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जयते

GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

Technical Report

on

Important Fasteners

for

Electric Locomotives

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FOREWORD

There are various types of fasteners used in an electric locomotive. Proper fitment of fasteners are essential for reliable and safe working. Engineers incharge of locomotive maintenance and production should have proper information regarding its use and fitment. Selection of a fastener for a particular type of use should be judiciously decided by taking into consideration the requirement of load and strength.

This technical report on fasteners provides basic information in brief about fasteners like property class, nomenclature, markings on fasteners, tightening torque etc. This will serve as useful reference as and when required by electric loco sheds and workshops in their day to day working.

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Chapter: 1 Introduction to Fasteners

1. Fasteners

A fastener is a hardware device that mechanically joins or affixes two or more objects together. They can be made from metals, Plastics or Composites. Fasteners can be threaded and non-threaded.

1.1 Fastener Types

i) Removable:

This type permits the parts to be readily disconnected without damaging the fastener, e.g. nut and bolt.

ii) Semi-permanent:

For this type, the parts can be disconnected, but some damage usually occurs to the fastener, e.g. cotter pin

iii) Permanent:

When this type of fastener is used, the parts will never be disassembled. e.g. rivets and welding

1.2 Definition of important Terminologies

Various parameters for defining the fasteners are indicated in Fig 1.1, 1.2 & 1.3. Terminology for the fasteners is defined below.

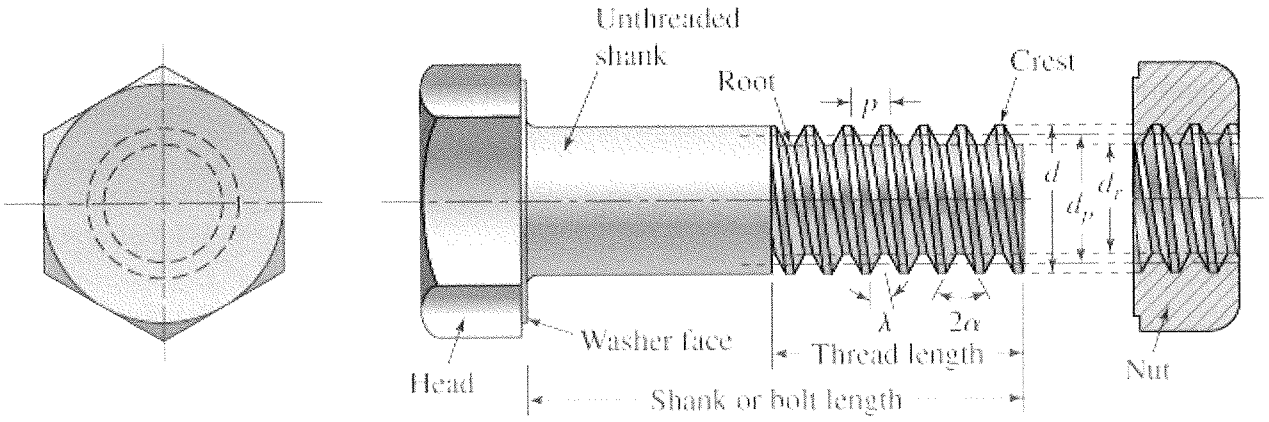


Fig 1.1: A typical diagram of a bolt & Nut

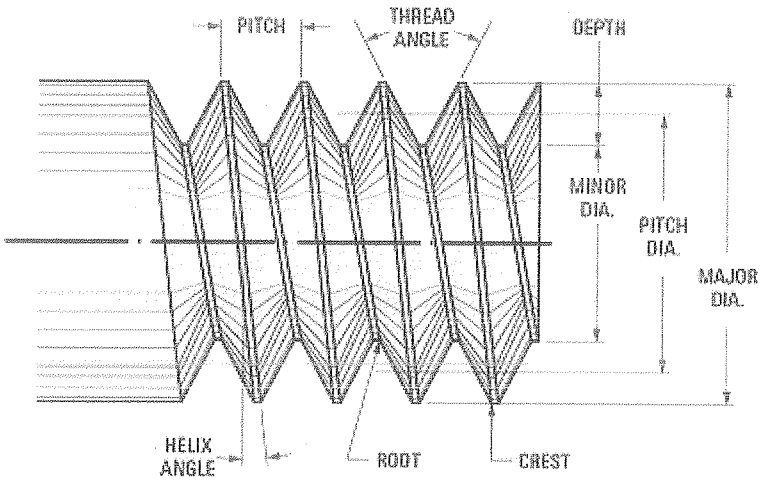


Fig 1.2: A view of the thread

- **Major diameter**
  The major diameter is the largest diameter of the thread. It determines the nominal size.

- **Minor diameter**
  It is the smallest diameter of the thread. In external thread, it is also called as root diameter.

- **Pitch**
  It is the axial distance between any point of one thread and the corresponding point of an adjacent thread.

- **Lead**
  The distance a bolt advances into a nut in one revolution is called lead.

- **Crest**
  The top of the rib is called the crest, or thread tip.

