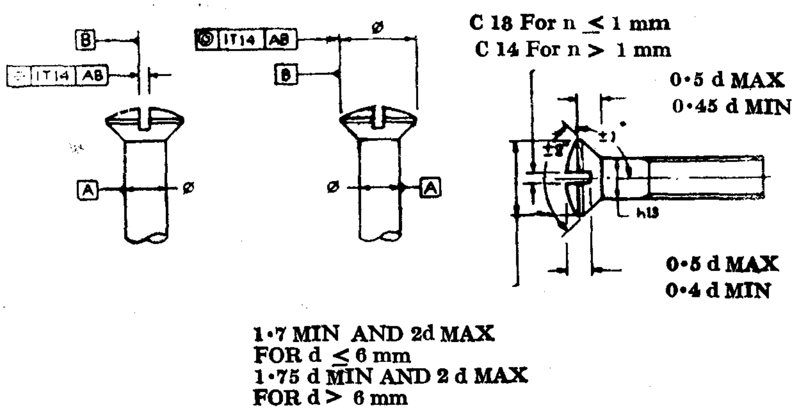


Fig. 6—Slotted or Recessed Raised Countersunk Head Screw ('P' Grade)

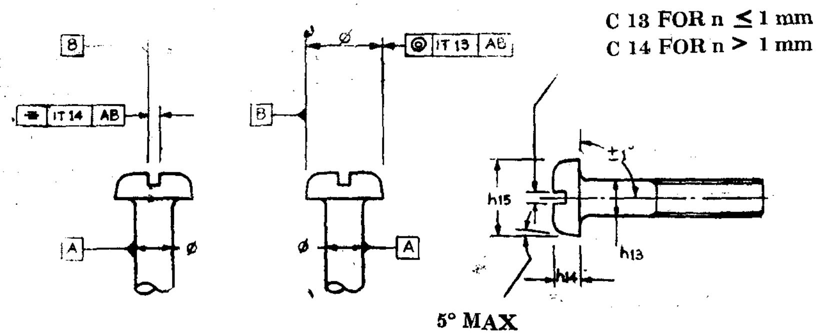


Fig. 7 — Slotted or Recessed Pan Head Screws ('P' Grade)

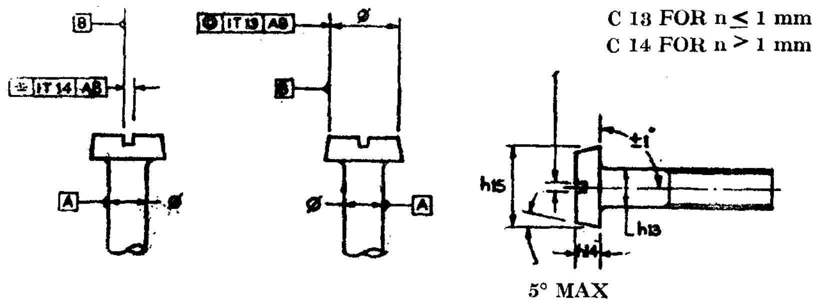
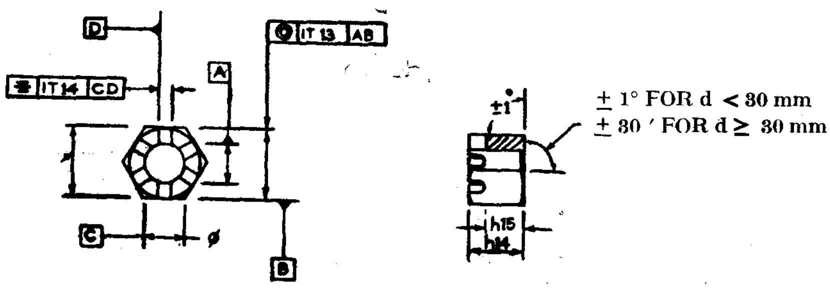


Fig. 8 — Slotted Cheese Head Screw ('P' Grade)



h 12 FOR S ≤ 8 mm
h 13 FOR 8 mm < S ≤ 32 mm
h 14 FOR S > 32 mm

Fig. 9 — Slotted Nuts ('P' Grade)

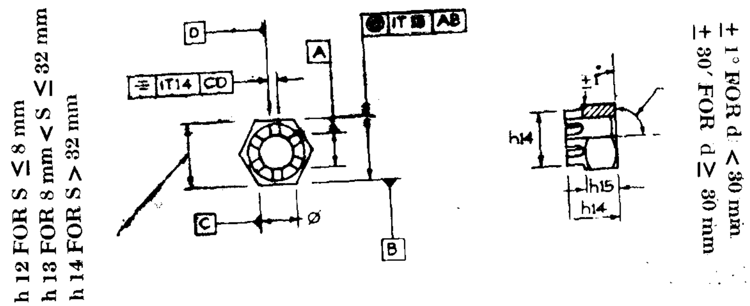


Fig. 10 — Castle Nuts ('P' Grade)

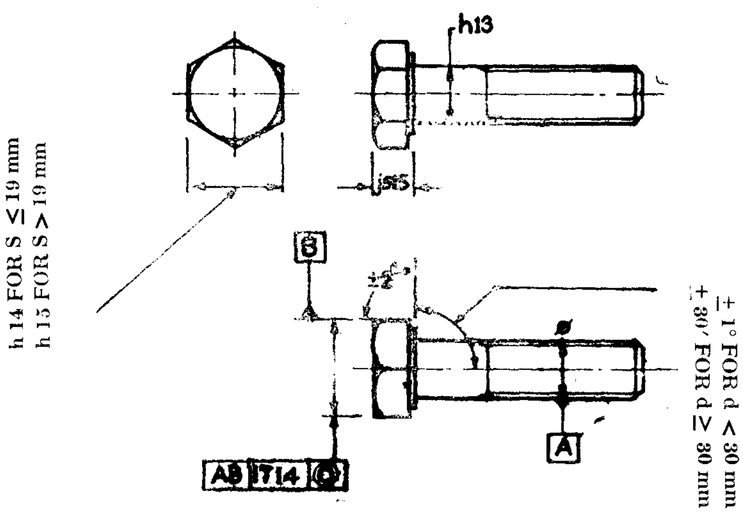


Fig. 11 — Hexagon Bolt ('S' Grade)

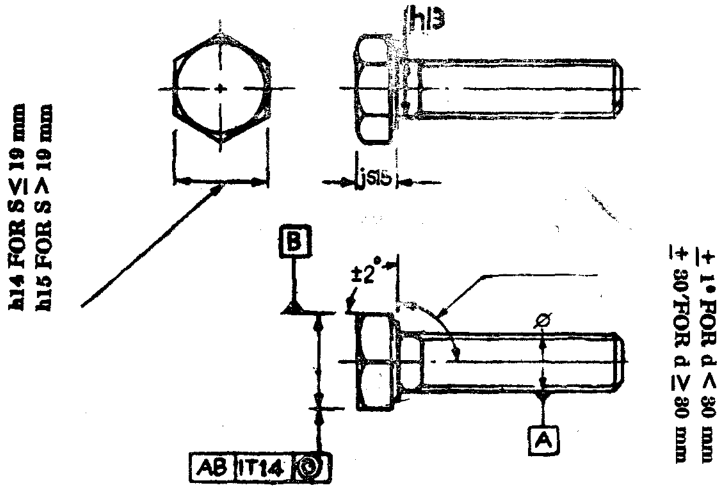


Fig. 12 — Hexagon Screw ('S' Grade)

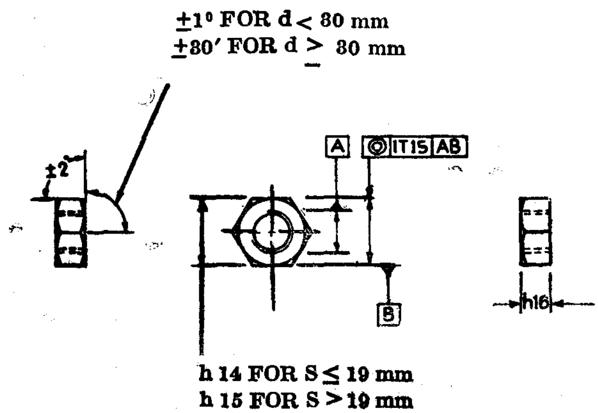


Fig. 13 — Hexagon Nut ('S' Grade)

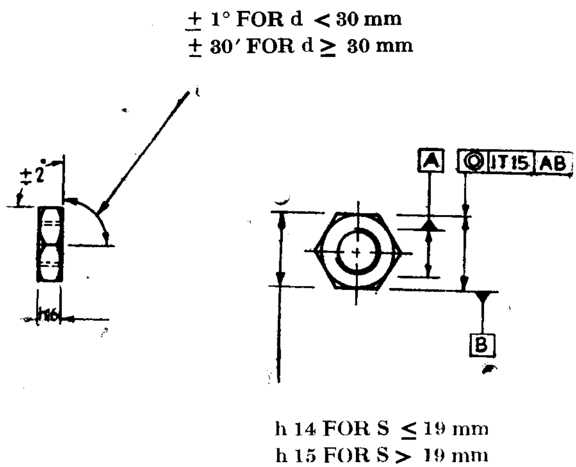


Fig. 14 — Hexagon Lock Nut ('S' Grade)

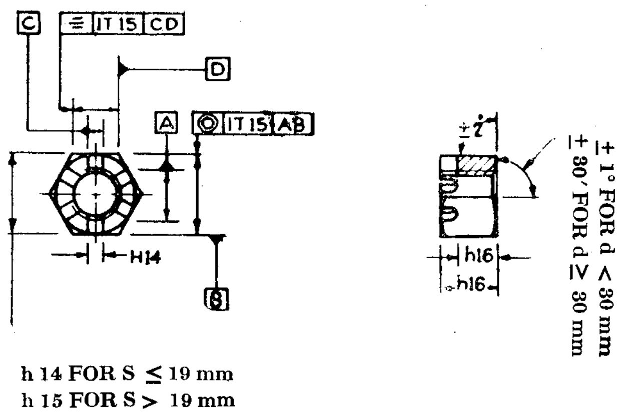


Fig. 15 — Slotted Nut ('S' Grade)

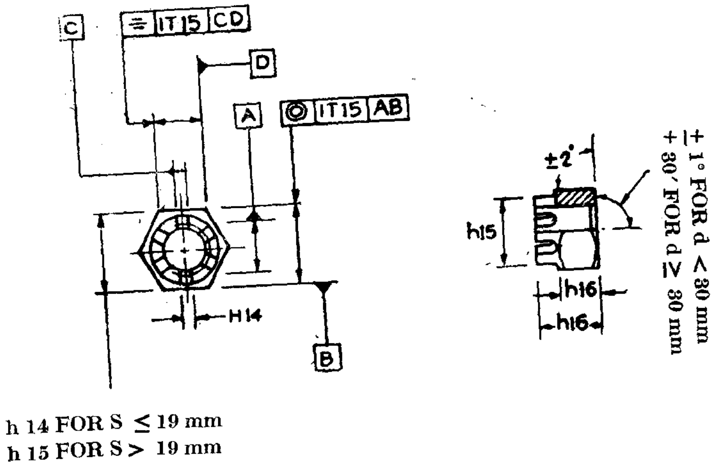


Fig. 16 — Castle Nut ('S' Grade)

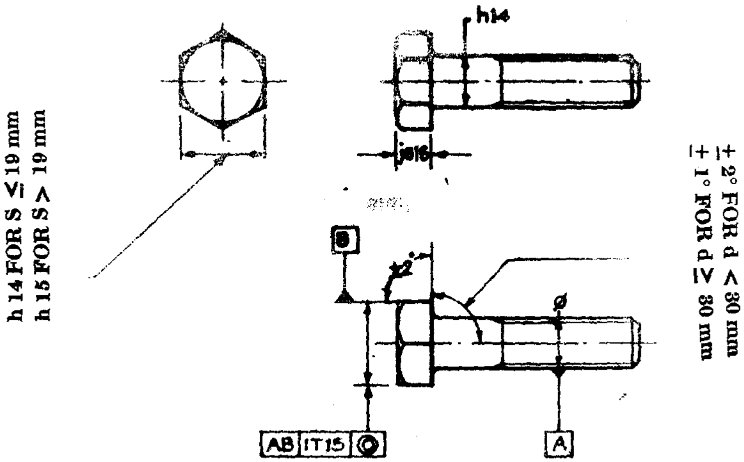


Fig. 17 — Hexagon Bolt ('C' Grade)

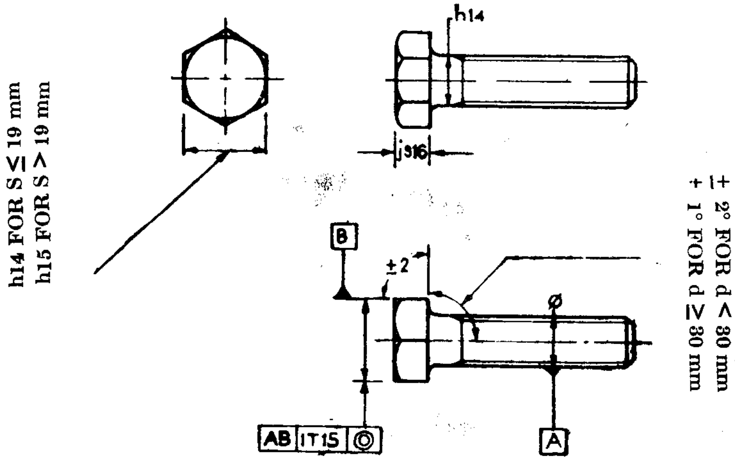


Fig. 18 — Hexagon Screw ('C' Grade)

