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IS 13096 (2000): Fasteners - Hexagon Nuts with Specified Proof Load Values - Fine Pitch Thread - Mechanical Properties [PGD 31: Bolts, Nuts and Fasteners Accessories]



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“Knowledge is such a treasure which cannot be stolen”

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IS 13096 : 2000
ISO 898-6 : 1994

भारतीय मानक

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(पहला पुनरीक्षण)

Indian Standard

FASTENERS — HEXAGON NUTS WITH SPECIFIED
PROOF LOAD VALUES — FINE PITCH THREAD —
MECHANICAL PROPERTIES
(*First Revision*)

ICS 21.060.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with ISO 898-6 : 1994 'Mechanical properties of fasteners — Part 6 : Nuts with specified proof load values — Fine pitch thread' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Bolts, Nuts and Fasteners Accessories Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard was originally published in 1991 by adopting ISO 898-6 : 1988. This first revision has been taken up consequent upon the revision of ISO 898-6 : 1988, to keep it in line with the latest version.

In the adopted standard, certain terminology and conventions are not identical to those used in Indian Standards. Attention **is drawn** especially to the following:

- a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as decimal marker while in Indian Standards the current practice is to use a full point (.) as the decimal marker.

In the adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 68 : 1973 ¹⁾	IS 4218 (Part 1) ISO General purpose metric screw threads : Part 1 Basic profile (<i>second revision</i>)(<i>under preparation</i>)	Identical
ISO 261 : 1973 ²⁾	IS 4218 (Part 2) ISO General purpose metric screw threads : Part 2 General plan (<i>second revision</i>)(<i>under preparation</i>)	do
ISO 262 : 1973 ³⁾	IS 4218 (Part 4) ISO General purpose metric screw threads : Part 4 Selected sizes of bolts, screws and nuts (<i>second revision</i>) (<i>under preparation</i>)	do
ISO 272 : 1982	IS 9519 : 1980 Dimensions for width across flats for hexagon head bolts and nuts	Modified
ISO 286-2 : 1988	IS 919 (Part 2) : 1993 ISO System of limits : Part 2 Table of standard tolerance grades and limit deviation for hole and shaft (<i>first revision</i>)	Identical
ISO 724 : 1993	IS 4218 (Part 3) : 1999 ISO General purpose metric screw threads : Part 3 Basic dimensions (<i>second revision</i>)	do

¹⁾ Revised in 1998 in two parts. Part 1 is applicable and being adopted as second revision of IS 4218 (Part 1).

²⁾ Revised in 1998 and being adopted as second revision of IS 4218 (Part 2).

³⁾ Revised in 1998.

(Continued on third cover)

Indian Standard

**FASTENERS — HEXAGON NUTS WITH SPECIFIED
PROOF LOAD VALUES — FINE PITCH THREAD —
MECHANICAL PROPERTIES**

(First Revision)

1 Scope

This part of ISO 898 specifies the mechanical properties of nuts with specified proof load values when tested at an ambient temperature range of + 10 °C to + 35 °C. Mechanical and physical properties will vary with respect to temperature and property class.

Products conforming to the requirements of this part of ISO 898 are evaluated only at the ambient temperature range and may not retain the specified physical properties at higher and lower temperatures.

At temperatures higher or lower than the ambient temperature range, a significant change in properties may occur. When fasteners are to be used above or below the ambient temperature range, it is the responsibility of the user to ensure that the mechanical and physical properties are suitable for his particular service conditions.

This part of ISO 898 applies to nuts

- with nominal thread diameters, ***d***, from 8 mm up to and including 39 mm (fine pitch thread);
- of triangular ISO thread and with diameters and pitches in accordance with ISO 68 and ISO 262 (fine pitch thread);
- with diameter/pitch combinations in accordance with ISO 261 (fine pitch thread);

- with thread tolerances 6H in accordance with ISO 965-1 and 965-2 (see note 2);
- with specific mechanical requirements;
- with widths across flats as specified in ISO 272;
- with nominal heights greater than or equal to $0,5d^{1)}$;
- made of carbon steel or alloy steel (see note 1).