- **Root**

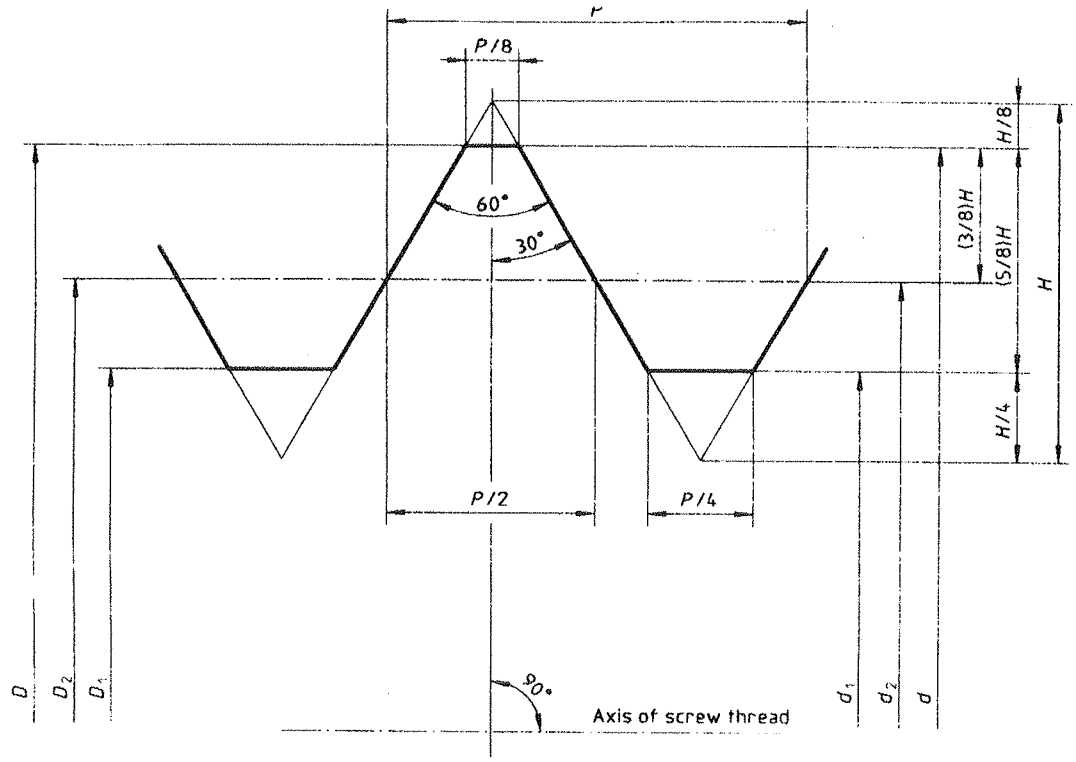
  Bottom of the groove is called the thread root.

- **Pitch Dia**

  Pitch Diameter is the simple effective diameter of screw thread, approximately halfway between the major and minor diameters.

1.3 Basic Profile:

The theoretical profile of a screw thread in an axial plane defined by theoretical dimensions and angles common to internal and external threads

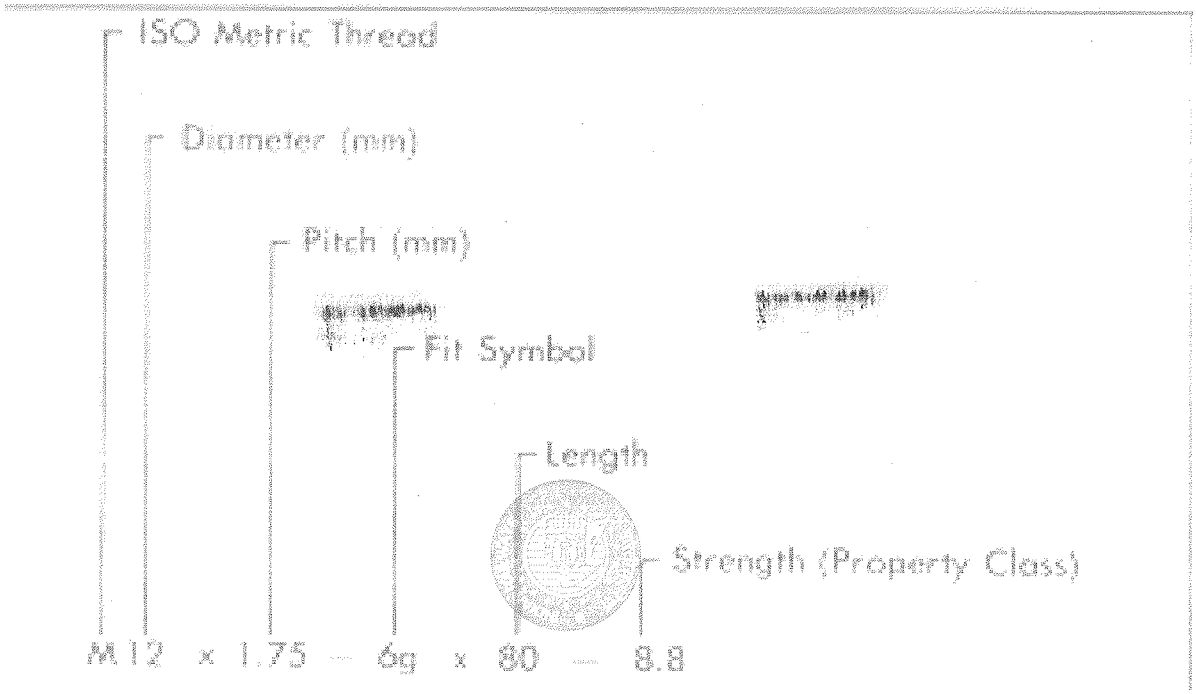


where

D	is the basic major diameter of internal thread (nominal diameter)
d	is the basic major diameter of external thread (nominal diameter)
D_2	is the basic pitch diameter of internal thread
d_2	is the basic pitch diameter of external thread
D_1	is the basic minor diameter of internal thread
d_1	is the basic minor diameter of external thread
H	is the height of fundamental triangle
P	is the pitch

Fig 1.3: Detailed view of the thread and its measurement/unit terminology

1.4 Established standards for classifying metric bolts and screws as per International Organization for Standardization(ISO)



1.5 Types of Thread

The type of threads that are used for most applications are coarse with deep grooves. Some threads are finer, with shallower grooves. Bolts with fine threads are used only under special conditions – such as when the parts being fastened have thin walls.

