
International Standard



2320

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Prevailing torque type steel hexagon nuts — Mechanical and performance properties

Écrous hexagonaux en acier, à freinage interne, à couple préalable — Caractéristiques mécaniques et performances

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2320 was developed by Technical Committee ISO/TC 2, *Fasteners*, and was circulated to the member bodies in December 1981.

It has been approved by the member bodies of the following countries:

Australia	Hungary	Norway
Belgium	India	Poland
Canada	Ireland	South Africa, Rep. of
China	Italy	Spain
Czechoslovakia	Japan	Sri Lanka
Denmark	Korea, Dem. P. Rep. of	Sweden
Egypt, Arab Rep. of	Korea, Rep. of	Switzerland
Finland	Mexico	USA
France	Netherlands	USSR
Germany, F.R.	New Zealand	

The member body of the following country expressed disapproval of the document on technical grounds:

United Kingdom

This second edition cancels and replaces the first edition (i.e. ISO 2320-1972).

Prevailing torque type steel hexagon nuts — Mechanical and performance properties

1 Scope and field of application

1.1 This International Standard specifies the mechanical and performance requirements for prevailing torque type steel hexagon nuts

- a) with thread sizes M3 to M39 inclusive;
- b) with specific strength requirements;
- c) with dimensions as specified in product standards;
- d) within the following temperature ranges :
 - 1) - 50 to + 300 °C for all-metal non-plated nuts;
 - 2) - 50 to + 230 °C for all-metal plated nuts;
 - 3) - 50 to + 120 °C for non-metallic insert nuts.

It does not apply to nuts requiring special properties which may require special materials or coatings to improve

- weldability;
- corrosion resistance;
- performance outside the above specified temperature ranges.

Unless stated otherwise, all references to nuts in this International Standard are to both prevailing torque hexagon nuts and prevailing torque hexagon flange nuts.

1.2 Torque tension requirements for nuts of two types, NF (normal friction) and LF (low friction), in sizes M6 to M24 inclusive, and of property classes 8, 9 and 10 will be covered in a future International Standard.

1.3 No recommendations, except those for prevailing torques, are currently available for fine thread nuts.

2 References

ISO/R 80, *Rockwell hardness test (B and C scales) for steel.*

ISO 898/1, *Mechanical properties of fasteners — Part 1: Bolts, screws and studs.*

ISO 898/2, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values.*

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

ISO 2358, *Prevailing torque-type steel hexagon locknuts — Dimensions — Metric series.*

ISO 4042, *Threaded components — Electroplated coatings components.*¹⁾

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

ISO 6507/1, *Metallic materials — Hardness test — Vickers test — Part 1: HV5 to HV100.*

3 Definitions

3.1 prevailing torque type nut: A nut which is frictionally resistant to rotation due to a self-contained prevailing torque feature, and not because of a compressive load developed against the bearing surface of the nut.

3.2 prevailing torque developed by a nut: The torque necessary to rotate the nut on its mating externally-threaded component, with the torque being measured while the nut is in approximately constant motion, and with no axial load in the mating component.

3.3 normal friction nuts: Nuts that usually have a zinc electroplated finish plus a chromate or phosphate conversion coating with or without supplementary lubricants to meet the torque tension requirements.

3.4 low friction nuts : Nuts that usually have a finish which is either cadmium electroplated with a supplementary EP (extreme pressure) lubricant, or phosphate coated (zinc or manganese) with a rust preventive oil containing an EP lubricant to meet the torque tension requirements.

NOTE — Use of cadmium-plated LF nuts is subject to regulation in certain countries.

1) At present at the stage of draft.