It does not apply to nuts requiring special properties such as

- weldability;
- prevailing torque performance (see ISO 2320);
- corrosion resistance (see ISO 3506);
- ability to withstand temperatures above + 300 °C or below – 50 °C. (However, see note 1.)

NOTES

1 Nuts made from free-cutting steel should not be used above + 250 °C.

2 With thread tolerances other or larger than 6H, a decrease in the stripping strength should be considered (see table 1).

1) In ISO 898:1988, the symbol *D* was used.

Table 1 — Reduction in thread strength

Nominal thread diameter <i>d</i> mm	Test load, %		
	Thread tolerances		
	6H	7H	6G
$8 \leq d \leq 16$	100	96	97,5
$16 < d \leq 39$	100	98	98,5

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 898. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 898 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 68:1973, *ISO general purpose screw threads — Basic profile.*

ISO 261:1973, *ISO general purpose metric screw threads — General plan.*

ISO 262:1973, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts.*

ISO 272:1982, *Fasteners — Hexagon products — Widths across flats.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 724:1993, *ISO general-purpose metric screw threads — Basic dimensions.*

ISO 898-2:1992, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread.*

ISO 965-1:1980, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data.*

ISO 965-2:1980, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose bolt and nut threads — Medium quality.*

ISO 4964: 1984, *Steel — Hardness conversions.*

ISO 6157-2:—²⁾, *Fasteners — Surface discontinuities — Part 2: Nuts with threads M5 to M39.*

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test.*

ISO 6507-1:1982, *Metallic materials — Hardness test — Vickers test — Part 1: HV5 to HV 700.*

ISO 6508: 1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K).*

3 Designation system

3.1 Nuts with nominal heights $\geq 0,8d$ (effective-lengths of thread $\geq 0,6d$): Nuts of style 1 and style 2

Nuts with nominal heights $\geq 0,8d$ (effective lengths of thread $\geq 0,6d$) are designated by a number to indicate the maximum appropriate property class of bolts with which they may be mated.

Failure of threaded fasteners due to over-tightening can occur by bolt shank fracture or by stripping of the threads of the nut and/or bolt. Shank fracture is sudden and therefore easily noticed. Stripping is gradual and therefore difficult to detect and this introduces the danger of partly failed fasteners being left in assemblies.

It would therefore be desirable to design threaded connections so that their mode of failure would always be by shank fracture but, unfortunately, because of the many variables which govern stripping strength (nut and bolt material strengths, thread clearances, across-flats dimensions, etc.), nuts would have to be excessively thick to guarantee this mode in all cases,

A bolt or screw of thread diameter 8 mm to 39 mm assembled with a nut of the appropriate property class, in accordance with table 2, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occurring.

²⁾ To be published.

Table 2 — Designation system for nuts with nominal heights $\geq 0,8d$

Property class of nut	Mating bolts		Nuts	
	Property class	Nominal thread diameter range mm	style 1	style 2
5	3.6; 4.6; 4.8	$d \leq 39$	$d \leq 39$	—
	5.6; 5.8			—
6	6.8	$d \leq 39$	$d \leq 39$	—
8	8.8	$d \leq 39$	$d \leq 39$	$d \leq 16$
10	10.9	$d \leq 39$	$d \leq 16$	$d \leq 39$
12	12.9	$d \leq 16$	—	$d \leq 16$

NOTE — In general, nuts of a higher property class can replace nuts of a lower property class. This is advisable for a bolt/nut assembly going into a stress higher than the yield stress or the stress under proof load of the bolt.

However, should tightening beyond bolt proof load take place, the nut design is intended to ensure at least 10 % of the over-tightened assemblies fail through bolt breakage in order to warn the user that the installation practice is not appropriate.

NOTE 3 For more detailed information on the strength of screw thread assemblies and for the styles of nuts, see ISO 898-2:1992, annex A.