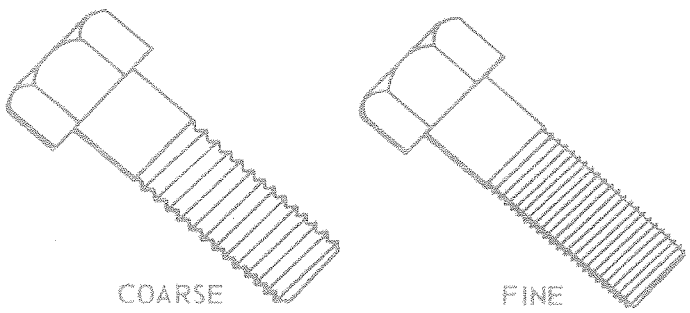


Fig 1.4: Diagrams of Coarse and Fine thread

Coarse Thread Fasteners

A coarse thread (low number of threads per inch) has more clamping power and is faster to torque down, but can't be adjusted as finely.

Fine Thread Fasteners

A fine thread (high number of threads per inch) can be more finely adjusted, but has less clamping power, and is slower to torque down.

Fine Thread Fasteners have following features

- Stronger Thread
- Less likely to come loose
- Slow to assemble
- Easier to ruin the thread (cross thread)

Identification by pitch, or threads per inch:

The picture shows a bolt and the tool used to measure the bolt's pitch.

Fig 1.5: Measurement of pitch or threads/inch

Right Hand Threads

Bolts and screws normally have right-hand threads. Turned to the right (clockwise) when tightened.

Left Hand Threads

Occasionally, bolts, screws and nuts with left-hand threads are needed. Turned to the left (counter-clockwise) when tightened.

Chapter: 2 General requirements of Fasteners

2. General requirements of Fasteners

Standardized Fasteners such as bolts, screws, studs and nuts are defined by the following elements:

a) Mechanical properties (property class, material);

b) Product grade (tolerances);

c) Standardized geometrical features (if any);

d) Surface coatings (if required);

e) special requirements (if agreed).

The fasteners should have intact surfaces and edges. It should be free of burrs consistent with the manufacturing methods used. It is not generally required that small burrs due to operations such as slotting, or resulting from forging, pressing or trimming, be removed. Any burr which influences the performance or would be a safety hazard when handled, however, shall be removed.

Trimming burrs beyond the bearing face of bolts and screws is not permissible. Centre holes for bolts and screws are permissible, unless otherwise specified.

Unless a surface coating is agreed, the surface finish shall be as processed for steel products, or plain for products made of stainless steel or non-ferrous metal.

Bolts, screws, studs and nuts shall be delivered in a clean condition and lightly oiled, if no other conditions have been agreed.

2.1 Specifications and reference standards

Various parameters of a hardwares are specified in ISO or equivalent IS standards for hardwares made of Carbon steel slloy, stainless steel and non-ferrous metals as given in Table 2.1

Table 2.1

Details	Carbon Steel Alloy		Stainless Steel		Non- Ferrous metals	
	ISO standard	Equivalent IS Standard	ISO standard	Equivalent IS Standard	ISO standard	Equivalent IS Standard
Mechanical and performance Characteristics	ISO 898-1,2, 5,6, 7 ISO 2320 ISO 7085	IS 1367(Pt 3, 5, 6, 8, 20), IS 13096	ISO 3506-1 to 3	IS 1367(Pt 14, Sec 1, 2 & 3)	ISO 8839	-
Tolerances	ISO 4759-1, IS 1367(Pt 2)					
Geometrical features - Thread - Driving features	ISO 965-1 to 5, IS 14962(Pt 1 to 5)					
	ISO 272, ISO 4757, ISO 10664, IS 9519, IS 7418					
- Ends of parts	ISO 4753, IS 1368					
- Countersunk head	ISO 7721, IS 11362					
- Others	ISO 885, ISO 888, ISO 3508, ISO 4755, ISO 7378, IS 4172, IS 4206, IS 1369(Pt 1), IS 1369(Pt 2)					
Surface discontinuities	ISO 6157-1 to 3	IS 1367(Pt 9, sec 1, 2 & 3)	-			
Surface finish	ISO 4042 ISO 10683 ISO 10684		ISO 16048		ISO 4042	
Quality aspect	ISO 3269, ISO 16426 IS 1367(Pt 17)					

Therefore, whenever hardware is inspected, the properties of the hardware like thread, surface finish etc. should conform to the relevant IS or ISO specification as given in Table 2.1

Chapter: 3 Description of bolts, Screws and Studs

3.1 Designation System for Property Classes

The symbol for property classes of bolts, screws, and studs consists of two numbers, separated by a dot. For example- 4.6, 4.8, 5.6, 5.8.6.8, 8.8, 9.8, 10.9, 12.9

a) The number to the left of the dot

The number to the left of the dot consists of one or two digits and indicates 1/100 of the nominal tensile strength, *R*m,nom, in Megapascals.

b) The number to the right of the dot

The number to the right of the dot indicates 10 times the ratio between the nominal yield strength and the nominal tensile strength, *R*m,nom.