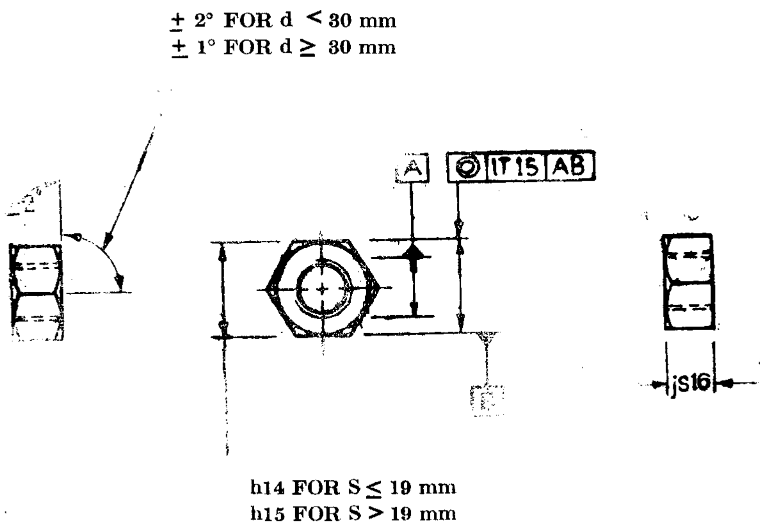


Fig. 19 — Hexagon Nut ('C' Grade)

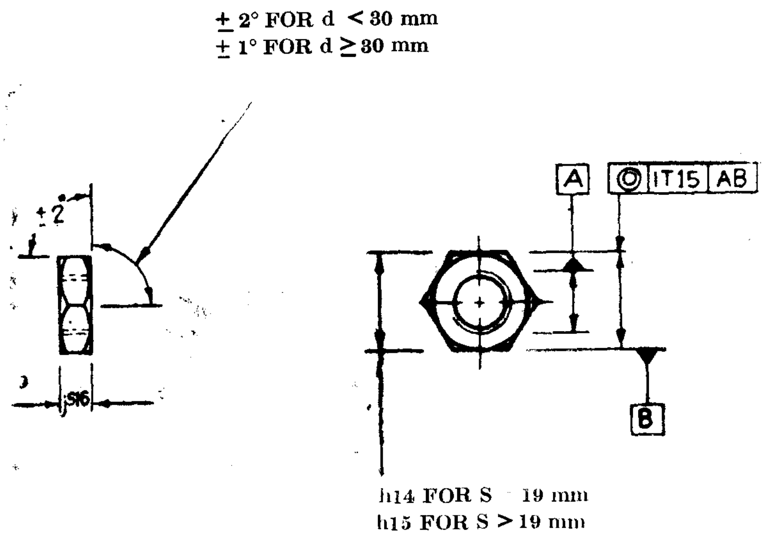


Fig. 20 — Hexagon Lock Nut

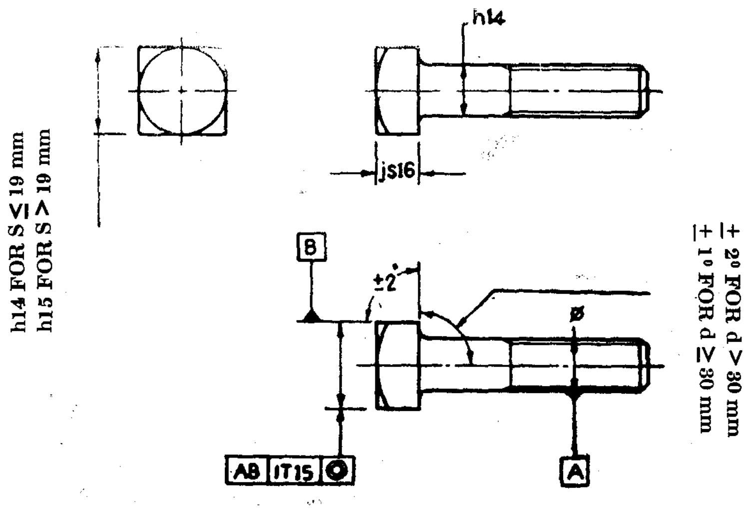


Fig. 21 — Square Bolt ('C' Grade)

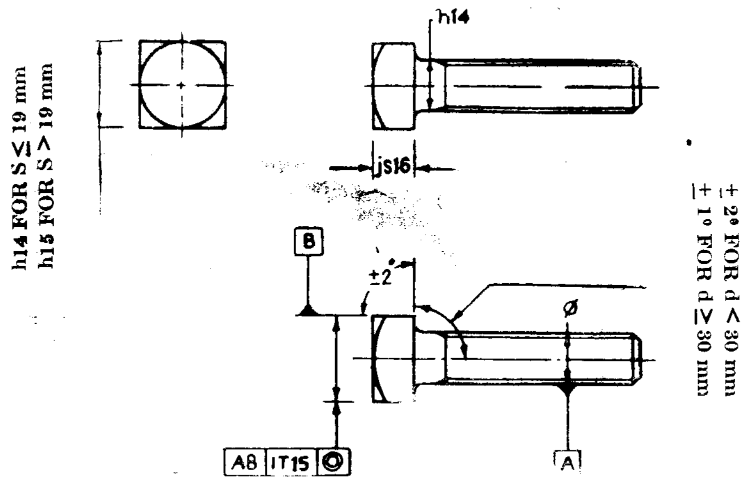
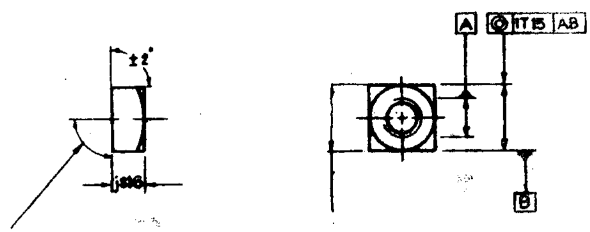


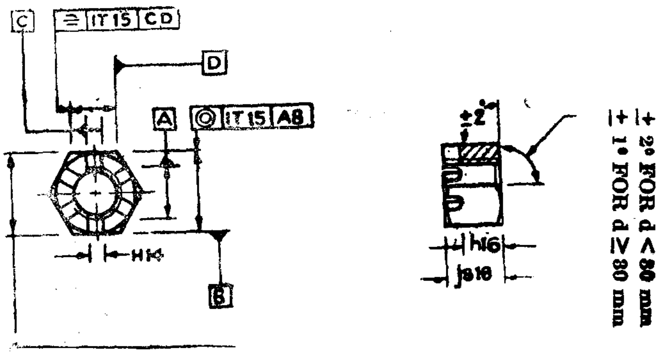
Fig. 22 — Square Screw ('C' Grade)



± 2° FOR d < 30 mm
± 1° FOR d ≥ 30 mm

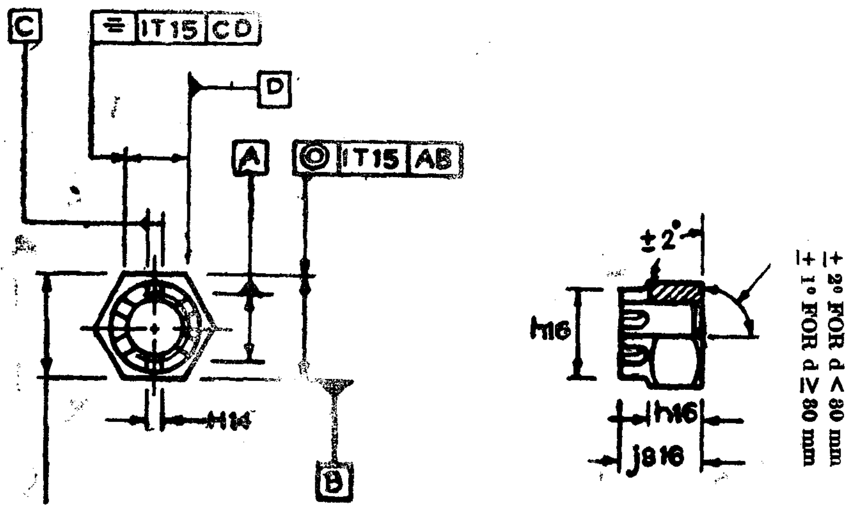
h14 FOR S ≤ 19 mm
h15 FOR S > 19 mm

Fig. 23 — Square Nut ('C' Grade)



h14 FOR S ≤ 19 mm
h15 FOR S > 19 mm

Fig. 24 — Slotted Nut ('C ' Grade)



h14 FOR S ≤ 19 mm
h15 FOR S > 19 mm

Fig. 25 — Castle Nut ('C' Grade)

6. RAW MATERIAL AND MECHANICAL PROPERTIES

6.1 The mechanical properties, specified hereunder, shall apply to threaded fasteners up to and including 39 mm thread diameter, made of carbon steel or alloy steel and not having special properties, such as weldability, corrosion resistance and ability to withstand temperature above 300 °C. The mechanical properties specified shall not apply to Bolts, Screws and Nuts made of Brass or Aluminium Alloy, unless specifically stated.

In case of nuts, the proof load requirements specified shall apply only to the nuts having the length of engagement of thread not less than 0·78 times the nominal diameter. These tests, however shall be applicable to all such nuts covered by Sri Lanka Standards except those specifically excluded from the provisions of these tests as may be mentioned in the appropriate specifications.

6.1.1 The mechanical property requirements of bolts and nuts covered by this standard are classified into a number of grades called property classes. Table 5 and Table 6 gives the preferred property classes for bolts, screws and nuts respectively.

6.2 Bolts and Screws

6.2.1 **Designation System** — The designation system for property classes of Bolts and Screws covered by this standard is shown in the system of co-ordinates in Table 7. The abscissa shows the tensile strength values while the ordinate shows the elongation after fracture.

The symbol consists of two figures, separated by a dot :

(a) the first figure indicates 1/100 of the nominal tensile strength value in N/mm^2,

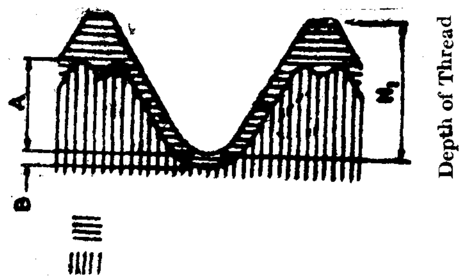
(b) the second figure indicates 1/10 of the ratio between the nominal yield stress and minimum tensile strength expressed as a percentage.

The multiplication of these two figures will give 1/10 of the nominal yield stress in N/mm^2.

6.2.2 Mechanical Properties and Decarburization

6.2.2.1 The bolts shall satisfy the requirements set out in Table 5. These tests shall be carried out as prescribed under Clause 9.2.

6.2.2.2 When Brass or Aluminium Alloy is used for the manufacture of bolts and screws, the material shall have a minimum tensile strength of 295 N/mm² (30 kgf/mm²).



A — MIN $\frac{2}{3}$ H_1 B — MAX $\frac{1}{10}$ H_1

≡ Completely and partially Decarburized Zone

|||| Non-Decarburized Zone.

Fig. 26 — Depth of Decarburization

6.2.3 Raw Material — Provided the bolts and screws meet all the requirements of 6.2.2.1, use of any particular steel or heat treatment procedure shall not be mandatory; these are left to the discretion of the manufacturer. Table 8 which specifies steels suitable for the property classes of Bolts and Screws mentioned in it, is for use as a guide only.

Brasses and Aluminium Alloys suitable for Bolts and Screws are also given in Table 9 as a guide.

6.3 Nuts

6.3.1 Designation System — The property classes of nuts are designated by the numbers which represent 1/100 of the proof load stress in N/mm² specified in Table 6.

6.3.2 Mechanical Properties

6.3.2.1 The nuts shall satisfy the requirements set out in Table 6. These tests shall be carried out as prescribed in Clause 9.3.

6.3.2.2 If Brass or Aluminium Alloy is used for the manufacture of Nuts, the material shall have a minimum tensile strength of 295 N/mm^2 (30 kgf/mm^2).

6.3.3 Raw Material — The nuts shall be made of steel conforming to the chemical composition specified in Table 10. Brasses and Aluminium Alloys suitable for nuts are also given in Table 9, as a guide.

7. SURFACE FINISH, COATINGS AND DEFECTS

7.1 Surface Finish —The surface finish of the three grades of fasteners shall be as detailed below.

Fastener Grade	Surface		Surface Conditions
	Bolts and Screws	Nuts	
P	All surfaces and threads except points	All surfaces and threads	Machined
	Point of bolt	Minor diameter of threads	Finished
S	Thread shank and bearing face	Thread and bearing face	Machined
	All other faces	Flats and minor diameter of thread	Finished
C	Flank and minor diameter of thread	Flank and major diameter of thread	Machined
	Major diameter of thread	Minor diameter of thread	Finished
	All other faces	All other faces	Unfinished

Notes : (a) Machined surfaces shall not have a roughness greater than 2 μm (CLA).

(b) Finished surfaces are those presenting a smooth and good appearance. The surface may be machined or not machined. The roughness shall not exceed 3 μm (CLA).

(c) Unfinished surfaces are those where slight irregularities are permissible within the tolerance given, and may be machined to remove noticeable defects.

(d) Centre Line Average (CLA) — Numerical assessment of the average height of the irregularities constituting the surface texture.

7.2 Surface Coatings — If the purchaser requires the Bolts, Screws and Nuts to be coated the coatings shall conform to the details given below.

7.2.1 Steel Fasteners — When steel fasteners are supplied without any coating they shall be oiled or oiled and blackened to protect the items from rusting in transport and storage under humid conditions upto a period of six months.

7.2.1.1 Coatings when required shall be of the following types :

Electro deposited coatings	(i) Cadmium (ii) Nickel or Nickel and Chromium (iii) Zinc
Chemically produced coatings	(i) Phosphate coating (ii) Oxide coating
Direct metallic coating	(i) Zinc (ii) Lead

In all cases the deposits shall adhere to the underlying metal and there shall be no visible signs of lamination or blistering.

7.2.1.2 Electro Deposited Coatings—The average thickness of a representative sample of a batch shall be within the limits specified in the following table. Thread dimensions of components supplied for plating and after plating shall comply with the relevant screw thread standards.

Plating Thickness (Unit : Millimetre)

Basic Major Diameter of Screw Thread		*Batch Average Thickness	
Over	Up to and including	Minimum	Maximum
1·52	3·20	0·0038	0·0051
3·20	6·35	0·0051	0·0064
6·35	12·70	0·0064	0·0076
12·70	19·05	0·0076	0·0089

*A ' batch ' shall mean a quantity of identical components plated together at one time (in a particular barrel).

7.2.1.3 Chemically produced Coatings—The thickness of chemically produced coatings shall be as follows :

Phosphate Coating	2 μm (minimum)
Oxide Coating	3 μm (minimum)

The thickness of coatings shall be determined by microscopic examination of the cross-section.