3.2 Nuts with nominal heights $\geq 0,5d$ and $< 0,8d$ (effective heights of thread $\geq 0,4d$ and $< 0,6d$)

Nuts with nominal heights $\geq 0,5d$ and $< 0,8d$ (effective height of thread $\geq 0,4d$ and $< 0,6d$) are desig-

nated by a combination of two numbers: the second indicates the nominal stress under proof load on a hardened test mandrel, while the first indicates that the loadability of a bolt-nut assembly is reduced in comparison with the loadability on a hardened test mandrel and also in comparison with a bolt-nut assembly described in 3.1. The effective loading capacity is not only determined by the hardness of the nut and the effective height of thread but also by the tensile strength of the bolt with which the nut is assembled. Table 3 gives the designation system and the stresses under proof load of the nuts. Proof loads are shown in table 6. A guide for minimum expected stripping strengths of the joints when these nuts are assembled with bolts of various property classes is shown in table 7.

Table 3 — Designation system and stresses under proof load for nuts with nominal heights $\geq 0,5d$ and $< 0,8d$

Property class of nut	Nominal stress under proof load N/mm ²	Actual stress under proof load N/mm ²
04	400	380
05	500	500

4 Materials

Nuts shall be made of steel conforming to the chemical composition limits specified in table 4. The chemical composition shall be analysed in accordance with relevant International Standards.

Table 4 — Limits of chemical composition

Property class		Chemical composition limits (check analysis), %			
		C max.	Mn min.	P max.	S max.
5 ¹⁾ ; 6	—	0,50	—	0,060	0,150
8 ²⁾	04 ¹⁾	0,58	0,25	0,060	0,150
10 ²⁾	05 ²⁾	0,58	0,30	0,048	0,058
12 ²⁾	—	0,58	0,45	0,048	0,058

1) Nuts of this property class may be manufactured from free-cutting steel unless otherwise agreed between the purchaser and the manufacturer. In such cases, the following maximum sulfur, phosphorus and lead contents are permissible:
sulfur 0,34 %; phosphorus 0,11%; lead 0,35 %

2) Alloying elements may be added, if necessary, to develop the mechanical properties of the nuts.

Nuts of property classes **05, 8** (style 1), 10 and 12 shall be hardened and tempered.

5 Mechanical properties

When tested by the methods described in clause 8, the nuts shall have the mechanical properties set out in table 5.

6 Proof load values

Proof load values are given in table 6.

The nominal stress area, A_s , is calculated as follows:

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

where

d_2^{*1} is the basic pitch diameter of the external thread;

d_3 is the minor diameter of the external thread

$$d_3 = d_1 - \frac{H}{6}$$

where

d_1^{*1} is the basic minor diameter of the external thread;

H is the height of the fundamental triangle of the thread.

●) See ISO 724.

Nominal thread diameter <i>d</i> mm	Property class														
	04					05					5				
	Stress under proof load, S_p N/mm ²	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm ²	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm ²	Vickers hardness, HV		Nut	
min.		max.	state	style	min.		max.	state	style	min.		max.	state	style	
$8 \leq d \leq 16$	380	188	302	NQT ¹⁾	thin	500	272	353	QT ²⁾	thin	690	175	302	NQT ¹⁾	1
$16 < d \leq 39$											720	190			

Nominal thread diameter <i>d</i> mm	Property class														
	6						8								
	Stress under proof load, S_p N/mm [*]	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm [*]	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm ²	Vickers hardness, HV		Nut	
min.		max.	state	style	min.		max.	state	style	min.		max.	state	style	
$8 \leq d \leq 10$	770	8 8	302	NQT ¹⁾³⁾	1	955	250	353	QT ²⁾	1	890	195	302	NQT ¹⁾	2
$10 < d \leq 16$	780														
$16 < d \leq 33$	870	233				1 030	295				—	—	—		—
$33 < d \leq 39$	930					1 090					—	—			