The nominal yield strength, as specified in Table 3.3(Nos. 2 to 4)), is:

- lower yield strength *R*eL,nom, or

- nominal stress at 0,2 % non-proportional elongation *R*p0,2 nom, or

- nominal stress at 0,0048*d* non-proportional elongation *R*pf,nom.

For ease of understanding, it is given in Table 3.1.

Table 3.1

Number to the right of dot			.6	.8	.9
$\frac{R_{eL,nom}}{R_{m,nom}}$ or	$\frac{R_{p0,2,nom}}{R_{m,nom}}$ or	$\frac{R_{pf,nom}}{R_{m,nom}}$	0.6	0.8	0.9

Note:

Proof Strength ($R_{p0.2}$)**:** Stress at which a non-proportional extension is equal to a specified percentage of the extensometer gauge length. The symbol used is followed by a suffix giving the prescribed percentage, for example: $R_{p0.2}$.

c) **An additional zero to the left of the property class designation**
An additional zero to the left of the property class designation indicates that fasteners have reduced loadability.

EXAMPLE 1

A fastener of nominal tensile strength *R*m,nom = 800 MPa and with a yield strength ratio of 0,8 has the property class designation 8.8.

EXAMPLE 2

A fastener with material properties of property class 8.8 but with reduced loadability is designated by 08.8.

3.2 Materials- Steels for Bolts, Screws and Studs

Table- 3.2 Specifies limits for the chemical composition of steels and minimum tempering temperatures for the different property classes of bolts, screws and studs. The chemical composition shall be assessed in accordance with the relevant International Standard.

Table 3.2

Property class	Material and heat treatment	Chemical composition limit (cast analysis, %)[a]					Tempering temperature °C
		C		P	S	B[b]	
		min.	max.	max.	max.	max.	min.
4.6[cd]	Carbon steel or carbon steel with additives	—	0,55	0,050	0,060	Not specified	—
4.8[d]							
5.6[c]		0,13	0,55	0,050	0,060		
5.8[d]		—	0,55	0,050	0,060		
6.8[d]		0,15	0,55	0,050	0,060		
8.8[f]	Carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered	0,15[e]	0,40	0,025	0,025	0,003	425
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
9.8[f]	Carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered	0,15[e]	0,40	0,025	0,025	0,003	425
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
10.9[f]	Carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered	0,20[e]	0,55	0,025	0,025	0,003	425
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
12.9[fhi]	Alloy steel quenched and tempered[g]	0,30	0,50	0,025	0,025	0,003	425
12.9[fhi]	Carbon steel with additives (e.g. Boron or Mn or Cr or Molybdenum) quenched and tempered	0,28	0,50	0,025	0,025	0,003	380

[a] In case of dispute, the product analysis applies.

[b] Boron content can reach 0,005 %, provided non-effective boron is controlled by the addition of titanium and/or aluminium.

[c] For cold forged fasteners of property classes 4.6 and 5.6, heat treatment of the wire used for cold forging or of the cold forged fastener itself may be necessary to achieve required ductility.

[d] Free cutting steel is allowed for these property classes with the following maximum sulfur, phosphorus and lead contents: S: 0,34 %; P: 0,11 %; Pb: 0,35 %.

[e] In case of plain carbon boron steel with a carbon content below 0,25 % (cast analysis), the minimum manganese content shall be 0,6 % for property class 8.8 and 0,7 % for property classes 9.8 and 10.9.

[f] For the materials of these property classes, there shall be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering.

[g] This alloy steel shall contain at least one of the following elements in the minimum quantity given: chromium 0,30 %, nickel 0,30 %, molybdenum 0,20 %, vanadium 0,10 %. Where elements are specified in combinations of two, three or four and have alloy contents less than those given above, the limit value to be applied for steel class determination is 70 % of the sum of the individual limit values specified above for the two, three or four elements concerned.

[h] Fasteners manufactured from phosphated raw material shall be dephosphated before heat treatment; the absence of white phosphorus enriched layer shall be detected by a suitable test method.

[i] Caution is advised when the use of property class 12.9/12.9 is considered. The capability of the fastener manufacturer, the service conditions and the wrenching methods should be considered. Environments can cause stress corrosion cracking of fasteners as processed as well as those coated.

3.3 Mechanical and Physical Properties of bolts, screws & studs

The bolt, screws & studs of the specified property classes shall, at ambient temperature meet all the mechanical & physical properties in accordance with Table 3.3 To Table 3.7 regardless of which tests are performed during manufacturing or final inspection.

Table 3.3 – Mechanical and physical properties of bolts, screws & studs

No.	Mechanical or physical property		Property class									
			4.6	4.8	5.6	5.8	6.8	8.8		9.8	10.9	12 . . 12.9
								$d \leq$ 16 mm[a]	$d >$ 16 mm[b]	$d \leq$ 16 mm		
1	Tensile strength, R_m, MPa	nom.[c]	400		500		600	800		900	1 000	1 200
		min.	400	420	500	520	600	800	830	900	1 040	1 220
2	Lower yield strength, R_{eL}[d], MPa	nom.[c]	240	—	300	—	—	—	—	—	—	—
		min.	240	—	300	—	—	—	—	—	—	—
3	Stress at 0,2 % non-proportional elongation, $R_{p0,2}$, MPa	nom.[c]	—	—	—	—	—	640	640	720	900	1 080
		min.	—	—	—	—	—	640	660	720	940	1 100
4	Stress at 0,0048d non-proportional elongation for full-size fasteners, R_{pf}, MPa	nom.[c]	—	320	—	400	480	—	—	—	—	—
		min.	—	340[e]	—	420[e]	480[e]	—	—	—	—	—
5	Stress under proof load, S_p[f], MPa	nom.	225	310	280	380	440	580	600	650	830	970
	Proof strength ratio $S_{p,nom}/R_{eL,min}$ or $S_{p,nom}/R_{p0,2,min}$ or $S_{p,nom}/R_{pf,min}$		0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
6	Percentage elongation after fracture for machined test pieces, A, %	min.	22	—	20	—	—	12	12	10	9	8
7	Percentage reduction of area after fracture for machined test pieces, Z, %	min.	—					52		48	48	44
8	Elongation after fracture for full-size fasteners, A_f (see also Annex C)	min.	—	0,24	—	0,22	0,20	—	—	—	—	—
9	Head soundness		No fracture									