All high tensile bolts (above grades 10.9) shall be stress relieved before any chemical treatment.

Thicker coatings shall be specified by the purchaser if required in agreement with the manufacturer.

7.2.1.4 Direct Metallic Coatings— The thickness of coating shall be a minimum of 50 μm (batch average).

The threads of galvanised fasteners may be re-rolled but not refinished unless specifically allowed. A tolerance of 1 mm max. will be permissible on the unthreading body diameter and height of head and width across flats of the fasteners.

Bolts may be further passivated (oxide coat) after completion. This is usually done by immersing in various acid mixtures at set temperatures for standard duration of time. They are then thoroughly rinsed with hot water.

7.2.2 Aluminium Alloy Fasteners—Aluminium alloy fasteners shall be anodised to give both protective and decorative effects when expressly desired by the purchaser.

7.2.3 Brass Fasteners

7.2.3.1 Coatings when required shall be of the following types :

i) Tin
ii) Nickel or Nickel and Chromium
iii) Chromium
iv) Lead

7.2.3.2 The deposit shall adhere firmly to the underlying metal and there shall be no visible signs of lamination or blistering.

7.2.3.3 The average thickness of a representative sample of a batch shall be within the limits specified in the table above (as for steel fasteners). Thread dimensions of components supplied for plating and after plating shall comply with the relevant screw thread standards.

7.3 Surface Defects — Fasteners shall be reasonably free of surface defects such as quench cracks, forging cracks, seams, bursts, shear failure, voids, laps, fold, tool marks and nicks. They shall not in anyway interfere with the strength and serviceability of the fasteners. Guidance in this respect is given in Appendix A.

8. IDENTIFICATION MARKING

8.1 General — The marking and identification requirements of this standard is only mandatory for steel Bolts, Screws and Nuts of 6 mm diameter and larger, manufactured to strength grade designations 8.8 (for Bolts or Screws) and 8 (for Nuts) or higher.

8.2 Bolts and Screws

8.2.1 Bolts and screws shall be identified as ISO metric by the symbol ' M ' embossed or indented on top of the head.

8.2.2 The manufacturer's identification (trade) marking shall be embossed or indented on the top of the head of Bolts and Screws manufactured by cold forging.

8.2.3 Bolts and Screws manufactured to strength grades 8.8, 10.9 and 12.9 shall be marked on top of the head with the appropriate symbol. Other grades may be similarly marked at the option of the manufacturer. The ' separating full stop ' in the strength grade symbol may be omitted so that the grades may be marked 88, 109 and 129 (see Fig. 27).

8.2.4 Bolts and Screws turned from bar shall alternatively have the metric symbol ' M ' and the appropriate strength grade symbol indented or rolled into the sides of the hexagon flat. (see Fig. 28).

8.3 Nuts

8.3.1 Nuts may carry some form of manufacturer's identification trade marking.

8.3.2 Nuts turned from hexagon bar shall have the metric symbol ' M ' indented or rolled into one of the hexagon flats.

8.3.3 Nuts manufactured to strength grades 8 and 12 shall be appropriately marked by either of the following alternative methods (see Figs. 29 and 30). Nuts manufactured in strength grades 4, 5 and 6 may be marked at the option of the manufacturer.

8.3.3.1 The strength grade symbol indented into the bearing or non-bearing face of the nut. In the case of nuts turned from hexagon bar the symbol may be indented or rolled into the side of one of two hexagon flats.

8.3.3.2 The strength grade indicated by means of a ' clock face ' system which shall be marked preferably on the external chamfers of the nut by indenting or embossing. Embossed marks shall in no case protrude beyond the bearing face of the nut. The ' clock face ' system may alternatively be indented in the bearing or non-bearing face of the nut.

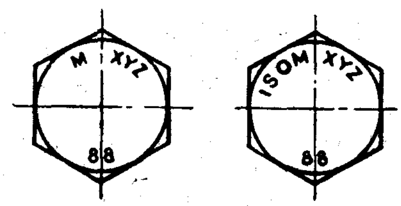


Fig. 27 — Examples of marking forged products

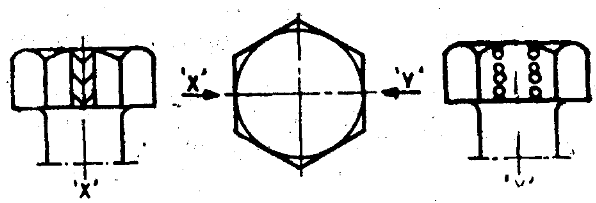
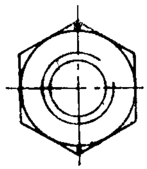
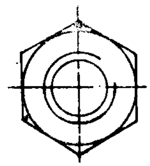
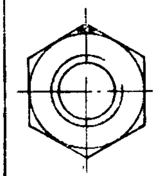


Fig. 28 — Examples of marking of bar turned products.

Strength grade	4	5	6	8	12
Symbol	4	5	6	8	12
Alternative 'clock face' marking system	—	—			

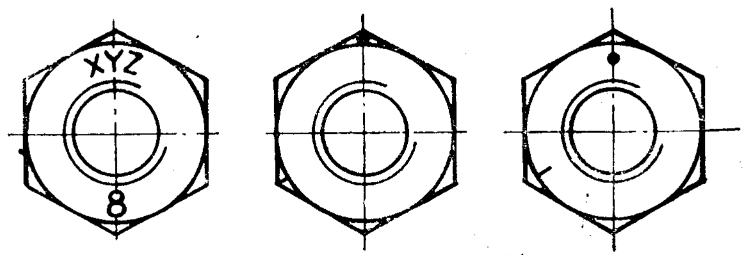


Fig. 29 — Examples of marking of forged products

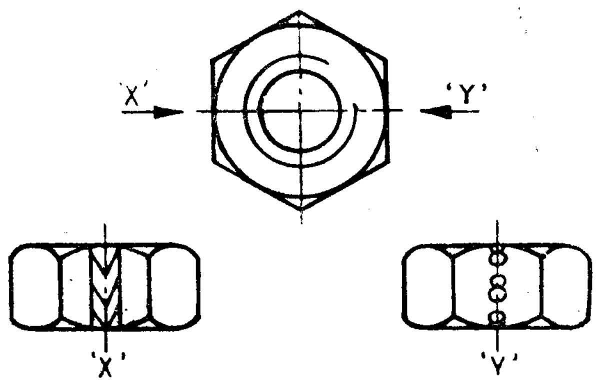


Fig. 30 — Examples of marking bar turned nut

9. ACCEPTANCE TESTS

9.1 General — The manufacturer should maintain statistical quality control to ensure that the product conforms to the accuracy, mechanical properties, finish and other requirements specified in this standard. Suitable number of samples from each consignment shall be selected as specified in Clause 10. The number of tests for acceptance shall be as specified in Clause 10. The tests given under 9.2 shall be applied for checking the requirements given in this standard.

9.2 Test for Mechanical Properties and Surface Decarburization of Bolts and Screws—Two programmes A and B, of tests for mechanical properties of Bolts and Screws using the methods described in 9.2 are set out in Table 11. The choice between A and B will be a matter of agreement between the purchaser and the manufacturer.

The mechanical properties of Bolts and Screws that are decisive for acceptance are shown in Table 11. These have been arranged in five groups marked I to V according to the manner in which these are related to one another. In each of these groups, the test marked ' @ ' is decisive for acceptance. If the purchaser wishes to simplify the acceptance test, the above mentioned tests may be replaced by the tests marked ' * '. In the case of doubt, the first mentioned tests are decisive unless it is not possible to carry out these for dimensional reasons. In this case, the test marked ' * ' will be decisive.

Subject to special agreement, tests marked ' O ' may be included in addition or may replace the tests marked ' @ '.

9.2.1 Tensile test for machined test pieces — The tensile test shall be conducted in accordance with CS 12 * on a test piece as shown in Fig. 31.

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*CS 12 Method of tensile testing of steel products other than Sheet, Strip, Wire and Tube.

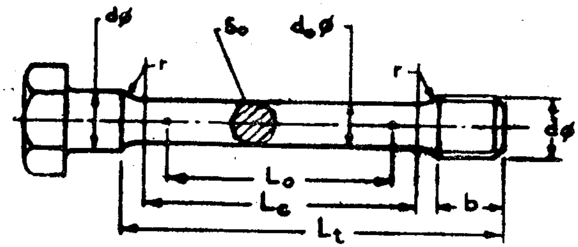

Fig. 31 — Test piece.

The following properties are to be checked by this test :

a) Tensile strength, R_m

b) Yield stress, R_e or stress at 0·2 per cent permanent set limit, $R_{0.2}$.

c) Percentage elongation after fracture

$$A = \frac{L_u - L_o}{L_o} \times 100 \text{ (per cent)}$$

The reduction of the shank diameter of heat-treated bolts and screws under 16 mm thread diameter shall not exceed 25 per cent of the diameter (about 44 per cent of the cross-sectional area) when preparing the test piece.

9.2.2 Tensile Test for Full Size Bolts — The tensile test should be carried out on full size bolts in conformity with the tensile test on machined test pieces (Clause 9.2.1). It is carried out to determine the tensile breaking load for the bolt which shall have a minimum tensile load as given in Tables 12 and 13 for bolts with coarse and fine series threads respectively.

When carrying out the test, a free threaded length equal to the nominal diameter of the bolt is subjected to the tensile load. To meet the requirement of this test, the fracture should occur in the shank or the thread of the bolt and not between the head and the shank.

Screws threaded to the head, should meet the requirement of this test, if a fracture, which causes failure, originates in the threaded area even if it has extended into the fillet area under the head, before separation.

9.2.3 Brinel Hardness Test — The Brinell hardness test shall be carried out with a 10 mm diameter steel ball and 3,000 kg load in accordance with CS 146 †. The hardness indentation shall be made on the top or side of the head or on the end point of the bolt. In case of studs, it shall be made on the unthreaded portion or on the end face.

9.2.4 Rockwell Hardness Test — The Rockwell hardness test shall be carried out in accordance with CS 145 *. The hardness indentation shall be made on the top or side of the head or on the end point of the bolt. In case of studs, it shall be made on the unthreaded portion or on the end face.

9.2.5 Proof load test for full Size Bolts — The proof load test consists of two main operations namely :

a) application of a specified tensile proof load ; and

b) measurement of permanent extension, if any, caused by the proof load.

The arrangement of the test is shown in Fig. 32.

The proof load is applied axially to the bolt in a tensile testing machine. The length of free thread above the nut should be between 0·5 d and 1 d.

For the measurement of permanent extension, the bolt should be axially centre-drilled (60° — cone) at each end. Before and after the application of the proof load, the bolt should be placed in a bench-mounted measuring instrument fitted with spherical anvils so as to ensure that the total of the measuring inaccuracies is less than $\pm$ 5 μm.

Other methods of measuring length may be used, provided that the above standard of accuracy is maintained.

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†CS 146 Method for Brinell Hardness test.
***CS 145 Method for Rockwell Hardness test.**

The proof leads tc be applied for bolts and screws with coarse series threads are given in Table 14 and for Bolts and Screws with fine series threads are given in Table 15.

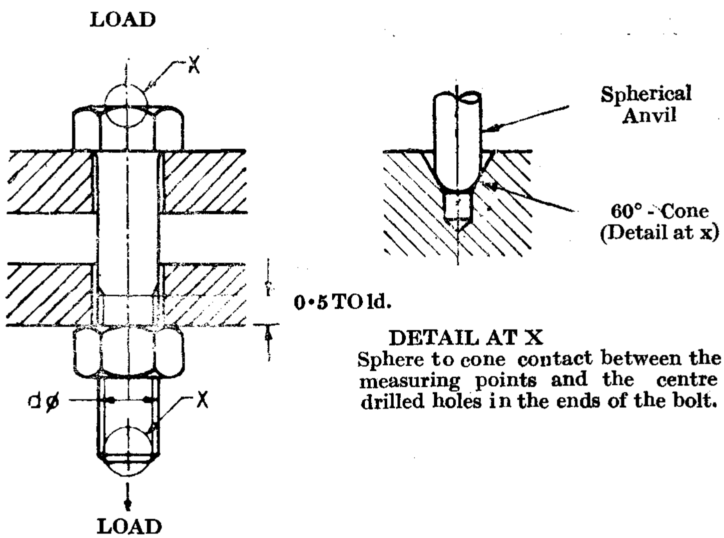


Fig. 32 — Application of Proof load to full size bolts.

9.2.6 Test for Strength under Wedged Loading of full Size Bolts — This test shall be carried out on full size bolts as per Clause 9.2.2 except that a hardened steel wedge shall be placed under the bolt head. The test shall be performed on the same bolt as previously tested for proof load (Clause 9.2.5). The bolt head shall be so placed that no corner of the hexagon or square takes a bearing load, that is, a flat of the head shall be aligned with the direction of uniform thickness of the wedge, details of which are given in Fig. 33. The hardness of the wedge shall be 50 HRC (in accordance with CS 145).

The bolt shall withstand, before fracture, the minimum tensile load given in Tables 12 and 13 for bolts with coarse and fine series threads respectively. The fracture shall take place in the shank or the thread of the bolt and not between the head and the shank.

Screws threaded to the head should meet the requirement of this test if a fracture, which causes failure, originates in the threaded area even if it has extended into the fillet area under the head before separation.

9.2.7 Impact Test for Machined Test Pieces — The impact test shall be carried out in accordance with SLS 355 *. The test piece shall be taken lengthwise, located as close to the surface of the Bolt as possible. The un-notched side of the test piece should be located near the surface of the Bolt. This test applies to Bolts having nominal diameter over 12 mm.