Table 1 — Mechanical properties

Thread size mm	Property class														
	5					8					9				
	Proof stress s_p N/mm ² min.	Vickers hardness HV min.	Vickers hardness HV max.	Rockwell hardness HRC min.	Rockwell hardness HRC max.	Proof stress s_p N/mm ² min.	Vickers hardness HV min.	Vickers hardness HV max.	Rockwell hardness HRC min.	Rockwell hardness HRC max.	Proof stress s_p N/mm ² min.	Vickers hardness HV min.	Vickers hardness HV max.	Rockwell hardness HRC min.	Rockwell hardness HRC max.
over															
—	520					800	170		—		900	170		—	
4	580	130		—	810		302		30	915					
7	590		302	30	830	183				940	188			302	30
10	610				840					950					
16	630	146		—	920	233	353		36	920					

Thread size mm	Property class									
	10					12				
	Proof stress s_p N/mm ² min.	Vickers hardness HV min.	Vickers hardness HV max.	Rockwell hardness HRC min.	Rockwell hardness HRC max.	Proof stress s_p N/mm ² min.	Vickers hardness HV min.	Vickers hardness HV max.	Rockwell hardness HRC min.	Rockwell hardness HRC max.
over										
—	1040					1150				
4	1040					1150		353	29	36
7	1040	272	353	28	36	1160	295			
10	1050					1190				
16	1060					1200				

NOTE — Minimum hardness is mandatory only when nuts cannot be proof load tested, or for heat-treated nuts. For all other nuts minimum hardness is given for guidance only.

4 Designations

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

A bolt or screw of a particular property class assembled with the equivalent property class of nut, in accordance with table 2, is intended to provide an assembly capable of being tightened to achieve a bolt tension equivalent to the bolt minimum proof load or yield load without stripping.

In addition, geometric and mechanical properties of nuts are designed to provide for a high degree of resistance to stripping (at least 10 % bolt breakage of individual lots even under adverse minimum material conditions) when inadvertently over-torqued, so as to warn the user that his installation practice is inappropriate.

If stripping proves a problem, it may be advisable to use a nut of the next higher property class.

NOTE — For more detailed information on the strength of screw thread assemblies, see *Analysis and design of threaded assemblies 770420*, E.A. Alexander, S.A.E. International Congress, 1977.

5 Mechanical and performance requirements

5.1 Materials and processes

5.1.1 Materials

Nuts shall be made of steel conforming to the chemical composition limits specified in table 3. The prevailing torque element of insert-type nuts may be made of a material other than steel.

5.1.2 Heat treatment

Class 5 nuts need not be heat-treated. Class 8 and 9 nuts may be hardened and tempered at the option of the manufacturer. Class 10 and 12 nuts shall be hardened and tempered. Case hardening is not allowed for any property class.

Table 2 — Nut/bolt assemblies

Property class of the nut	5	8 ¹⁾	9 ¹⁾	10 ¹⁾	12
Property class of the mating bolt or screw	5.8 and lower	8.8 and lower	9.8, 8.8 and lower	10.9 9.8 8.8	12.9 10.9

1) It is not recommended that a heat-treated all-metal nut be combined with a bolt of a class lower than 8.8.

Table 3 — Limits of chemical composition

Property class	Chemical composition limit (check analysis), %			
	C max.	Mn min.	P max.	S max.
5 ¹⁾	0,500	—	0,110	0,150
8 and 9	0,580	0,250	0,060	0,150 ³⁾
10 ²⁾	0,580	0,300	0,048	0,058 ³⁾
12 ²⁾	0,580	0,450	0,048	0,058

1) May be manufactured from free cutting steel, unless otherwise agreed between the user and the manufacturer. In such cases the following maximum sulphur, phosphorus and lead contents are permissible :

S 0,34 %, P 0,12 % and Pb 0,35 %.

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

3) For nuts machined from bar, a sulphur maximum of 0,24 % is permitted when agreed by the user.

5.1.3 Finish

Nuts may be supplied plain (bare metal) or with a protective coating (electrodeposited plating or chemical conversion coating) as specified by the user.

Nuts may be provided with supplementary lubrication if necessary to meet the stated performance requirements without galling. The lubricant shall not constitute a health hazard to the user, nor emit an unpleasant odour during the assembly.

Lubricant when used must be suited to high speed assembly.