Table 3.3 (continued)

No.	Mechanical or physical property		Property class									
			4.6	4.8	5.6	5.8	6.8	8.8		9.8	10.9	12.9/ 12.9
								$d \leq$ 16 mm[a]	$d >$ 16 mm[b]	$d \leq$ 16 mm		
10	Vickers hardness, HV $F \geq 98$ N	min.	120	130	155	160	190	250	255	290	320	385
		max.	220[g]				250	320	335	360	380	435
11	Brinell hardness, HBW $F = 30\,D^2$	min.	114	124	147	152	181	245	250	286	316	380
		max.	209[g]				238	316	331	355	375	429
12	Rockwell hardness, HRB	min.	67	71	79	82	89	—				
		max.	95,0[g]				99,5	—				
	Rockwell hardness, HRC	min.	—					22	23	28	32	39
		max.	—					32	34	37	39	44
13	Surface hardness, HV 0,3	max.	—					—			390	435
14	Non-carburization, HV 0,3	max.	—					h			h	h
15	Height of non-decarburized thread zone, E, mm	min.	—					$^1/_2 H_1$			$^2/_3 H_1$	$^3/_4 H_1$
	Depth of complete decarburization in the thread, G, mm	max.	—					0,015				
16	Reduction of hardness after retempering, HV	max.	—					20				
17	Breaking torque, M_B, Nm	min.	—					in accordance with ISO 898-7				
18	Impact strength, K_V[i], J	min.	—		27		—	27	27	27	27	k
19	Surface integrity in accordance with		ISO 6157-1[l]									ISO 6157-3

[a] Values do not apply to structural bolting.

[b] For structural bolting $d \geq$ M12.

[c] Nominal values are specified only for the purpose of the designation system for property classes. See Clause 5.

[d] In cases where the lower yield strength, R_{eL}, cannot be determined, it is permissible to measure the stress at 0,2 % non-proportional elongation $R_{p0,2}$.

[e] For the property classes 4.8, 5.8 and 6.8, the values for $R_{pf\,min}$ are under investigation. The values at the time of publication of this part of ISO 898 are given for calculation of the proof stress ratio only. They are not test values.

[f] Proof loads are specified in Tables 5 and 7.

[g] Hardness determined at the end of a fastener shall be 250 HV, 238 HB or 99,5 HRB maximum.

[h] Surface hardness shall not be more than 30 Vickers points above the measured base metal hardness of the fastener when determination of both surface hardness and base metal hardness are carried out with HV 0,3 (see 9.11).

[i] Values are determined at a test temperature of −20 °C (see 9.14).

[j] Applies to $d > 16$ mm.

[k] Value for K_V is under investigation.

[l] Instead of ISO 6157-1, ISO 6157-3 may apply by agreement between the manufacturer and the purchaser.

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Table 3.4 – Minimum ultimate tensile loads-ISO metric coarse pitch thread

Thread[a] d	Nominal stress area $A_{s,nom}$[b] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Minimum ultimate tensile load, $F_{m,min}$ ($A_{s,nom} \times R_{m,min}$), N								
M3	5,03	2 010	2 110	2 510	2 620	3 020	4 020	4 530	5 230	6 140
M3,5	6,78	2 710	2 850	3 390	3 530	4 070	5 420	6 100	7 050	8 270
M4	8,78	3 510	3 690	4 390	4 570	5 270	7 020	7 900	9 130	10 700
M5	14,2	5 680	5 960	7 100	7 380	8 520	11 350	12 800	14 800	17 300
M6	20,1	8 040	8 440	10 000	10 400	12 100	16 100	18 100	20 900	24 500
M7	28,9	11 600	12 100	14 400	15 000	17 300	23 100	26 000	30 100	35 300
M8	36,6	14 600[c]	15 400	18 300[c]	19 000	22 000	29 200[c]	32 900	38 100[c]	44 600
M10	58	23 200[c]	24 400	29 000[c]	30 200	34 800	46 400[c]	52 200	60 300[c]	70 800
M12	84,3	33 700	35 400	42 200	43 800	50 600	67 400[d]	75 900	87 700	103 000
M14	115	46 000	48 300	57 500	59 800	69 000	92 000[d]	104 000	120 000	140 000
M16	157	62 800	65 900	78 500	81 600	94 000	125 000[d]	141 000	163 000	192 000
M18	192	76 800	80 600	96 000	99 800	115 000	159 000	—	200 000	234 000
M20	245	98 000	103 000	122 000	127 000	147 000	203 000	—	255 000	299 000
M22	303	121 000	127 000	152 000	158 000	182 000	252 000	—	315 000	370 000
M24	353	141 000	148 000	176 000	184 000	212 000	293 000	—	367 000	431 000
M27	459	184 000	193 000	230 000	239 000	275 000	381 000	—	477 000	560 000
M30	561	224 000	236 000	280 000	292 000	337 000	466 000	—	583 000	684 000
M33	694	278 000	292 000	347 000	361 000	416 000	576 000	—	722 000	847 000
M36	817	327 000	343 000	408 000	425 000	490 000	678 000	—	850 000	997 000
M39	976	390 000	410 000	488 000	508 000	586 000	810 000	—	1 020 000	1 200 000

[a] Where no thread pitch is indicated in a thread designation, coarse pitch is specified.