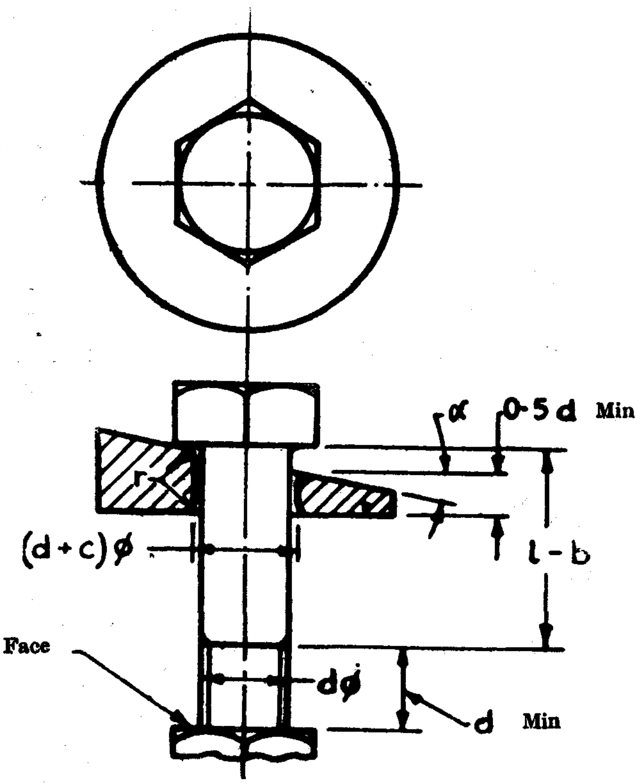


Fig. 33 — Wedge loading of full size bolts (see table below)

*SLS 355 Method of Charpy impact test (U-notch) for steel.

Table for Figure 33

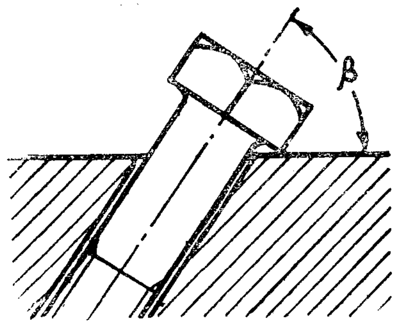
Nominal Bolt Size		r	c	ANGLE $\alpha \pm 30'$			
Over	Up to			(l — b)	≥ 2d	(l — b)	< 2d
mm	mm	mm	mm	Property Class 4·6, 4·8 6·8 & 8·8	Property Class 10·9 & 12·9	Property Class 4·6, 4·8, 6·8 & 8·8	Property Class 10·9 & 12·9
—	6	0·5	0·7	10°	6°	6°	4°
6	12	0·8	0·8	10°	6°	6°	4°
12	20	1·6	1·3	10°	6°	6°	4°
20	39	3·2	1·6	6°	4°	4°	4°

where b = length of thread
l = length of bolt.

9.2.8 Head Soundness Test for full Size Bolts — The head soundness test is carried out as illustrated in Fig. 34. The hardness of the block and the dimensions of the hole shall be the same as those given for the wedge in Clause 9.2.6.

When struck several blows with a hammer, the head of the Bolt or Screws should bend through an angle of (90° — β) without exhibiting any sign of cracking at the fillet between the head and the shank.

9.2.9 Decarburization Test — The decarburization is to be determined from longitudinal section taken from the threaded portion. The plane of section should be within 1/10 of the diameter from the Bolt axis. For permissible depth of surface decarburization, see Fig. 26.



Property class — 4.6 4.8 6.6 8.8 10.9 12.9
Angles β — 60° 80° 60° 80° 80° 80°

Fig. 34 — Head Soundness test.

For the purpose of determining surface decarburization, a longitudinal microsection should be polished and subsequently etched with an alcoholic solution of nitric acid. The surface decarburization should be measured with a micrometer ocular at a magnification of 100 : 1.

9.3 Tests for Mechanical Properties of Nuts — The Nuts shall be tested in accordance with test methods described in Clauses 9.3.1 and 9.3.2 for strength under proof load and hardness.

To meet the requirements of this specification, both proof load and hardness test shall be decisive for acceptance.

Nuts with specified proof load in excess of 343 kN may be exempted from proof load testing.

Such nuts, in addition to complying with the maximum hardness requirement, shall meet the minimum hardness requirement as agreed to between the purchaser and the manufacturer.

9.3.1 Proof Load Test — The Nut shall be assembled on a hardened and threaded mandrel as shown in Fig. 35.

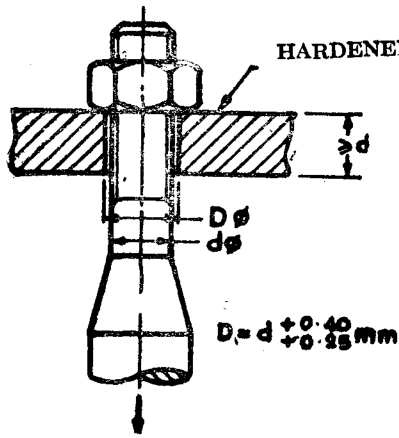


Fig. 35 — Application of Proof Load to Nut.

The proof load shall be applied against the Nut in an axial direction. The Nut shall resist this load without failure by stripping or rupture, and shall be removable by the fingers (except for prevailing torque type self locking nuts) after the load is released. If the threads of the mandrel are damaged during the test, the test shall be discarded. (It may be necessary to use a wrench to start the nut in motion. Such wrenching is permissible provided it is restricted to half turn and the nut is then removable by the fingers following initial loosening).

The proof loads to be applied for nuts with coarse series threads are given in Table 16 and for Nuts with fine series threads, in Table 17.

The hardness of the test mandrel shall be HRC 45, minimum (in accordance with CS 145).

Mandrels used in testing shall be threaded to tolerance class 5h, except that the tolerance of the major diameter shall be one quarter of the 6 g range on the minimum material side.

9.3.2 Hardness Test — Either Brinell hardness or Rockwell hardness may be determined.

The Brinell hardness test shall be carried out with 10 mm diameter steel ball and 3 000 kg load in accordance with CS 146.

The Rockwell hardness test shall be carried out in accordance with CS 145.

The hardness indentation shall be made on the face or side of the nut.

10. SAMPLING

10.1 Scale of Sampling

10.1.1 Fasteners shall be selected and examined for each lot separately for ascertaining their conformity to the requirements of the relevant specification. Only one set of samples as indicated in 10.1.2 shall be drawn from a lot for all the characteristics of the product to be inspected.

10.1.2 The number of fasteners to be selected from a lot shall depend upon the size of the lots and shall be in accordance with Columns 1 to 3 of Table 18 for normal inspection, and Columns 1 and 2 of Table 19 for inspection of physical properties.

10.1.3 All these fasteners shall be taken at random from the lot.

10.2 Criteria for Conformity

10.2.1 Visual Characteristics — All the fasteners drawn under 10.1.2 shall be first examined for visual characteristics like type, finish, workmanship, surface defects, duds and identification mark. To ascertain the conformity of the lot to the requirements of all visual characteristics except duds, the procedure given in 10.2.1.1 shall be followed and for duds the procedure given in 10.2.1.2 shall be followed.

10.2.1.1 Visual Characteristics Other than Duds — If in the first sample the number of defective fasteners with respect to all visual characteristics except duds is less than or equal to the corresponding acceptance number given in Column 5 of Table 18, the lot shall be declared as conforming to the requirements for these characteristics. If the number of defectives is greater than or equal to the corresponding rejection number given in Column 6 of Table 18, the lot shall be deemed as not meeting the requirements for these characteristics. If the number of defectives is greater than the acceptance number but less than the rejection number, a second sample of the same number of fasteners selected as the first sample shall be taken to determine the conformity or otherwise of the lot. The number of defectives found in the first and second sample shall be combined and if the combined number of defectives is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements, otherwise not.

10.2.1.2 If the number of defective fasteners with respect to duds is less than or equal to the corresponding acceptance number given in Column 7 of Table18 the lot shall be declared as conforming to the requirements for duds. If the number of defective fasteners is greater than or equal to the rejection number given in Column 8 of Table 18, the lot shall be declared as not conforming to the requirements for duds. If the number of defective fasteners is greater than the acceptance number but less than the rejection number, a second sample of the same number of fasteners selected as the first sample shall be taken to determine the conformity or otherwise of the lot. The number of defective fasteners found in the first and second samples shall be combined and if the combined number of defective fasteners is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements for duds, otherwise not.

10.2.2 Dimensional characteristics — The lot which had been found satisfactory in respect of visual characteristics (see 10.2.1) shall next be tested for dimensional characteristics like diameter, length and pitch. The fasteners for this purpose shall be taken at random in accordance with Columns 9 and 10 of Table 18, from those already drawn for inspection of visual characteristics (see 10.2.1.1 and 10.2.1.2. and tested for the dimensional characteristics. If the number of fasteners failing to satisfy the requirements for these characteristics is less than or equal to the correspon-ding acceptance number given in Column 12, 14, 16 or 18 of Table 18, the lot shall be declared to have met the require-ments of the specification in respect of these characteristics). If the number of defectives is greater than or equal to the corresponding rejection number given in Column 13, 15, 17 or 19 of Table 18 the lot shall be deemed as not conforming to these characteristics. In case the number of defectives lies in between the acceptance and rejection numbers, a second sample of the same size shall be taken and inspected for the dimensional characteristics and inference drawn accordingly.

10.2.3 Physical Properties — In case proper quality control of the raw material to the satisfaction of the purchaser or the inspecting officer, has been maintained by the manufac-turers and the quality was found to be satisfactory as evi-denced by suitable certificates accompanying the lot, no test may be required for the determination of physical pro-perties like hardness and tensile strength. If, however, such a control did not exist, or if the purchaser so desires, fasteners may be drawn at random in accordance with Colu-mn 1 and 2 of Table 19 from those already selected according to 10.1.2 and tested for physical properties. If the number of defectives found in the sample is less than or equal to the corresponding acceptance number in Column 13, the lot shall be deemed as meeting the requirements for physical properties, otherwise not.

10.2.4 A lot shall be declared as conforming to this specification if it satisfies the requirements for the visual and dimensional characteristics and physical properties.

Table 19 — Scale of Sampling and Conformity Criteria for Physical Properties

Lot Size (1)	Sample Size (2)	Acceptance Number (3)
Up to 1 000	5	0
1 001 to 3 000	8	0
3 001 to 10 000	13	0
10 001 to 35 000	20	0
Over 35 000	32	1

10.3 Tightened and Reduced Inspection

10.3.1 In case the quality of the submitted lots varies considerably, it may be desirable to make appropriate changes in the sampling plan. If the quality of the submitted lots is consistently bad, it may be desirable to tighten the inspection : on the other hand, if the quality of the submitted lots is consistently good, it may be desirable to relax the inspection. The following procedure may be helpful in deciding on tightened or reduced inspection :

a) Shift to tightened inspection if 2 of the last 5 (or less) lots under normal inspection were rejected ; reinstate normal inspection when three successive lots are accepted under tightened inspection ; and

b) Shift to reduced inspection if the preceding 10 lots under normal inspection have all been accepted ; reinstate normal inspection if on reduced inspection a lot is rejected and if at the same time the rejected lot is preceded by less than 10 lots accepted on reduced inspection.

10.3.1. 1 Tightened Inspection—Inspection shall be tightened by using, a sampling plan as given in Table 20 for the corresponding lot size and drawing appropriate inference on the same lines as given in 10.2.1, 10.2.2 and 10.2.3 for determining the conformity of the lot.

Tightening of inspection has been achieved by retaining the same sample size as in the normal inspection but reducing the acceptable quality levels by way of reduction in the acceptance and rejection numbers wherever possible.

10.3.1.2 **Reduced Inspection**— Inspection shall be relaxed by using a sampling plan as given in Table 21 for the corresponding lot size and drawing appropriate inference as before.

Relaxation of inspection has been achieved by reducing the sample size as recommended for normal inspection and retaining approximately the same acceptable quality levels as far as possible.

Table 1 — Tolerances for Grades IT11 to IT17

(Clause 5.1.1)

All dimensions in millimetres

Nominal Size Range	Tolerance Grade						
	IT11	IT12	IT13	IT14	IT15	IT16	IT17
From 0·2 to 1	—	—	—	*	*	—	—
Above 1 to 3	0·06	0·10	0·14	0·25	0·40	0·60	1·00
Above 6	0·075	0·12	0·18	0·30	0·48	0·75	1·20
Above 6 to 10	0·09	0·15	0·22	0·36	0·58	0·90	1·50
Above 10 to 18	0·11	0·18	0·27	0·43	0·70	1·10	1·80
Above 18 to 30	0·13	0·21	0·33	0·52	0·84	1·30	2·10
Above 30 to 50	0·16	0·25	0·39	0·62	1·00	1·60	2·50
Above 50 to 80	0·19	0·30	0·46	0·74	1·20	1·90	3·00
Above 80 to 120	0·22	0·35	0·54	0·87	1·40	2·20	3·50
Above 120 to 180	0·25	0·40	0·63	1·00	1·60	2·50	4·00
Above 180 to 250	0·29	0·46	0·72	1·15	1·85	2·90	4·60
Above 250 to 315	0·32	0·52	0·81	1·30	2·10	3·20	5·20
Above 315 to 400	0·36	0·57	0·89	1·40	2·30	3·60	5·70
Above 400 to 500	0·40	0·63	0·97	1·55	2·50	4·00	6·30

	For Slot Widths	For Slot Depths
* Up to 0·25	+ 0·1	+ 0·15
Above 0·25	+ 0·15	+ 0·2

Table 2 — Tolerance Zones for External Dimensions
(Clause 5.1.1)
All dimensions in millimetres

Nominal Size Range	Tolerance Zone										
	h11	h12	h13	h14	h15	h16	js13	js14	js15	js16	js17
From 0·2 to 1	—0·06	—	—	—	—	—	—	—	—	—	—
Above 1 to 3	—0·065	—0·10	—0·14	—0·25	—0·40	—0·60	±0·070	±0·125	±0·20	±0·30	±0·50
Above 3 to 6	—0·075	—0·10	—0·18	—0·30	—0·48	—0·75	±0·090	±0·15	±0·24	±0·375	±0·60
Above 6 to 10	—0·09	—0·15	—0·22	—0·36	—0·58	—0·90	±0·110	±0·18	±0·29	±0·45	±0·75
Above 10 to 18	—0·11	—0·18	—0·27	—0·43	—0·70	—1·10	±0·135	±0·215	±0·35	±0·55	±0·90
Above 18 to 30	—0·13	—0·21	—0·33	—0·52	—0·84	—1·30	±0·165	±0·26	±0·42	±0·65	±1·05
Above 30 to 50	—0·16	—0·25	—0·39	—0·62	—1·00	—1·60	±0·195	±0·31	±0·50	±0·80	±1·25
Above 50 to 80	—0·19	—0·30	—0·46	—0·74	—1·20	—1·90	±0·230	±0·37	±0·60	±0·95	±1·50
Above 80 to 120	—0·22	—0·35	—0·54	—0·87	—1·40	—2·20	±0·270	±0·435	±0·70	±1·10	±1·75
Above 120 to 180	—0·25	—0·40	—0·63	—1·00	—1·60	—2·50	±0·315	±0·50	±0·80	±1·25	±2·00
Above 180 to 250	—0·29	—0·46	—0·72	—1·15	—1·85	—2·90	±0·360	±0·575	±0·925	±1·45	±2·30
Above 250 to 315	—0·32	—0·52	—0·81	—1·30	—2·10	—3·20	±0·405	±0·65	±1·05	±1·60	±2·60
Above 315 to 400	—0·36	—0·57	—0·89	—1·40	—2·30	—3·60	±0·445	±0·70	±1·15	±1·80	±2·85
Above 400 to 500	—0·40	—0·63	—0·97	—1·55	—2·50	—4·00	±0·485	±0·775	±1·25	±2·00	±3·15