The performance of nuts which are supplied with a protective coating and/or lubricant shall not deteriorate when the nuts are stored indoors for a period of six months. The storage temperature shall be within the range $-5\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

In cases where nuts are given a protective coating or cleaning following delivery to the user, the nut manufacturer shall not be held responsible for failure of the nut to meet dimensional, mechanical or performance requirements traceable to the plating or coating.

5.1.4 Hydrogen embrittlement

Nuts shall not be embrittled. When heat-treated nuts are electroplated or phosphate-coated, appropriate plating or coating processes should be employed to avoid hydrogen embrittlement. If necessary, the product shall be suitably treated as soon as practicable after plating or coating to obviate detrimental hydrogen embrittlement.

5.2 Mechanical requirements

5.2.1 Proof load

Nuts shall withstand the proof loads specified in table 4 for the applicable class when tested as specified in 6.1.

5.2.2 Hardness

Nuts shall be of a hardness conforming to the limits specified for the applicable class in table 1 when tested as specified in 6.2.

5.3 Performance requirements

5.3.1 Prevailing torque

The prevailing torque developed by nuts (see 3.2) during their first fixing, or any subsequent fixing or removal, shall not exceed the maximum first fixing torque specified for the applicable class in table 4 when tested as specified in 6.3. In addition, the prevailing torques developed by nuts during their first and fifth removals shall be not less than the removal torques specified in table 4 when tested as specified in 6.3.

6 Test methods

6.1 Proof load test

The test sample nut shall be assembled on a test bolt (6.1.1) or on a hardened mandrel (6.1.2) with a minimum of three threads protruding through the nut. For referee test purposes, the hardened mandrel shall be used for nuts with non-metallic inserts and the test bolt shall be used for all-metal nuts. The maximum prevailing torque occurring during the assembly of the nut on the test bolt or mandrel shall be recorded after the first full form thread has passed through the prevailing torque feature.

A tensile load equal to the specified proof load for the nut, as given in table 4, shall be applied through the test bolt or mandrel against the nut bearing surface in an axial direction and shall be held for 15 s. The nut shall resist this load without thread stripping or rupture.

The axial tensile test is decisive. The maximum prevailing torque occurring during disassembly of the nut after a half-turn to full disengagement shall not exceed the recorded maximum prevailing torque during assembly, measured with the nut in motion.

6.1.1 Test bolt for proof load test

The bolt used for proof load testing nuts shall be as specified in 6.3.5 but shall have a proof load in excess of the proof load of the nut to be tested.

6.1.2 Hardened mandrel for proof load test

The mandrel used shall be threaded to tolerance class 5h/6g, except that the tolerance of the major diameter shall be in the lowest quarter of the 6g range on the minimum material side.

The hardness for the test mandrel shall be HV 450-510 (HRC 45-50).

6.2 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 and Rockwell hardness tests are applied, the conversion tables in accordance with the appropriate ISO documents shall be used.

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

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

The Rockwell hardness test shall be carried out in accordance with the provisions of ISO/R 80.

6.3 Prevailing torque test

Two test programmes are included in this International Standard. The first, programme A, is intended for the routine acceptance of lots of prevailing torque nuts as produced by the manufacturer and received by the user. Programme A also forms part of programme B, which is an extension of programme A. It covers four more assemblies and removals of the prevailing torque nuts without axial loading. A record shall be made, as in the first removal of the nut in programme A, of the prevailing off-torque of the nut for the fifth removal.

It is generally considered that products meeting programme B requirements may ordinarily be accepted by the routine test procedure of programme A.

6.3.1 Programme A

Programme A is recommended for routine inspection for lot acceptance.

The prevailing torque test shall be conducted at room temperature using a load measuring device (6.3.4).

A test bolt (6.3.5) shall be inserted in the load measuring device, a test washer (6.3.6) placed on the bolt and the sample nut then assembled on the bolt. The nut shall be advanced on the bolt until a minimum of two full bolt threads protrude through the nut. Nut tightening may be either manually with a torque wrench (a recommended technique is described in annex A), or with an equivalent torque-sensing power device (6.3.3) (a suitable device is shown in annex B). The maximum torque occurring while the nut is being advanced through the next 360° of nut rotation shall be measured. For the nut to be acceptable, this torque shall not exceed the first installation prevailing torque value as specified for the applicable nut in table 4.