[b] To calculate $A_{s,nom}$, see 9.1.6.1.

[c] For fasteners with thread tolerance 6az in accordance with ISO 965-4 subject to hot dip galvanizing, reduced values in accordance with ISO 10684:2004, Annex A, apply.

[d] For structural bolting 70 000 N (for M12), 95 500 N (for M14) and 130 000 N (for M16).

Table 3.5 – Proof loads -ISO metric coarse pitch thread

Thread[a] d	Nominal stress area $A_{s,nom}$[b] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Proof load, F_p ($A_{s,nom} \times S_{p,nom}$), N								
M3	5,03	1 130	1 560	1 410	1 910	2 210	2 920	3 270	4 180	4 880
M3,5	6,78	1 530	2 100	1 900	2 580	2 980	3 940	4 410	5 630	6 580
M4	8,78	1 980	2 720	2 460	3 340	3 860	5 100	5 710	7 290	8 520
M5	14,2	3 200	4 400	3 980	5 400	6 250	8 230	9 230	11 800	13 800
M6	20,1	4 520	6 230	5 630	7 640	8 840	11 600	13 100	16 700	19 500
M7	28,9	6 500	8 960	8 090	11 000	12 700	16 800	18 800	24 000	28 000
M8	36,6	8 240[c]	11 400	10 200[c]	13 900	16 100	21 200[c]	23 800	30 400[c]	35 500
M10	58	13 000[c]	18 000	16 200[c]	22 000	25 500	33 700[c]	37 700	48 100[c]	56 300
M12	84,3	19 000	26 100	23 600	32 000	37 100	48 900[d]	54 800	70 000	81 800
M14	115	25 900	35 600	32 200	43 700	50 600	66 700[d]	74 800	95 500	112 000
M16	157	35 300	48 700	44 000	59 700	69 100	91 000[d]	102 000	130 000	152 000
M18	192	43 200	59 500	53 800	73 000	84 500	115 000	—	159 000	186 000
M20	245	55 100	76 000	68 600	93 100	108 000	147 000	—	203 000	238 000
M22	303	68 200	93 900	84 800	115 000	133 000	182 000	—	252 000	294 000
M24	353	79 400	109 000	98 800	134 000	155 000	212 000	—	293 000	342 000
M27	459	103 000	142 000	128 000	174 000	202 000	275 000	—	381 000	445 000
M30	561	126 000	174 000	157 000	213 000	247 000	337 000	—	466 000	544 000
M33	694	156 000	215 000	194 000	264 000	305 000	416 000	—	576 000	673 000
M36	817	184 000	253 000	229 000	310 000	359 000	490 000	—	678 000	792 000
M39	976	220 000	303 000	273 000	371 000	429 000	586 000	—	810 000	947 000

[a] Where no thread pitch is indicated in a thread designation, coarse pitch is specified.

[b] To calculate $A_{s,nom}$, see 9.1.6.1.

[c] For fasteners with thread tolerance 6az in accordance with ISO 965-4 subject to hot dip galvanizing, reduced values in accordance with ISO 10684:2004, Annex A, apply.

[d] For structural bolting 50 700 N (for M12), 68 800 N (for M14) and 94 500 N (for M16).

Note: Proof load: Proof load is defined as the maximum tensile force that can be applied to a bolt that will not result in plastic deformation. In other words, the material must remain in its elastic region when **loaded** up to its **proof load**. **Proof load** is typically between 85-95% of the yield strength.

Table 3.6 – Minimum ultimate tensile loads-ISO metric fine pitch thread

Thread $d \times P$	Nominal stress area $A_{s,nom}$[a] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Minimum ultimate tensile load, $F_{m,min}$ ($A_{s,nom} \times R_{m,min}$), N								
M8×1	39,2	15 700	16 500	19 600	20 400	23 500	31 360	35 300	40 800	47 800
M10×1,25	61,2	24 500	25 700	30 600	31 800	36 700	49 000	55 100	63 600	74 700
M10×1	64,5	25 800	27 100	32 300	33 500	38 700	51 600	58 100	67 100	78 700
M12×1,5	88,1	35 200	37 000	44 100	45 800	52 900	70 500	79 300	91 600	107 000
M12×1,25	92,1	36 800	38 700	46 100	47 900	55 300	73 700	82 900	95 800	112 000
M14×1,5	125	50 000	52 500	62 500	65 000	75 000	100 000	112 000	130 000	152 000
M16×1,5	167	66 800	70 100	83 500	86 800	100 000	134 000	150 000	174 000	204 000
M18×1,5	216	86 400	90 700	108 000	112 000	130 000	179 000	—	225 000	264 000
M20×1,5	272	109 000	114 000	136 000	141 000	163 000	226.000	—	283 000	332 000
M22×1,5	333	133 000	140 000	166 000	173 000	200 000	276 000	—	346 000	406 000
M24×2	384	154 000	161 000	192 000	200 000	230 000	319 000	—	399 000	469 000
M27×2	496	198 000	208 000	248 000	258 000	298 000	412 000	—	516 000	605 000
M30×2	621	248 000	261 000	310 000	323 000	373 000	515 000	—	646 000	758 000
M33×2	761	304 000	320 000	380 000	396 000	457 000	632 000	—	791 000	928 000
M36×3	865	346 000	363 000	432 000	450 000	519 000	718 000	—	900 000	1 055 000
M39×3	1 030	412 000	433 000	515 000	536 000	618 000	855 000	—	1 070 000	1 260 000

[a] To calculate $A_{s,nom}$, see 9.1.6.1.