Table 3 — Tolerance Zones for Internal Dimensions

(Clause 5.1.1)

All dimensions in millimetres

Nominal Size Range	Tolerance Zone					
	D 12	H 11	H 12	H 13	H 14	H 15
From 0·2 to 1	—	—	—	—	—	—
Above 1 to 3	+0·12 +0·02	+0·06	+0·10	+0·14	+0·25	+0·40
Above 3 to 6	+0·15 +0·03	+0·075	+0·12	+0·18	+0·30	+0·48
Above 6 to 10	+0·19 +0·04	+0·09	+0·15	+0·22	+0·36	+0·58
Above 10 to 18	+0·23 +0·05	+0·11	+0·18	+0·27	+0·43	+0·70
Above 18 to 30	+0·275 +0·065	+0·13	+0·21	+0·33	+0·52	+0·84
Above 30 to 50	+0·33 +0·08	+0·16	+0·25	+0·39	+0·62	+1·00
Above 50 to 80	+0·40 +0·10	+0·19	+0·30	+0·46	+0·74	+1·20
Above 80 to 120	+0·47 +0·12	+0·22	+0·35	+0·54	+0·87	+1·40
Above 120 to 180	+0·545 +0·145	+0·25	+0·40	+0·63	+1·00	+1·60
Above 180 to 250	+0·63 +0·17	+0·29	+0·46	+0·72	+1·15	+1·85
Above 250 to 315	+0·71 +0·19	+0·32	+0·52	+0·81	+1·30	+2·10
Above 315 to 400	+0·78 +0·21	+0·36	+0·57	+0·89	+1·40	+2·30
Above 400 to 500	+0·86 +0·23	+0·40	+0·63	+0·97	+1·55	+2·50

Table 4 — Eccentricity Limits

	Eccentricity		Refer to figure	Reference dimensions for tolerance
	of	with respect to		
BOLTS & SCREWS	Width across flats	Shank or thread if threaded to head	1, 2, 11, 12, 17, 18, 21, 22	Widths across flats
	Head diameter	Shank or thread if threaded to head	5, 6, 7, 8.	Head diameter
	Slot in head	Shank or thread if threaded to head	5, 6, 7, 8.	Shank or thread diameter
NUTS	Width across flats	Thread	3, 4, 9, 10, 13, 14, 15, 16, 19, 20, 23, 24, 25.	Width across flats
	Slot	Thread	9, 10, 15, 16, 24, 25.	Thread diameter

Table 6 — Preferred Property Classes for Nuts

Property Class of Nut*	4	5	6	8	10	12
For use with bolts of property class	4·6, 4·8	5·6, 5·8	6·8	8·8	10·9	12·9
Proof load stress N/mm²**	400	500	600	800	1000	1200
Brinell hardness HB, Max.	302	302	302	302	353	353
Rockwell hardness HRC, Max.	30	30	30	30	36	36

* Nuts of a higher strength property class may substitute the nuts of a lower strength property class.

** The proof load is calculated by multiplying the proof load stress by the nominal stress area (A_s) of the corresponding bolt thread, where

$$A_s = \frac{\pi}{4} (d_2 + d_3)^2$$

d_2 = basic pitch diameter

d_3 = basic minor diameter.

Table 5 — Preferred Property Classes for Bolts and Screws

Property Ref. No.	Mechanical Property		Property Class									
			3·6	4·6	4·8	5·6	5·8	6·8	8·8	9·8	10·9	12·9
1 and 2	ensile strength R_m N/mm²	nominal	300	400		500		600	800	900	1000	1200
		minimum	330	400	420	500	520	600	830	900	1040	1220
3	Brinell Hardness HB	minimum	90	114	124	147	152	181	242	266	294	353
		maximum		242				266	319	342	362	409
4	Rockwell Hardness min.	HRB	52	67	71	79	82	—	—	—	—	—
		HRC	—	—	—	—	—	18	23	27	31	38
	max.	HRB			100					—		
		HRC			—			28	34	36	39	44
5	Yield Stress, R_e N/mm²	nominal	180	240	340	300	420	480	—	—	—	—
		minimum	190	240	340	300	420	480	—	—	—	—
6	Stress at permanent set limit $R_{0,2}$ N/mm²	nominal			—				640	720	900	1080
		min.			—				660	720	940	1100
7	Stress under proof load, Sp	Sp/Re	0·94	0·94	0·91	0·94	0·91	0·91	0·91	0·91	0·88	0·88
		N/mm²	180	225	310	280	380	440	600	650	830	970
8	Elongation after fracture A_s	min. %	25	25	14	20	10	8	12	10	9	8
9	Strength under wedge loading		The values for full size bolts should equal the minimum values for tensile strength shown under 2 above.									
10	Impact strength min kgf. m/cm²				—				6	5	4	3
11	Head soundness		No fracture									
12	Decarburization at root of thread		Depth not more than 1/10 H_1 (see Figure 26)									
	Non-decarburised zone		Depth not less than 2/3 H_1 (see Figure 26)									

Table 7 — System of Coordinates

Minimum tensile strength R_m*	N/mm²	300	400	500	600	700	800	900	1000	1200	1400
	1000 lbf/in²	45	60	74	90	100	120		150	180	200
Minimum elongation after fracture A_s%	7										
	8										
	9				6·8					12·9	
	10								10·9		
	12			5·8				9·8			
	14						8·8				
	16		4·8								
	18										
	20										
	22			5·6							
	25		4·6								
	30	3·6									

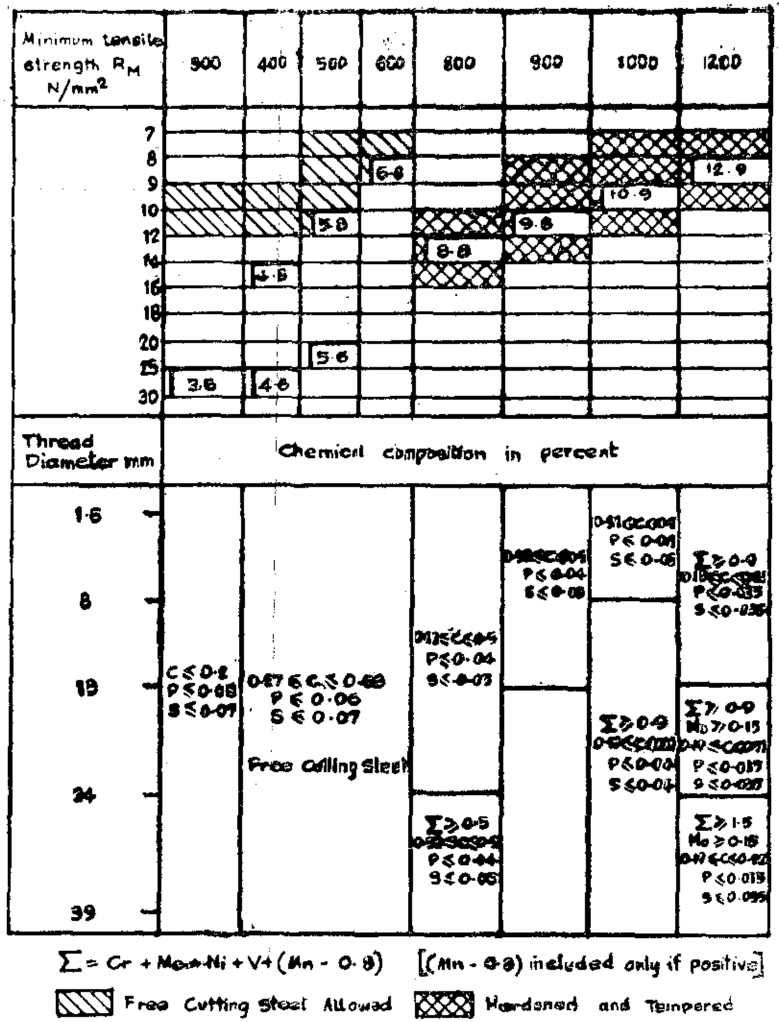
Second figure of symbol	·6	·7	·8	·9
$\frac{\textit{Minimum yield stress } R_e}{\textit{Minimum tensile strength } R_m} \times 100$ or $\frac{R_{0\cdot2}}{R_m} \times 100\%$	60	70	80	90

* The figures shown for 1000 lbf/in² are rounded values and not exact conversions of the corresponding values for N/mm². The differences, due to rounding, do not indicate differences in quality.

Values in N/mm² are only to be used for metric series bolts and screws.

Values in lbf/in² are only to be used for inch series bolts and screws.

Table 8 — Steels Suitable for Bolts and Screws



Note — For all classes in the Table, except for class 3·6 a steel of higher grade may be used provided that the bolts produced meet all the requirements of the desired grades.

Table 9 — Brasses and Aluminium Alloys Suitable for Bolts, Screws and Nuts

9·1 Brasses

Designation	Cu	Pb	Zn	Maximum impurities		Mainly used for
				Fe	Total excluding Fe	
CuZn 40 Pb 3	56·0—59·0	2·0—3·5	THE REMAINDER	0·35	0·7	General high speed machined parts
CuZn 39 Pb 2	57·0—60·0	1·0—2·5		0·35	0·7	Hot forgings appropriate for free cutting
CuZn 36 Pb 3	60·0—63·0	2·5—3·7		0·35	0·5	General high speed machined parts with some cold formability
CuZn 40 Pb	59·0—62·0	0·3—0·8		0·2	0·3	General application with reasonable machinability
CuZn 38 Pb 1	59·0—63·0	0·5—1·5		0·2	0·3	Reasonable machinability with sufficient ductibility to permit a degree of cold bending and cold forming
CuZn 36 Pb 2	61·0—64·0	1·0—2·0		0·2	0·3	Good machinability with sufficient ductility to permit a degree of rivetting heading and cold forming

9·2 — Aluminium Alloys

Designation	Chemical Composition										Mainly used for
	Cu	Mg	Si	Fe	Mn	Zn	Cr	Ti+Zr	Remarks	Al	
Al - Mg5 min. max.	—	4·5	—	—	—	—	—	—	(Mn+Cr) min : 0·1 max : 0·5	THE REMAINDER	turned parts
Al - Cu4 Si Mg min. max.	3·8 5·0	0·2 0·8	0·5 1·2	— 0·7	0·3 1·2	— 0·2	— —	— —	Ni : 0·2 max Ti + Zr + Cr 0·3 max		suitable for a degree of cold forming

Table 10 — Steels Suitable for Nuts

Property class	Chemical composition (check analysis)			
	Carbon max. per cent	Manganese min. per cent	Phosphorous max. per cent	Sulphur max. per cent
4*	0·50	—	0·11	0·150
6*	0·50	—	0·11	0·150
8*	0·58	0·30	0·06	0·150
10*	0·58	0·45	0·05	0·050

* Use of free-cutting steel is allowed for these two classes only. In such cases the following maximum Sulphur, Phosphorous and Lead contents are permissible.

Sulphur	0·34	per cent
Phosphorous	0·12	per cent
Lead	0·35	per cent

Table 11 — Test Programmes A and B

Test Group	Property Ref. No. (see Table 5)	Mechanical Property	Reference to Method of test: Clause	Reference to Method of test: Test	Test Programme A — Machined Test Pieces and Bolts with a Shank Area less than the Stress Area		Test Programme B	
					Property classes		Property classes	
					3·6, 4·6, 4·8, 5·6, 5·8, 6·8	8·8, 9·8, 0·9, 2·9	3·6, 4·6, 4·8, 5·6, 5·8, 6·8	8·8, 9·8, 0·9, 2·9
I	1	Tensile strength	9·2·1	Tensile test	@	@	@	@
	2	Tensile strength R_m	9·2·2	Tensile test			@	@
	3	Brinell hardness HB	9·2·3	Brinell hardness test	*	*	*	*
	4	Rockwell hardness HR	9·2·4	Rockwell hardness test	O	O	O	O
II	5	Yield point stress Re	9·2·1	Tensile test	@			
	6	Stress at permanent set limit $R_{0\cdot2}$	9·2·1	Tensile test		@		
	7	Stress under proof load	9·2·5	Proof load test			@	@
III	8	Percentage elongation after fracture	9·2·1	Tensile test	@	@		
	9	Strength under wedge loading	9·2·6	Wedge loading test			@	@
IV	10	Impact strength	9·2·7	Impact test		@		
	11	Head soundness	9·2·8	Head soundness test	@	*	O	O
V	12	Decarburization	9·2·9	Decarburization test		@		@