Tightening shall be continued until the nut is seated against the test washer. The length of the test bolt shall be such that seating of the nut occurs when a length equivalent to four to seven thread pitches of the test bolt protrudes through the top of the nut, measured from the end of the bolt. The nut shall then be tightened until a tensile load equal to the clamp load, as specified in table 4, is developed in the bolt. The test washer shall be prevented from turning during nut tightening.

The nut shall then be slackened by the application of reverse torque until the tensile load in the bolt has been reduced to zero. The maximum torque occurring while the nut is being slackened through the next 360° of rotation shall be measured. For the nut to be acceptable, this torque shall be not less than the first removal prevailing torque value specified for the applicable nut in table 4.

6.3.2 Programme B

Programme B shall be used when assessing quality of nuts, and also for referee inspection for lot acceptance.

Programme A test procedure (6.3.1) shall be carried out. After the first removal prevailing torque has been measured, the nut

shall be slackened until the prevailing torque element is disengaged from the bolt thread.

The nut shall then be reassembled and removed four more times. On each assembly, the nut shall be advanced sufficiently to allow a length equivalent to four to seven thread pitches to protrude through the nut. On each removal, the prevailing torque element shall be disengaged from the bolt thread. This portion of the test need not be carried out in the load measuring device.

During the fifth removal, the maximum torque occurring while the nut is being slackened through the first 360° of rotation shall be measured. For the nut to be acceptable, this torque shall be not less than the fifth removal prevailing torque value as specified in table 4. In addition, at no time during these four additional refixings and removals shall the torque exceed the maximum first fixing prevailing torque value as specified in table 4.

To avoid overheating of the test assembly, sufficient time shall elapse between the torque application cycles.

The speed of installation and removal of the nut shall not exceed 30 rev/min, and shall be continuous and uniform.

6.3.3 Torque measuring device

The torque measuring device (torque wrench or power device) shall be accurate to $\pm 2\%$ of the maximum specified torque range of the device. For reference purposes, the measuring device shall be chosen so that all readings fall within the upper half of its torque range.

6.3.4 Load measuring device

The load measuring device used in the prevailing torque test shall be an instrument capable of measuring the actual tension induced in the test bolt as the nut is tightened. The device shall be accurate to $\pm 5\%$ of the test clamp load being used. The bolt clearance hole in the backing plate shall have the same diameter and tolerance as the test washer.

6.3.5 Test bolt for torque testing

Threads on all bolts of 24 mm diameter and smaller shall be produced by rolling. Bolt length shall be such that a length of four to seven thread pitches as measured from the end of the bolt will protrude through the nut when the nut is seated against the test washer. Thread length shall be such that a minimum of two full threads are within the grip after the nut is seated. The bolt shall have a point which is flat and chamfered; this will be the subject of a future International Standard. The thread surface shall be free of burrs or other contamination that might affect an accurate determination of the prevailing torque developed by the nut.

The bolt shall have an ultimate strength related to the specified proof load of the nut to be tested and the properties shall be in accordance with ISO 898/1.

A new bolt shall be used for testing each nut.

6.3.5.1 When testing normal friction (NF) nuts, the bolt shall have the same finish (metallic coating) as the nut tested. Thread tolerances of the bolt shall be as specified in the standard of the actual surface coating. When testing nuts with coating other than zinc, cadmium or phosphate, a zinc-phosphated and oiled test bolt shall be used.

6.3.5.2 When testing low friction (LF) nuts, the test bolt shall have a zinc-phosphate and oil finish and have threads conforming to ISO 965/1 class 6g tolerances.

6.3.6 Test washer

If tests according to this International Standard are carried out, no special properties need be applicable to the test washer.

If torque tension testing is required, the qualities of the test washer shall be the subject of a specific agreement.

A future International Standard will deal with torque tension testing and will incorporate a definition for an appropriate test washer.