Nominal thread diameter <i>d</i> mm	Property class														
	10							12							
	Stress under proof load, S_p N/mm [*]	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm [*]	Vickers hardness, HV		Nut		Stress under proof load, S_p N/mm [*]	Vickers hardness, HV		Nut	
min.		max.	state	style	min.		max.	state	style	min.		max.	state	style	
$8 \leq d \leq 10$	1 100	295	353	QT ²⁾	1	1 055	250	353	QT ²⁾	2	1 200	295	353	QT ²⁾	2
$10 < d \leq 16$	1 110														
$16 < d \leq 39$	—	—	—	—	—	1 080	260	—	—	—	—	—	—	—	—

NOTE — Minimum hardness is mandatory only for heat-treated nuts and nuts too large to be proof-load tested. For all other nuts, minimum hardness is not mandatory but is provided for guidance only. For nuts which are not hardened and tempered, and which satisfy the proof-load test, minimum hardness shall not be cause for rejection.

1) NQT = Not quenched and tempered.
2) QT = Quenched and tempered.
3) Nuts with nominal thread diameters $d > 16$ mm may be quenched and tempered at the discretion of the manufacturer.

Table 5 — Mechanical properties

Thread $d \times P$	Nominal stress area of mandrel A_s mm ²	Property class								
		04	05	5	6	8	10	12		
		Proof load ($A_s \times S_p$) N								
				style 1	style 1	style 1	style 2	style 1	style 2	style 2
M8 × 1	39,2	14 900	19 600	27 000	30 200	37 400	34 900	43 100	41 400	47 000
M10 × 1	64,5	24 500	32 200	44 500	49 700	61 600	57 400	71 000	68 000	77 400
M10 × 1,25	61,2	23 300	30 600	44 200	47 100	58 400	54 500	67 300	64 600	73 400
M12 × 1,25	92.1	35 000	46 000	63 500	71 800	88 000	82 000	102 200	97 200	110 500
M12 × 1.5	88.1	33 500	44000	60 800	68 700	84100	78400	97 800	92 900	105700
M14 × 1.5	125	47 500	62 500	86 300	97 500	119 400	111 200	138 800	131 900	150 000
M16 × 1.5	167	63 500	83 500	115200	130 300	159 500	148 600	185 400	176 200	200400
M16 × 1.5	215	81 700	107 500	154 800	187 000	221 500	—	—	232200	—
M18 × 2	204	77 500	102 000	146 900	177 500	210100	—	—	220300	—
M20 × 1,5	272	103400	136 000	195800	236600	280200	—	—	293800	—
M20 × 2	258	98 000	129 000	185 800	224 500	265 700	—	—	278600	—
M22 × 1,5	333	126 500	166 500	239 800	289 700	343000	—	—	359600	—
M22 × 2	318	120 800	159 000	229 000	276 700	327500	—	—	343400	—
M24 × 2	384	145900	192 000	276 500	334100	395500	—	—	414 700	—
M27 × 2	496	188 500	248 000	351 100	431 500	510900	—	—	535700	—
M30 × 2	621	236 000	310 500	447 100	540 300	639600	—	—	670700	—
M33 × 2	761	289 200	380 500	547 900	662 100	783800	—	—	821 900	—
M36 × 3	865	328 700	432 500	622 800	804 400	942800	—	—	934200	—
M39 × 3	1 030	391 400	515 000	741 600	957 900	1123000	—	—	1112000	—

Table 6 — Proof load values

7 Failure loads for nuts with nominal heights of $\geq 0,5d$ and $< 0,8d$

The values of failure loads given for guidance in table 7 apply to different bolt classes. Bolt stripping is the expected failure mode for lower strength bolts, while nut stripping can be expected for bolts of higher property classes.