Table 12—Minimum ultimate tensile Loads — ISO Metric Coarse Thread

Nominal thread diameter mm	Pitch of the thread mm	Nominal stress area mm²	Property class 3·6	4·6	4·8	5·6	5·8	6·8	8·8	9·8	10·9	12·9
			Minimum ultimate tensile load ($A_s \times R_m$), N									
1·6	0·35	1·27	420	510	530	630	660	760	1 050	1 140	1 320	1 550
2	0·4	2·07	680	830	870	1 030	1 080	1 240	1 720	1 860	2 150	2 530
2·5	0·45	3·39	1 120	1 360	1 420	1 700	1 760	2 030	2 810	3 050	3 530	4 140
3	0·5	5·03	1 660	2 010	2 110	2 510	2 620	3 020	4 170	4 530	5 230	6 140
3·5	0·6	6·78	2 240	2 710	2 850	3 390	3 530	4 070	5 630	6 100	7 050	8 270
4	0·7	8·78	2 900	3 510	3 690	4 380	4 370	5 270	7 290	7 900	9 130	10 700
5	0·8	14·2	4 690	5 680	5 960	7 100	7 380	8 520	11 800	12 800	14 800	17 300
6	1	20·1	6 630	8 040	8 440	10 000	10 400	12 100	16 700	18 100	20 900	24 500
7	1	28·9	9 540	11 600	12 100	14 400	15 000	17 300	24 000	26 000	30 100	35 300
8	1·25	36·6	12 100	14 600	15 400	18 300	19 000	22 000	30 400	32 900	38 100	44 600
10	1·5	58·0	19 100	23 200	24 400	29 000	30 200	34 800	48 100	52 200	60 300	70 800
12	1·75	84·3	27 800	33 700	35 400	42 200	43 800	50 600	70 000	75 900	87 700	103 000
14	2	115	38 000	46 000	48 300	57 500	59 800	69 000	95 400	104 000	120 000	140 000
16	2	157	51 800	62 800	65 900	78 500	81 600	94 000	130 000	141 000	163 000	192 000
18	2·5	192	63 400	76 800	80 600	96 000	99 800	115 000	159 000	—	200 000	234 000
20	2·5	245	80 800	98 000	103 000	122 000	127 000	147 000	203 000	—	255 000	299 000
22	2·5	303	100 000	121 000	127 000	152 000	158 000	182 000	252 000	—	315 000	370 000
24	3	353	116 000	141 000	148 000	176 000	184 000	212 000	293 000	—	367 000	431 000
27	3	459	152 000	184 000	193 000	230 000	239 000	275 000	381 000	—	477 000	560 000
30	3·5	561	185 000	224 000	236 000	280 000	292 000	337 000	466 000	—	583 000	684 000
33	3·5	694	229 000	278 000	292 000	347 000	361 000	416 000	576 000	—	722 000	847 000
36	4	817	270 000	327 000	343 000	408 000	425 000	490 000	678 000	—	850 000	997 000
39	4	976	322 000	390 000	410 000	488 000	508 000	586 000	810 000	—	1 020 000	1 200 000

Table 13 — Minimum Ultimate Tensile Loads — ISO Metric Fine Thread

Nominal thread diameter mm	Pitch of the thread mm	Nominal stress area mm²	Property class 3·6	4·6	4·8	5·6	5·8	6·8	8·8	9·8	10·9	12·9
			Proof load ($A_s \times R_m$), N									
8	1	39·2	12 900	15 700	16 500	19 600	20 400	23 500	32 500	35 300	40 800	47 800
10	1·25	61·2	20 200	24 500	25 700	30 600	31 800	36 700	50 800	55 100	63 600	74 700
12	1·25	92·1	30 400	36 800	38 700	46 000	47 900	55 300	76 400	82 900	95 800	112 000
14	1·5	125	41 200	50 000	52 500	62 500	65 000	75 000	104 000	112 000	130 000	152 000
16	1·5	167	55 100	66 800	70 100	83 500	86 800	100 000	139 000	150 000	174 000	204 000
18	1·5	216	71 300	86 400	90 700	108 000	112 000	130 000	179 000	—	225 000	264 000
20	1·5	272	89 800	109 000	114 000	136 000	141 000	163 000	226 000	—	283 000	332 000
22	1·5	333	110 000	133 000	140 000	166 000	173 000	200 000	276 000	—	346 000	406 000
24	2	384	127 000	154 000	161 000	192 000	200 000	230 000	319 000	—	399 000	469 000
27	2	496	164 000	194 000	208 000	248 000	258 000	298 000	412 000	—	516 000	605 000
30	2	621	205 000	248 000	261 000	310 000	323 000	373 000	515 000	—	646 000	758 000
33	2	761	251 000	304 000	320 000	380 000	396 000	457 000	632 000	—	791 000	928 000
36	3	865	285 000	346 000	363 000	432 000	450 000	519 000	718 000	—	900 000	1 050 000
39	3	1 030	340 000	412 000	433 000	515 000	536 000	618 000	855 000	—	1 070 000	1 260 000

Table 14 — Proof Loads — ISO Metric Coarse Thread

Nominal thread diameter mm	Pitch of the thread mm	Nominal stress area mm²	Property class 3·6	4·6	4·8	5·6	5·8	6·8	8·8	9·8	10·9	12·9
			Proof load ($A_s \times S_p$), N									
1·6	0·35	1·27	230	280	390	360	480	560	760	830	1 050	1 280
2	0·4	2·07	370	470	640	580	790	910	1 240	1 350	1 720	2 010
2·5	0·45	3·39	610	760	1 050	950	1 290	1 490	2 080	2 200	2 810	3 290
3	0·5	5·03	910	1 130	1 560	1 410	1 910	2 210	3 020	3 270	4 180	4 880
3·5	0·6	6·78	1 220	1 530	2 100	1 900	2 580	2 980	4 070	4 410	5 630	6 580
4	0·7	8·78	1 580	1 980	2 720	2 460	3 340	3 860	5 270	5 710	7 290	8 520
5	0·8	14·2	2 560	3 200	4 400	3 980	5 400	6 250	8 520	9 230	11 800	13 800
6	1	20·1	3 620	4 520	6 230	5 630	7 640	8 840	12 100	13 100	16 700	19 500
7	1	28·9	5 200	6 500	8 960	8 090	11 000	12 700	17 300	18 800	24 000	28 000
8	1·25	36·6	6 590	8 240	11 400	10 200	13 900	16 100	22 000	23 800	30 400	35 500
10	1·5	58·0	10 400	13 000	18 000	16 200	22 000	25 500	34 800	37 700	48 100	56 300
12	1·75	84·3	15 200	19 000	26 100	23 600	32 000	37 100	50 600	54 800	70 000	81 800
14	2	115	20 700	25 900	35 600	32 200	43 700	50 600	69 000	74 800	95 500	112 000
16	2	157	28 300	35 300	48 700	44 000	59 700	69 100	94 200	102 000	130 000	152 000
18	2·5	192	34 600	43 200	59 500	53 800	73 000	84 500	115 000	—	159 000	186 000
20	2·5	245	44 100	55 100	76 000	68 600	93 100	108 000	147 000	—	203 000	238 000
22	2·5	303	54 500	68 200	93 900	84 800	115 000	133 000	182 000	—	252 000	294 000
24	3	353	63 500	79 400	109 000	98 800	134 000	155 000	212 000	—	293 000	342 000
27	3	459	82 600	103 000	142 000	128 000	174 000	202 000	275 000	—	381 000	445 000
30	3·5	561	101 000	126 000	174 000	157 000	213 000	247 000	337 000	—	466 000	544 000
33	3·5	694	125 000	156 000	215 000	194 000	264 000	305 000	416 000	—	570 000	673 000
36	4	817	147 000	184 000	253 000	229 000	310 000	359 000	490 000	—	678 000	792 000
39	4	976	176 000	220 000	303 000	273 000	371 000	429 000	586 000	—	810 000	947 000

Table 15 — Proof Loads — ISO Metric Fine Thread

Nominal thread diameter mm	Pitch of the thread mm	Nominal stress area mm²	Property class 3·6	4·6	4·8	5·6	5·8	6·8	8·8	9·8	10·9	12·9
			Proof load ($A_s \times S_p$), N									
8	1	39·2	7 060	8 820	12 200	11 000	14 900	17 200	23 500	25 500	32 500	38 000
10	1·25	61·2	11 000	13 800	19 000	17 100	23 300	26 900	36 700	39 800	50 800	59 400
12	1·25	92·1	16 600	20 700	28 600	25 800	35 000	40 500	55 300	59 900	76 400	89 300
14	1·5	125	22 500	28 100	38 800	35 000	47 500	55 000	75 000	81 200	104 000	121 000
16	1·5	167	30 100	37 600	51 800	46 800	63 500	73 500	100 000	109 000	139 000	162 000
18	1·5	216	38 900	48 600	67 000	60 500	82 100	95 000	130 000	—	179 000	210 000
20	1·5	272	49 000	61 200	84 300	76 200	103 000	120 000	163 000	—	226 000	264 000
22	1·5	333	59 900	74 900	103 000	93 200	126 000	146 000	200 000	—	276 000	323 000
24	2	384	69 100	86 400	119 000	108 000	146 000	169 000	230 000	—	319 000	372 000
27	2	496	89 300	112 000	154 000	139 000	188 000	218 000	298 000	—	412 000	481 000
30	2	621	112 000	140 000	192 000	174 000	236 000	273 000	373 000	—	515 000	602 000
33	2	761	137 000	171 000	236 000	213 000	289 000	335 000	457 000	—	632 000	738 000
36	3	865	156 000	195 000	268 000	242 000	329 000	381 000	519 000	—	718 000	838 000
39	3	1 030	185 000	232 000	319 000	288 000	391 000	453 000	618 000	—	855 000	999 000

Table 16 — Proof Load for Nuts with ISO Metric Coarse Threads

Nominal Thread Diameter mm	Pitch of Thread mm	Tensile Stress Area of Test Mandrel mm²	Property Class of Nuts					
			4	5	6	8	10	12
			Proof load, N					
1·6	0·35	1·27	500	620	750	980	1 220	1 470
2	0·4	2·07	810	1 010	1 180	1 620	2 010	2 450
2·5	0·45	3·39	1 320	1 670	1 960	2 650	3 330	3 920
3	0·5	5·03	1 960	2 450	2 940	3 920	4 900	5 880
3·5	0·6	6·78	2 650	3 300	3 970	5 300	6 670	7 990
4	0·7	8·78	3 430	4 310	5 150	6 860	8 580	10 300
5	0·8	14·2	5 590	6 960	8 340	11 200	13 900	16 700
6	1	20·1	7 850	9 810	11 800	15 700	19 600	23 500
7	1	28·9	11 300	14 200	17 000	22 600	28 400	34 000
8	1·25	36·6	14 200	18 000	21 600	28 500	35 800	42 200
10	1·5	58·0	22 600	28 400	34 300	45 100	56 900	68 200
12	1·75	84·3	32 800	41 300	49 500	65 700	82 400	98 100
14	2	115	45 100	56 400	67 700	90 200	103 000	135 000
16	2	157	61 800	77 000	92 200	124 000	154 000	184 000
18	2·5	192	75 500	94 100	113 000	151 000	188 000	226 000
20	2·5	245	96 100	120 000	144 000	192 000	240 000	288 000
22	2·5	303	119 000	148 000	178 000	237 000	297 000	357 000
24	3	353	138 000	173 000	208 000	277 000	346 000	415 000
27	3	459	180 000	226 000	271 000	360 000	450 000	539 000
30	3·5	561	220 000	275 000	330 000	439 000	550 000	660 000
33	3·5	694	273 000	340 000	408 000	544 000	680 000	817 000
36	4	817	321 000	400 000	481 000	640 000	801 000	961 000
39	4	976	382 000	479 000	574 000	765 000	957 000	1147 000

Table 17 — Proof Load for Nuts with ISO Metric Fine Threads

Nominal thread diameter mm	Pitch of thread mm	Tensile strength area of test mandrel mm	Property class of nuts					
			4	5	6	8	10	12
			Proof load, N					
8	1	39·2	15 400	19 200	23 000	30 400	38 200	46 100
10	1·25	61·2	23 500	30 000	36 300	48 100	59 800	72 100
12	1·25	92·1	36 300	45 100	53 900	72 500	90 200	108 000
14	1·5	125	49 000	61 300	73 600	98 100	123 000	147 000
16	1·5	167	65 700	81 900	98 100	131 000	164 000	196 000
18	1·5	216	84 300	106 000	127 000	169 000	212 000	253 000
20	1·5	272	107 000	133 000	160 000	214 000	267 000	320 000
22	1·5	333	130 000	163 000	196 000	261 000	327 000	392 000
24	2	384	151 000	188 000	226 000	301 000	377 000	451 000
27	2	496	195 000	243 000	292 000	389 000	486 000	583 000
30	2	621	243 000	304 000	366 000	487 000	609 000	731 000
33	2	761	298 000	373 000	447 000	596 000	746 000	986 000
36	3	865	339 000	424 000	509 000	679 000	848 000	1020 000
39	3	1030	407 000	509 000	606 000	809 000	1010 000	1216 000

Table 18 — Scale of Sampling and Criteria for Conformity for Normal Inspection

Lot Size	Visual Characteristics					Duds		Dimensional Characteristics										
	Sample	Sample size	Cumulative Sample Size	Ac	Re	Ac	Re	Sample	Sample Size	Cumulative Sample Size	Black Fasteners				Precision or Semi-Precision Fasteners			
											Major defect		Minor defect		Major defect		Minor defect	
											Ac	Re	Ac	Re	Ac	Re	Ac	Re
	AQL			6·5		1·0					4·0		6·5		2·5		4·0	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Up to 100	First	20	20	2	5	0	2	First	8	8	0	2	0	3	0	2	0	2
	Second	20	40	6	7	1	2	Second	8	16	1	2	3	4	1	2	1	2
101 to 300	First	32	32	3	7	0	2	First	13	13	0	3	1	4	0	2	0	3
	Second	32	64	8	9	1	2	Second	13	26	3	4	4	5	1	2	3	4
301 to 500	First	50	50	5	9	0	3	First	20	20	1	4	2	5	0	3	1	4
	Second	50	100	12	13	3	4	Second	20	40	4	5	6	7	3	4	4	5
501 to 1 000	First	80	80	7	11	1	4	First	32	32	2	5	3	7	1	4	2	5
	Second	80	160	18	19	4	5	Second	32	64	6	7	8	9	4	5	6	7
1 001 to 3 000	First	125	125	11	16	2	5	First	50	50	3	7	5	9	2	5	3	7
	Second	125	250	26	27	6	7	Second	50	100	8	9	12	13	6	7	8	9
3 001 to 10 000	First	200	200	11	16	3	7	First	80	80	5	9	7	11	3	7	5	9
	Second	200	400	26	27	8	9	Second	80	160	12	13	18	19	8	9	12	13
10 001 to 35 000	First	315	315	11	16	5	9	First	125	125	7	11	11	16	5	9	7	11
	Second	315	630	26	27	12	13	Second	125	250	18	19	26	27	12	13	18	19
Over 35 000	First	500	500	11	16	7	11	First	200	200	11	16	11	16	7	11	11	16
	Second	500	1000	26	27	18	19	Second	200	400	26	27	26	27	18	19	26	27

Note — For most of the sampling plans given in this table the LTPD values are less than 20 per cent.