Table 3.7 – Proof loads -ISO metric fine pitch thread

Thread $d \times P$	Nominal stress area $A_{s,nom}$[a] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Proof load, F_p ($A_{s,nom} \times S_{p,nom}$), N								
M8×1	39,2	8 820	12 200	11 000	14 900	17 200	22 700	25 500	32 500	38 000
M10×1,25	61,2	13 800	19 000	17 100	23 300	26 900	35 500	39 800	50 800	59 400
M10×1	64,5	14 500	20 000	18 100	24 500	28 400	37 400	41 900	53 500	62 700
M12×1,5	88,1	19 800	27 300	24 700	33 500	38 800	51 100	57 300	73 100	85 500
M12×1,25	92,1	20 700	28 600	25 800	35 000	40 500	53 400	59 900	76 400	89 300
M14×1,5	125	28 100	38 800	35 000	47 500	55 000	72 500	81 200	104 000	121 000
M16×1,5	167	37 600	51 800	46 800	63 500	73 500	96 900	109 000	139 000	162 000
M18×1,5	216	48 600	67 000	60 500	82 100	95 000	130 000	—	179 000	210 000
M20×1,5	272	61 200	84 300	76 200	103 000	120 000	163 000	—	226 000	264 000
M22×1,5	333	74 900	103 000	93 200	126 000	146 000	200 000	—	276 000	323 000
M24×2	384	86 400	119 000	108 000	146 000	169 000	230 000	—	319 000	372 000
M27×2	496	112 000	154 000	139 000	188 000	218 000	298 000	—	412 000	481 000
M30×2	621	140 000	192 000	174 000	236 000	273 000	373 000	—	515 000	602 000
M33×2	761	171 000	236 000	213 000	289 000	335 000	457 000	—	632 000	738 000
M36×3	865	195 000	268 000	242 000	329 000	381 000	519 000	—	718 000	839 000
M39×3	1 030	232 000	319 000	288 000	391 000	453 000	618 000	—	855 000	999 000

[a] To calculate $A_{s,nom}$, see 9.1.6.1.

Note: Clause 9.1.6.1 referred above is relevant to IS:1367(Pt 3)

3.4 Marking and identification of fasteners with full loadability

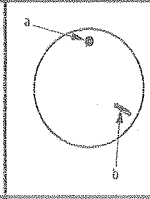
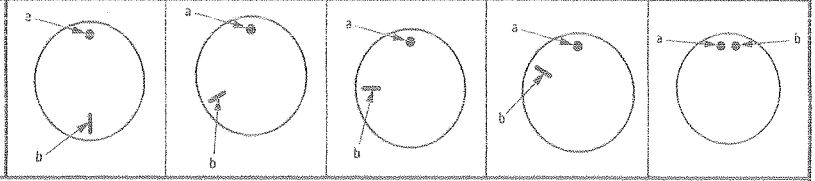
Marking of property classes and identification mark of manufacturer for the fasteners with full loadability shall be included during manufacturing process. Marking of property classes and identification mark of manufacturer shall be in accordance with Clause 10.3.2 to 10.3.4 of IS 1367(Pt 3). Examples of marking of property classes and identification mark of manufacturer for bolt, screw & stud has been shown in Table 3.8, 3.9, 3.10, Fig.- 3.1, 3.2, 3.3 respectively.

Table 3.8 - Property class marking of fasteners with full loadability

Property class	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9	12.9
Marking symbol[a]	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9	12

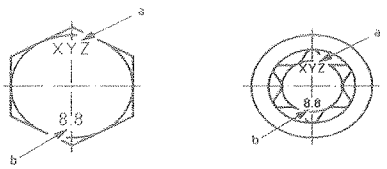
[a] The dot in the marking symbol may be omitted.

Table 3.9 - Clock face system for marking of bolts and screws with full loadability

Property class	4.6	4.8	5.6	5.8	
Marking symbol					
Property class	**6.8**	**8.8**	**9.8**	**10.9**	**12.9**
Marking symbol					

[a] The twelve o'clock position (reference mark) shall be marked either by the manufacturer's identification mark or by a dot.

[b] The property class is marked by a dash or a double dash and, in the case of 12.9, by a dot.



a - Manufacturer's identification mark
b - Property class symbol

Fig. 3.1- Examples of marking on hexagon & hexalobular head bolts and screws

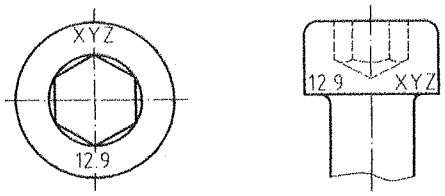


Fig. 3.2- Examples of marking on hexagon socket head cap screws

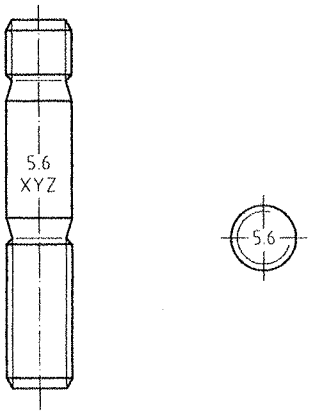


Fig. 3.3- Examples of marking of studs

Table 3.10 - Alternate marking symbols for studs

Property class	5.6	8.8	9.8	10.9	12.9
Marking symbol	—	○ [a]	+	□ [a]	△ [a]

[a] It is permissible to indent only the contour or the whole area of the symbol.