7 Marking

Nuts of diameter M5 and larger shall be marked legibly to identify property class and manufacturer. Property class identification symbols shall conform to ISO 898/2. Manufacturer's identification symbols shall be at the manufacturer's option.

Marking may be raised or indented at the manufacturer's option; however, raised markings shall not project beyond the specified maximum width or height of nut. Indented marking may be located on any surface, but preferably not on the nut bearing surface; raised marking shall not be on the nut bearing surface.

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Table 4 — Proof loads, clamp loads and prevailing torques for nuts

Nut Thread size <i>d</i>	Thread pitch <i>P</i> mm	Proof load, kN												Clamp load, kN						Prevailing torque, N·m ¹⁾					
		Property class						Property class						Property classes 5, 8 and 9			Property classes 10 and 12								
		5	8	9	10	12	12	5	8	9	10	12	12	First fixing max.	First removal min.	Fifth removal min.	First fixing max.	First removal min.	Fifth removal min.						
M 3	0,5	2,97	4	—	5,2	5,8	1,43	2,19	—	3,13	3,66	0,43	0,12	0,08	0,15	0,6	0,15	0,10							
M 4	0,7	5,18	7	—	9,15	10,1	2,50	3,82	—	5,47	6,39	0,90	0,18	0,12	0,22	1,2	0,22	0,15							
M 5	0,8	8,34	11,5	—	14,8	16,3	4,05	6,17	6,92	8,85	10,4	1,6	0,29	0,20	0,35	2,1	0,35	0,24							
M 6	1	11,9	16,3	18,1	20,9	23,7	5,73	8,70	9,82	12,5	14,6	3,0	0,45	0,30	0,55	4,0	0,55	0,40							
M 8	1,25	21,6	30,4	34,4	38,1	42,5	10,4	15,9	17,8	22,8	26,6	6,0	0,85	0,60	1,15	8,0	1,15	0,80							
M10	1,5	34,2	48,1	54,5	60,3	67,3	16,5	25,3	28,3	36,1	42,2	10,5	1,5	1,0	2,0	14	2,0	1,4							
M12	1,75	49,7	70,8	80,1	88,5	100	24,0	36,7	41,1	52,5	61,4	15,5	2,3	1,6	3,1	21	3,1	2,1							
M14	2	67,8	96	109	121	137	32,8	50,0	56,1	71,6	84	24	3,3	2,3	4,4	31	4,4	3,0							
M16	2	92,6	132	149	165	187	44,8	68,2	76,5	97,5	114	32	4,5	3,0	6,0	42	6,0	4,2							
M18	2,5	113	177	—	204	230	54,8	86,2	—	119	140	42	6,0	4,2	8,0	56	8,0	5,5							
M20	2,5	145	225	—	260	294	69,8	110	—	152	178	54	7,5	5,3	10,5	72	10,5	7,0							
M22	2,5	179	279	—	321	364	86,2	136	—	189	220	68	9,5	6,5	13	90	13	9,0							
M24	3	208	325	—	374	424	100,5	159	—	220	256	80	11,5	8,0	15	106	15	10,5							
M27	3	271	422	—	487	551	77,2	206	—	286	334	94	13,5	10	17	123	17	12							
M30	3,5	331	516	—	595	673	94,5	253	—	350	408	108	16	12	19	140	19	14							
M33	3,5	409	638	—	736	832	117	312	—	432	505	122	18	14	21,5	160	21,5	15,5							
M36	4	482	752	—	866	980	138	368	—	509	594	136	21	16	24	180	24	17,5							
M39	4	576	898	—	1035	1171	165	440	—	608	710	150	23	18	26,5	200	26,5	19,5							

1) If pitches according to table 8 of ISO 898/1 are used, these values also apply.

NOTE — The clamp load for class 5 nuts is equal to 75 % of the proof load of property class 5.8 bolts for sizes M3 to M24 inclusive, and 75 % of property class 4.6 bolts for sizes larger than M24. The clamp loads for classes 8, 9 and 10 nuts are equal to 75 % of the proof load of property classes 8.8, 9.8 and 10.9 bolts, respectively. Proof loads of bolts are given in ISO 898/1.