Table 7 — Minimum stripping strength of nuts as a percentage of the proof load of bolts

Property class of the nut	Minimum stripping strength of nuts as a percentage of the proof load of bolts with property classes			
	6.9	8.8	10.9 I	12.9
04	85	65	45	40
05	100	85	60	50

8 Test methods

8.1 Proof load test

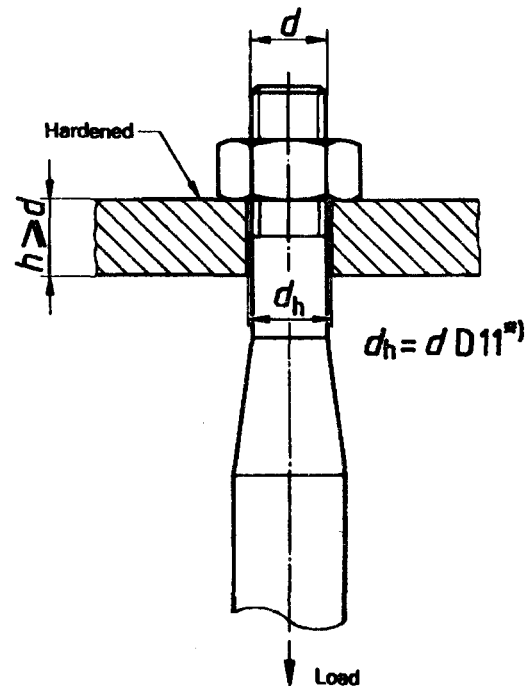
The proof load test shall be used wherever the capacity of available testing equipment permits, and shall be the referee method.

The nut shall be assembled on a hardened and threaded test mandrel as shown in figures 1 and 2. For referee purposes, the axial tensile test is decisive.

The proof load shall be applied against the nut in an axial direction, and shall be held for 15 s. The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released. If the thread of the mandrel is damaged during the test, the test should be discarded. It may be necessary to use a manual wrench to start the nut in motion. Such wrenching is permissible provided that it is restricted to one half turn and that the nut is then removable by the fingers.

The hardness of the test mandrel shall be 45 HRC minimum.

Mandrels used shall be threaded to tolerance class 5h6g except that the tolerance of the major diameter shall be the last quarter of the 6g range on the minimum material side.



*) D11 is taken from ISO 286-2.

Figure 1 — Axial tensile test

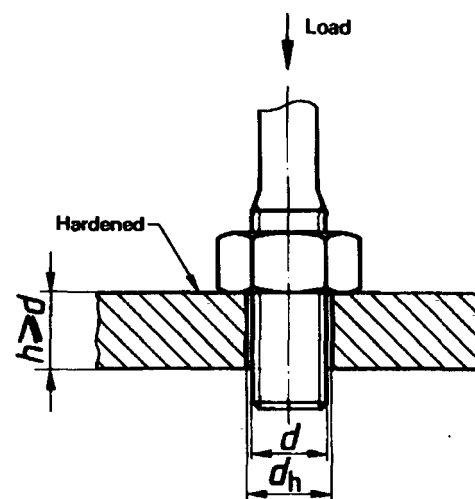


Figure 2 — Axial compressive test

8.2 Hardness test

For routine inspection, hardness tests shall be carried out on one bearing surface of the nut and the hardness shall be taken as the mean of three values spaced 120° apart. In case of dispute, the hardness tests shall be carried out on a longitudinal section through the nut axis and with impressions placed as close as possible to the nominal major diameter of the nut thread.

The Vickers hardness test is the referee test, and where practicable a load of HV 30 shall be applied.

If Brinell or Rockwell hardness tests are applied, the conversion tables in accordance with ISO 4964 shall be used.

The Vickers hardness test shall be carried out in accordance with the requirements of ISO 6507-1.

The Brinell hardness test shall be carried out in accordance with the requirements of ISO 6506.

The Rockwell hardness test shall be carried out in accordance with the requirements of ISO 6508.

8.3 Surface integrity test

For the surface integrity test, see ISO 6157-2.

9 Marking

9.1 Symbols

Marking symbols are shown in tables 8 and 9.

9.2 Identification

Hexagon nuts of all property classes shall be marked in accordance with the designation system described in clause 3, by indenting on the side or bearing surface, or by embossing on the chamfer. See figures 3 and 4. Embossed marks shall not protrude beyond the bearing surface of the nut.