(See page 47 for Table 19)

Table 20 — Scale of Sampling and Criteria for Conformity for Tightened Inspection

Lot Size	Visual Characteristics: Sample	Sample Size	Cumulative Sample Size	Ac	Re	Duds: Ac	Re	Dimensional Characteristics: Sample	Sample Size	Cumulative Sample Size	Commercial Grade: Major defect Ac	Re	Minor defect Ac	Re	Precision or Semi Precision Grade: Major defect Ac	Re	Minor defect Ac	Re
	AQL			4·0		0·65					2·5		4·0		1·5		2·5	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Up to 100	First	20	20	1	4	0	2	First	8	8	0	2	0	2	0	2	0	2
	Second	20	40	4	5	1	2	Second	8	16	1	2	1	2	1	2	1	2
101 to 300	First	32	32	2	5	0	2	First	13	13	0	2	0	3	0	2	0	2
	Second	32	64	6	7	1	2	Second	13	26	1	2	3	4	1	2	1	2
301 to 500	First	50	50	3	7	0	2	First	20	20	0	3	1	4	0	2	0	3
	Second	50	100	8	9	1	2	Second	20	40	3	4	4	5	1	2	3	4
501 to 1 000	First	80	80	5	9	0	3	First	32	32	1	4	2	5	0	3	1	4
	Second	80	160	12	13	3	4	Second	32	64	4	5	6	7	3	4	4	5
1 001 to 3 000	First	125	125	7	11	1	4	First	50	50	2	5	3	7	1	4	2	5
	Second	125	250	18	19	4	5	Second	50	100	6	7	8	9	4	5	6	7
3 001 to 10 000	First	200	200	11	16	2	5	First	80	80	3	7	5	9	2	5	3	7
	Second	200	400	26	27	6	7	Second	80	160	8	9	12	13	6	7	8	9
10 001 to 35 000	First	315	315	11	16	3	7	First	125	125	5	9	7	11	3	7	5	9
	Second	315	630	26	27	8	9	Second	125	250	12	13	18	19	8	9	12	13
Over 35 000	First	500	500	11	16	5	9	First	200	200	7	11	11	16	5	9	7	11
	Second	500	1000	26	27	12	13	Second	200	400	18	19	26	27	12	13	18	19

Note — For most of the sampling plans given in this table the LTPD values are less than 15 per cent.

Table 21 — Scale of Sampling and Criteria for Conformity for Reduced Inspection

Lot Size	Visual Characteristics					Duds		Dimensional Characteristics										
											Commercial Grade				Precision or Semi Precision Grade			
											Major defect		Minor defect		Major defect		Minor defect	
	Sample	Sample Size	Cumulative Sample Size	Ac	Re	Ac	Re	Sample	Sample Size	Cumulative Sample Size	Ac	Re	Ac	Re	Ac	Re	Ac	Re
	AQL			6·5		1·0					4·0		6·5		2·5		4·0	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
Up to 100	First	13	13	1	4	0	2	First	5	5	0	2	0	2	0	2	0	2
	Second	13	26	4	5	1	2	Second	5	10	1	2	1	2	1	2	1	2
101 to 300	First	20	20	2	5	0	2	First	8	8	0	2	0	3	0	2	0	2
	Second	20	40	6	7	1	2	Second	8	16	1	2	3	4	1	2	1	2
301 to 500	First	32	32	3	7	0	2	First	13	13	0	3	1	4	0	2	0	3
	Second	32	64	8	9	1	2	Second	13	26	3	4	4	5	1	2	3	4
501 to 1 000	First	50	50	5	9	0	3	First	20	20	1	4	2	5	0	3	1	4
	Second	50	100	12	13	3	4	Second	20	40	4	5	6	7	3	4	4	5
1 001 to 3 000	First	80	80	7	11	1	4	First	32	32	2	5	3	7	1	4	2	5
	Second	80	160	18	19	4	5	Second	32	64	6	7	8	9	4	5	6	7
3 001 to 10 000	First	125	125	11	16	2	5	First	50	50	3	7	5	9	2	5	3	7
	Second	125	250	26	27	6	7	Second	50	100	8	9	12	13	6	7	8	9
10 001 to 35 000	First	200	200	11	16	3	7	First	80	80	5	9	7	11	3	7	5	9
	Second	200	400	26	27	8	9	Second	80	160	12	13	18	19	8	9	12	13
Over 35 000	First	315	315	11	16	5	9	First	125	125	7	11	11	16	5	9	7	11
	Second	315	630	26	27	12	13	Second	125	250	18	19	26	27	12	13	18	19

Note — For most of the sampling plans given in this table the LTPD values are less than 20 per cent.

APPENDIX A
LIMITS OF SURFACE DISCONTINUITIES
(Given as a guide only)

A - 1 Bolts and Screws

A - 1.1 Cracks—Quench cracks or forging cracks of any depth, any length, or in any location, are not permitted. (See Figs. 36 and 37).

A - 1.2 Laps in Screw Threads — Laps of any depth and any length which (a) originates in the root of the screw thread, or (b) originates on the flank, traverse toward the interior, and extend in depth below the pitch line of the bolt or screw, or (c) originates below the pitch line on the pressure flank and traverse toward the major diameter, are not permitted. (This requirement is not applicable to tapping screws having spaced threads). (See Fig. 38).

A - 1.3 Folds

A - 1.3.1 Folds located in internal corners at or below the bearing surface, for example, in the fillet at the junction of head and shank, are not permitted.

A - 1.3.2 Folds located at the intersection of the flange periphery and bearing surface of flanged bolts and screws, and project below the bearing surface, are not permitted. (See Fig. 39).

A - 1.4 Seams — Seams in the shanks of bolts, screws, and studs shall not exceed (a) an open width at the surface of 0·13 mm for sizes 6 mm to 12 mm inclusive and 0·25 mm for sizes 13 mm to 25 mm inclusive and (b) a depth of $0{\cdot}015D + 0{\cdot}10$ mm for sizes 6 mm to 16 mm and $0{\cdot}030D$ mm for sizes over 16 mm ; where D is the nominal size of the bolt or screw. (see Fig. 40).

A - 1.5 Bursts

A - 1.5.1 Bursts in the flats of hex bolts and screws shall not exceed a width or an open depth of $0 \cdot 25 + 0 \cdot 025D$ mm, where D is the nominal bolt or screw size in millimetres. In addition, no bursts shall extend into the bearing surface.

A - 1.5.2 Flanges of bolts and screws shall not have more than one burst with a width greater than $0 \cdot 13 + 0 \cdot 020$ F mm or an open depth greater than $0 \cdot 08 + 0 \cdot 012$ F mm, and this one burst shall not exceed a width of $0 \cdot 25 + 0 \cdot 040$ F mm or an open depth of $0 \cdot 15 + 0 \cdot 024$ F mm where F is the nominal flange diameter in millimetres.

A - 1.5.3 Bursts at the periphery of round head style screws shall not exceed an open width or depth of $0 \cdot 25 + 0 \cdot 025D$ mm, where D is the nominal screw size in millimetres. (See Fig. 41).

A - 1.6 Shear Failure — Shear failure on flanged bolts and screws shall not exceed a width of $0 \cdot 5$ mm for a depth greater than $0 \cdot 030F$, where F is the nominal flange diameter in inches. (See Fig. 41).

A - 1.7 Voids on Bearing Surface — Voids on the bearing surface of bolts and screws shall not exceed a depth of $0 \cdot 25$ mm and the combined area of all voids shall not exceed 5 % of the specified minimum area of the bearing surface. (See Fig. 42).

A - 1.8 Tool Marks — Tool marks on the bearing surface shall not exceed surface roughness measurement of 3 µm determined as the arithmetic average deviation from the mean surface. (See Fig. 43).

A - 1.9 Nicks and Gouges — Shall not interfere with gauging if found in threaded portions.

A - 2 Nuts

A - 2.1 Cracks — Quench cracks or forging cracks of any depth, any length, or in any location are not permitted. (See Figs. 44 and 45).

A - 2.2 **Seams** — Seams shall not exceed an open width at the surface of 0·13 mm for sizes 6 mm to 12 mm inclusive and 0·25 mm for sizes 13 mm to 25 mm inclusive. (See Fig. 46).

A - 2.3 **Bursts** — Bursts in flanged nuts shall not exceed a width of 0·13 + 0·020F mm or an open depth of 0·08 + 0·012F mm except that one burst may have a width no greater than 0·25 + 0·040F mm or an open depth no greater than 0·15 + 0·024F, where F is the nominal flanged diameter in millimetres. (See Fig. 47).

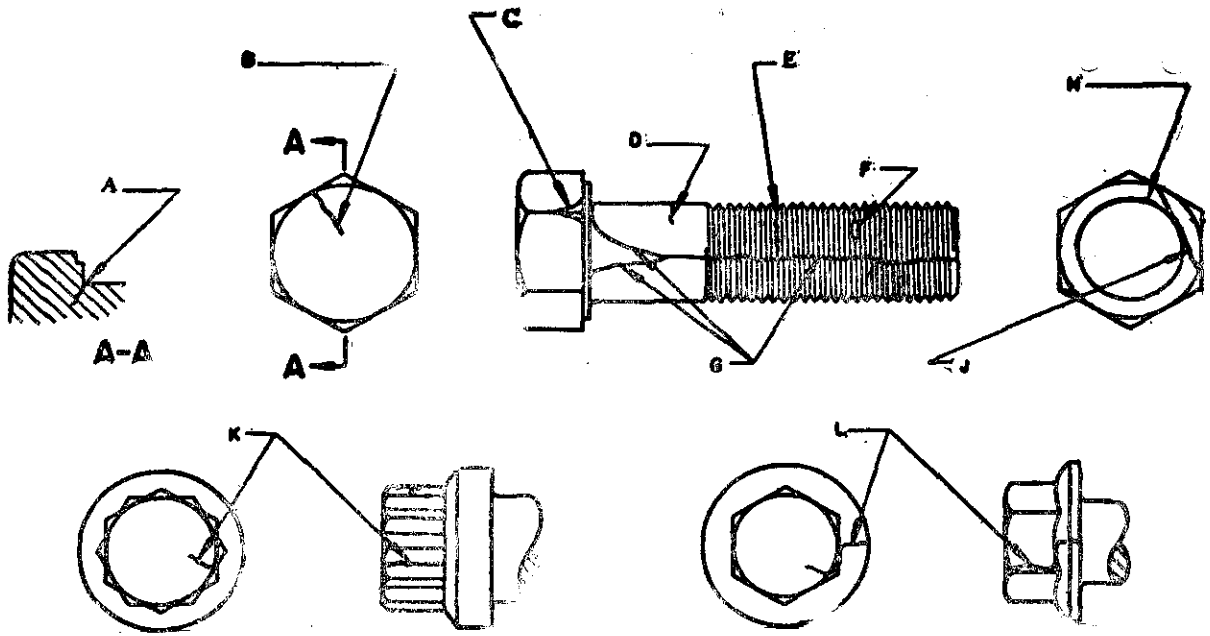
A - 2.4 **Shear failures** — Shear failures on flanged nuts shall not exceed a width of 0·020F mm or a depth of 0·030F mm, where F is the nominal flange diameter in millimetres. (See Fig. 47).

A - 2.5 **Folds** — Folds located at the intersection of the flange periphery and bearing surface of flanged nuts shall not project below the bearing surface. (See Fig. 48).

A - 2.6 **Voids** — Voids on the bearing surface of nuts shall not exceed a depth of 0·25 mm and the combined area of all voids on the bearing surface shall not exceed 5% of the specified minimum area of the bearing surface. (See Fig. 49).

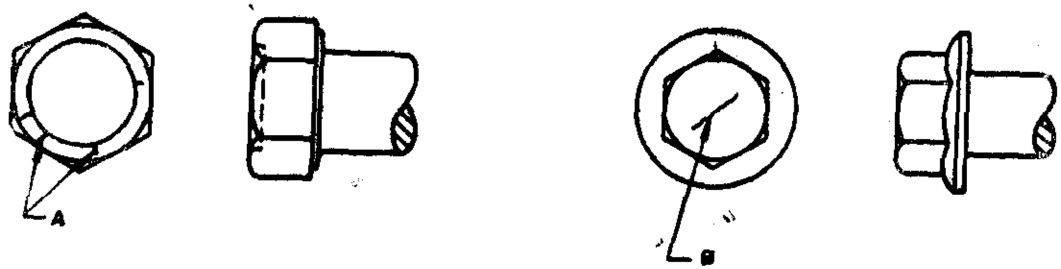
A - 2.7 **Tool Marks** — Tool marks on the bearing surface shall not exceed a surface roughness measurement of 3 μm determined as the arithmetic average deviation from the mean surface. Tool marks on other surfaces are permissible. (See Fig. 50).

A - 2.8 **Nicks and Gouges** — Shall not interfere with gauging if found in threaded portions.