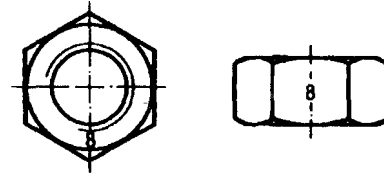


Figure 3 — Examples Of marking with designation symbol

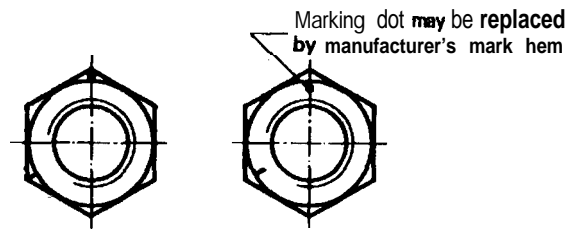


Figure 4 — Examples of marking with code symbol (clock-face system)

9.3 Marking of left-hand thread

Nuts with left-hand thread shall be marked as shown in figure 5 on one bearing surface of the nut by indenting.

The alternative marking for left-hand thread shown in figure 6 may also be used.

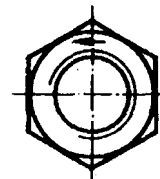
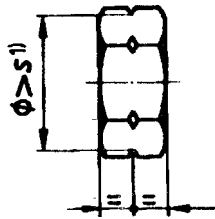


Figure 5 — Left-hand thread marking



1) s = width across flats.

Figure 6 — Alternative left-hand thread marking

9.4 Alternative marking

Alternative or optional permitted marking as stated in 9.1 to 9.3, is left to the choice of the manufacturer.

9.5 Trade (identification) marking

The trade (identification) marking of the manufacturer is **mandatory** on all products covered by the obligatory marking requirements for property classes, provided this is possible for technical reasons. Packages, however, shall be marked in all cases.

Table 8 — Marking for nuts with property classes in accordance with 3.1

Property class		5	6	8	10	12 ¹⁾
Alternative marking	either designation symbol	5	6	8	10	12
	or code symbol (clock-face system)					

¹⁾ Indication of the 12 o'clock position with the manufacturer's mark is not possible.

Table 9 — Marking for nuts with property classes in accordance with 3.2

Property class	04	05
Marking		

(Continued from second cover)

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 898-2: 1992	IS 1367 (Part 6): 1994 Technical supply conditions for threaded steel fasteners : Part 6 Mechanical properties and test methods for nuts with specified proof loads (<i>third revision</i>)	Identical
ISO 965-1 : 1980 ¹⁾	IS —ISO General purpose metric screw threads — Tolerances : Part 1 Principles and basic data (<i>under preparation</i>)	do
ISO 965-2 : 1980 ²⁾	IS —ISO General purpose metric screw threads — Tolerances : Part 2 Limits of sizes for general purpose external and internal screw threads — Medium quality (<i>under preparation</i>)	do
ISO 4964 : 1984	IS 4258 : 1982 Hardness conversion for metallic materials (<i>first revision</i>)	Modified
ISO 61 57-2 ³⁾	IS 1367 (Part 10): 1979 Technical supply conditions for threaded steel fasteners : Part 10 Surface discontinuities on nuts (<i>second revision</i>)	do
ISO 6506 : 1981	IS 1500 : 1983 Method for Brinell hardness test for metallic materials (<i>second revision</i>)	do
ISO 6507-1 : 1982 ⁴⁾	IS 1501 (Part 1): 1984 Method for Vickers hardness test for metallic materials : Part 1 HV 5 to HV 100 (<i>second revision</i>)	do
ISO 6508 : 1986	IS 1586 : 1988 Method for Rockwell hardness test for metallic material (Scales A-B-C-D-E-F-G-H-K)(<i>second revision</i>)	do

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

¹⁾ Revised in 1998.

²⁾ Revised in 1998.

³⁾ Published in 1995.

⁴⁾ Revised in 1997.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed **periodically**; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of **the** latest amendments or edition by referring to the latest issue of '**BIS Handbook**' and '**Standards : Monthly Additions**'.

This Indian Standard has been developed from **Doc** : No. BP 33 (0091) / LM 14 (0375).

Amendments Issued Since Publication

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