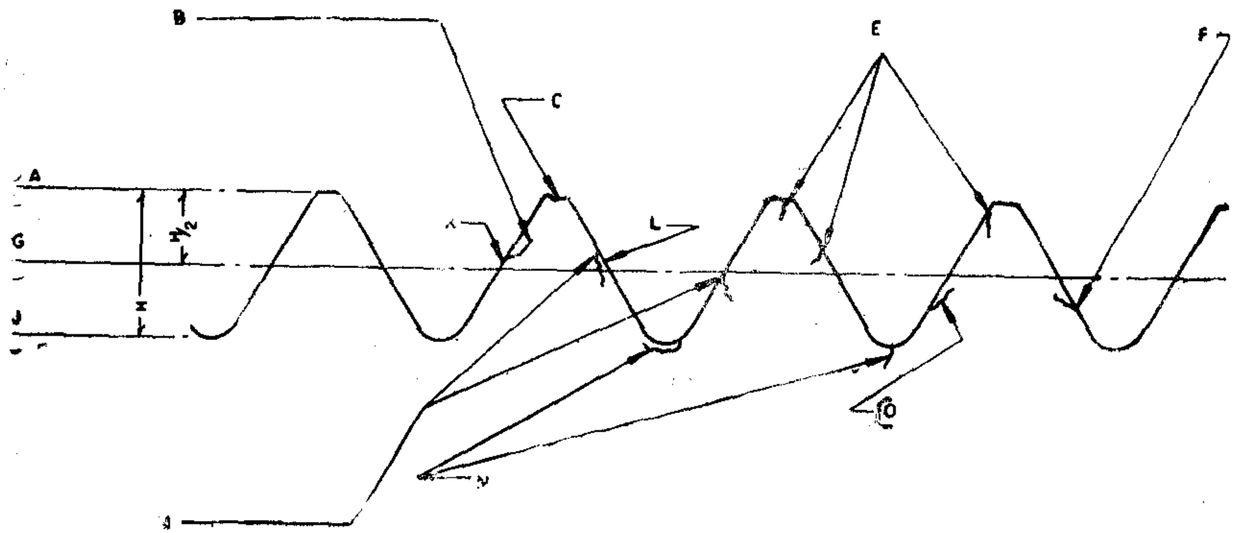
A — Quench crack extending radially into fillet. B — Quench crack across top of head, usually an extention of crack in shank or side of head. C — Quench crack at corner of head D — Transverse quench crack E — Quench crack at root F — Quench crack, section at crest of thread missing G — Longitudinal Quench crack H — Quench crack, circumferential and adjacent to fillet J — Quench crack across washer face and to depth of washer face thickness K — Quench crack, at Root between points L — Quench crack

Fig. 36 — Typical Quench Cracks



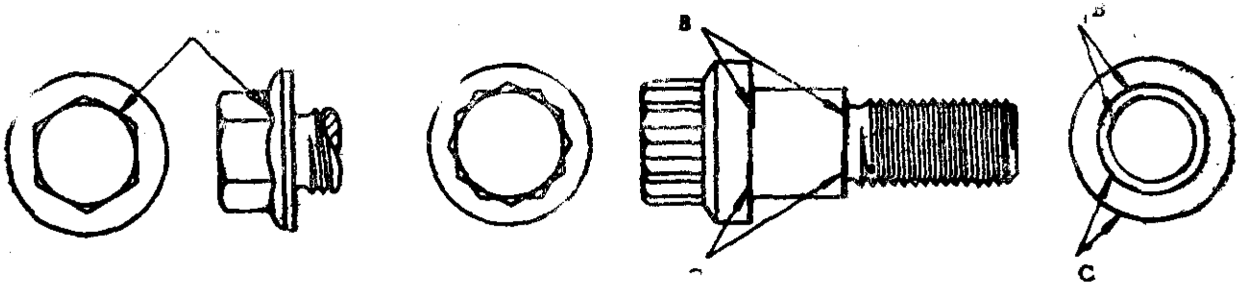
A — Forging cracks on raised periphery of indented head B — Forging crack on top of head

Fig. 37 — Typical Forging Cracks



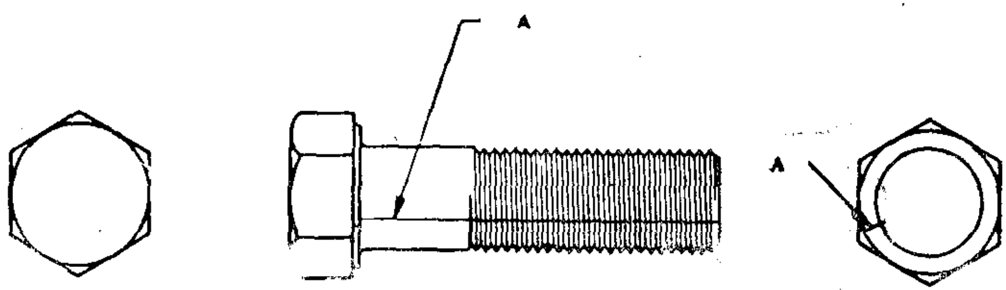
A — Major diameter B — Laps originating above the pitch line on the pressure flank and with traverse directed toward the major diameter are permissible discontinuities C — Contour variation at major diameter is permissible E — Laps originating on either flank and with traverse directed toward the interior of the product and with a depth that does not extend below the pitch line are permissible discontinuities F — Laps originating on non-pressure flank with traverse directed toward major diameter are permissible discontinuities G — Pitch diameter J — Minor diameter K — Pressure flank L — Non-pressure flank M — Laps originating on either flank and with tranverse directed toward the interior and with a depth extending below the pitch line are non-permissible discontinuities N — Laps originating in root of thread are non-permissible discontinuities O — Laps originating below the pitch line on the pressure flank and with traverse directed toward the major diameter are non-permissible discontinuities.

Fig. 38 — Discontinuities in External Screw Threads



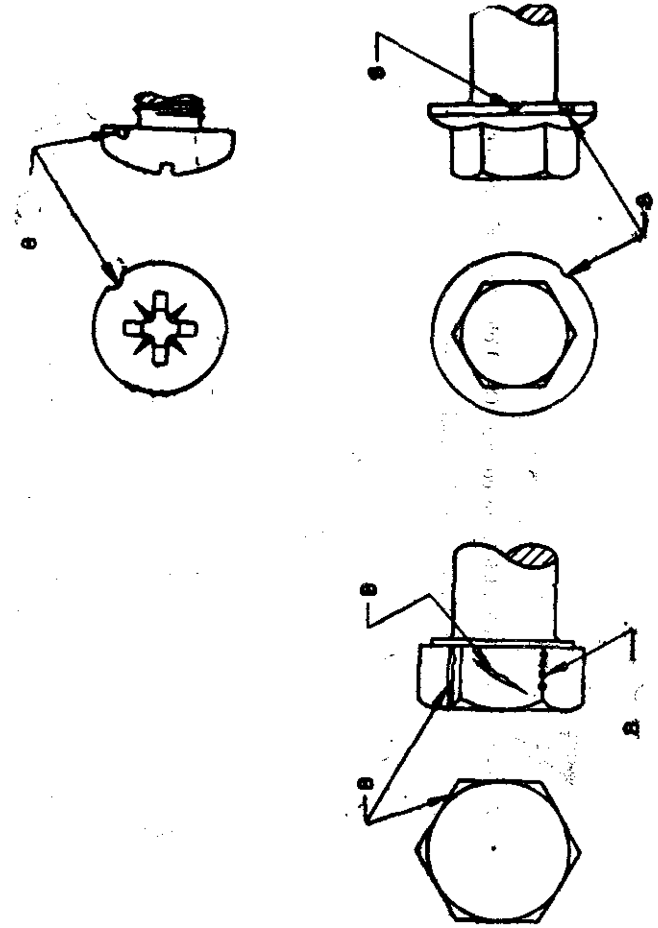
A — Fold B — Fold at interior corner C — Fold at exterior corner

Fig. 39 — Typical Folds



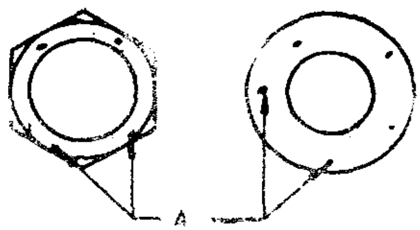
A — Seam, usually a straight or smooth-curved line discontinuity running longitudinally

Fig. 40 — Typical Seam



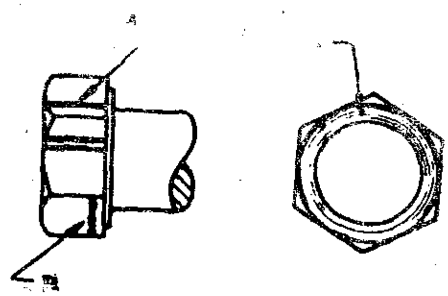
B — Burst
S — Shear failure

Fig. 41 — Typical Burst and Shear Failures



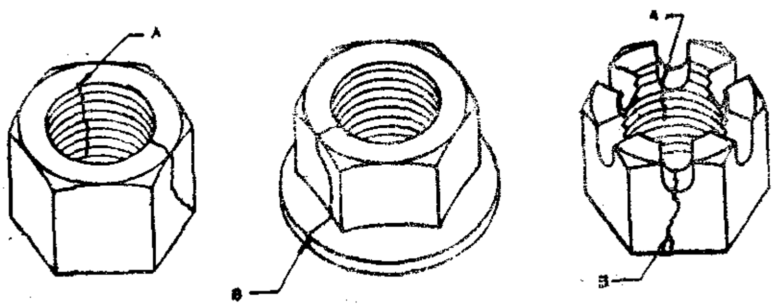
A — Voids

Fig. 42 — Typical Voids on Bearing Surface



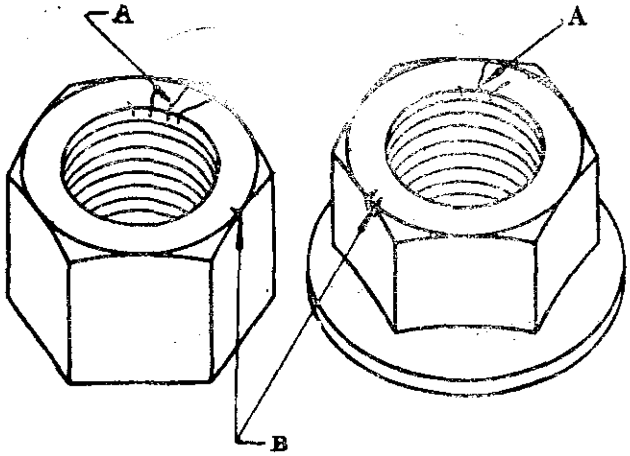
A — Tool Marks   B — Tool mark from trimming operation

Fig. 43 — Typical Tool Marks



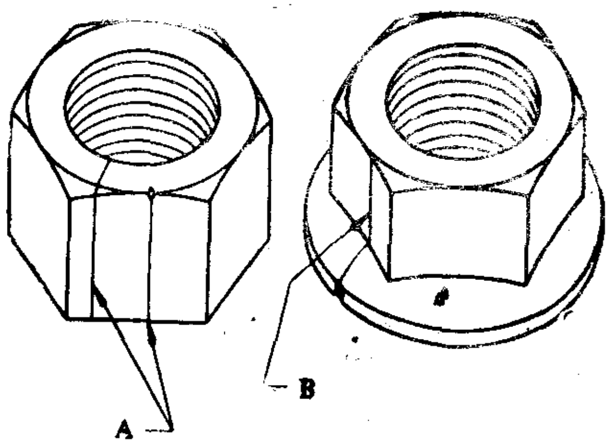
A — Quench crack in threads   B — Quench crack

Fig. 44 — Typical Quench Cracks



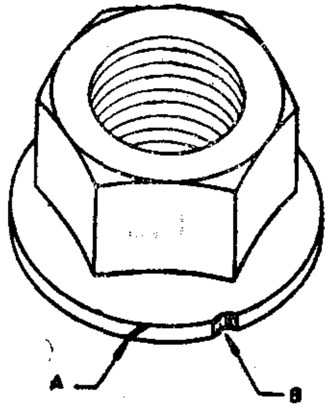
A — Forging cracks in top or bottom face
B — Forging cracks at intersection of face and flat

Fig. 45 — Typical Forging Cracks



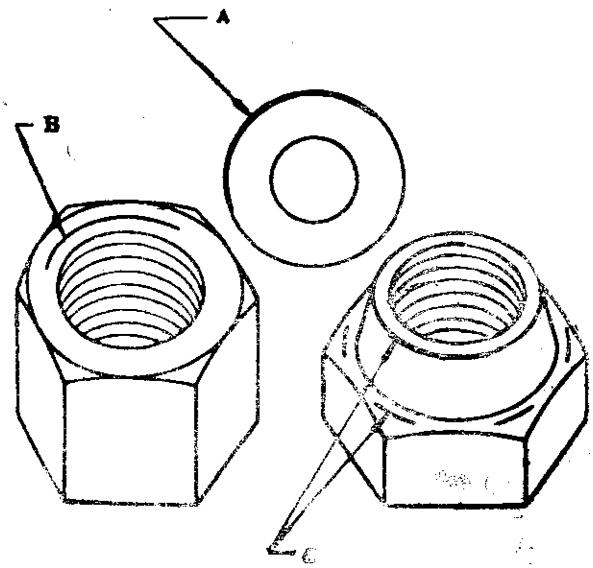
A — Seam
B — Seam, sometimes opening into small burst at periphery of flanged nut

Fig. 46 — Typical Seams



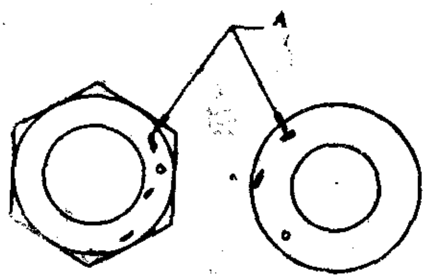
A — Shear failure
B — Burst

Fig. 47 — Typical Burst and Shear Failures on Flanged Nuts



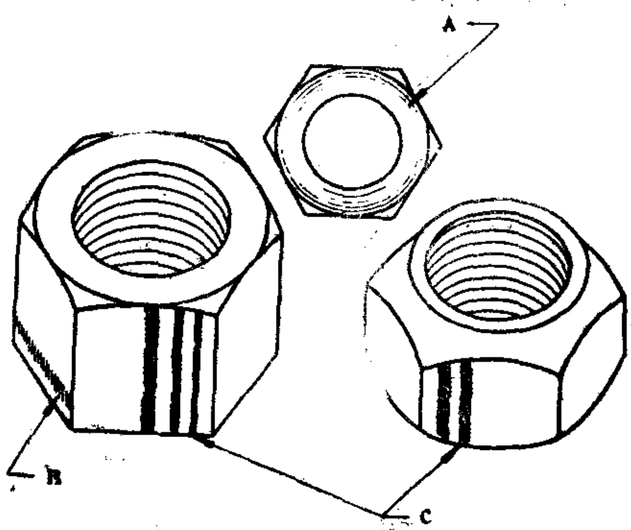
A — Fold at periphery of bearing surface of flanged nut
B — Fold on top or bottom face
C — Fold

Fig. 48 — Typical Folds



A — Voids

Fig. 49 — Typical Voids on Bearing Surfaces



A — Tool marks on bearing surface
B — Tool marks from trimming operation
C — Tool marks

Fig. 50 — Typical Tool Marks

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