3.5 Product Grade (Tolerances)

IS 1367, Pt. 2(or ISO 4759-1) specifies a selection of tolerances for bolts, screws, studs and nuts with ISO metric threads and with product grades A, B and C and for tapping screws with product grade A.

The product grades refer to the size of the tolerances **where grade** A is **the most precise and grade C is the least precise.**

The tolerances, except tolerances for threads, are selected from the system of limits and fits specified in ISO 286-1 and ISO 286-2. The tolerances for metric threads are taken from the series of tolerance classes specified in ISO 965-3. The tolerances for tapping screw threads are covered in ISO 1478.
The tolerances of form and position are specified and indicated in accordance with ISO 1101, ISO 8015 and ISO 2692.

The tolerances specified in IS 1367, Pt. 2(or ISO 4759-1) apply to fasteners prior to coating unless otherwise specified.

Dimensional and Geometrical tolerances for bolts, screws, studs are given at Clause No. 3.1 & 3.2 of IS 1367(Pt-2). Dimensional and Geometrical tolerances for vital features are given at Table 3.11.

Dimensional and Geometrical tolerances for nuts are given at Clause No. 4.1 & 4.2 of IS 1367(Pt-2). Dimensional and Geometrical tolerances for vital features are given at Table 3.12.

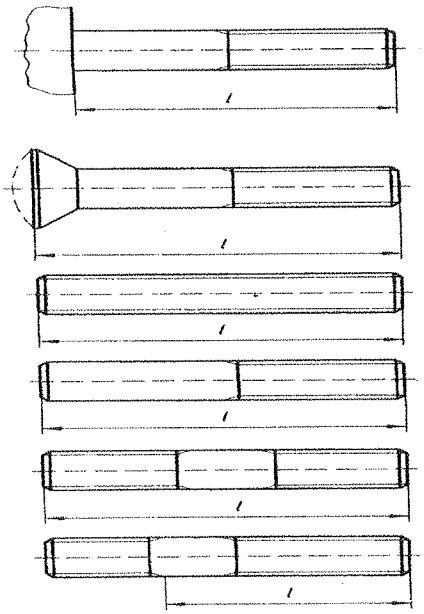
Dimensional and Geometrical tolerances for tapping screws are given at Clause No. 5.1 & 5.2 of IS 1367(Pt-2). Dimensional and Geometrical tolerances for vital features are given at Table 3.13.

Deviations from the tolerances specified in IS 1367, Pt. 2(or ISO 4759-1) are only permitted in product standards where there are valid technical reasons. In cases where there is a difference between the tolerance requirements in IS 1367, Pt. 2(or ISO 4759-1) and the product standard, the product standard takes precedence.

It is recommended that these tolerances also be used for non-standard fasteners.
Dimensions and tolerances given in IS 1367, Pt. 2(or ISO 4759-1) are in millimeters.

Values for Standard Tolerances(IT), Limits deviation for shaft & limit deviations for holes given at Table 3.14, 3.15 & 3.16 respectively.

Table- 3.11 Dimensional tolerances for bolts, screws, studs

Feature	Tolerance for product grades A	B	C	Notes
3.1.4.4 Length  Figure 20	js15	js17	$l \leq 150$: js17 $l > 150$: ± IT17	

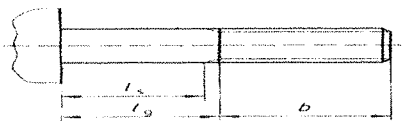
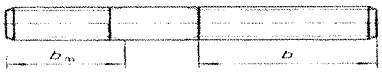
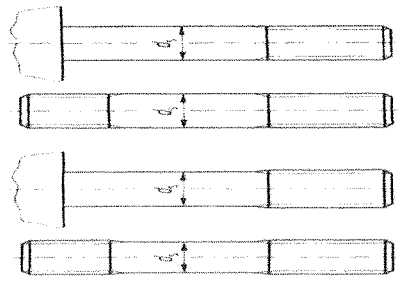
Feature	Tolerance for product grades A	B	C	Notes
3.1.4.5 Thread length Bolt  Tie rod  Stud  Figure 21	b^{+2P}_{0} b^{+2P}_{0} b^{+2P}_{0} b_m js16	b^{+2P}_{0} b^{+2P}_{0} b^{+2P}_{0} b_m js17	b^{+2P}_{0} b^{+2P}_{0} b^{+2P}_{0} b_m js17	P is the pitch of thread. l_s is the minimum length of the unthreaded (plain) shank. l_g is the maximum length of the unthreaded shank (thread run-out included) and is therefore the minimum clamping length. Tolerance + 2 P related to dimension b applies only where l_s and l_g are not specified in the product standard. b_m refers to metal end of studs only.
3.1.4.6 Shank diameter  Figure 22	h13	h14	± IT 15	The tolerance is not applicable in the areas of the underhead fillet and thread run-out.
	Reduced shank diameter ≈ pitch diameter			

Table- 3.12 Dimensional tolerances for Nuts

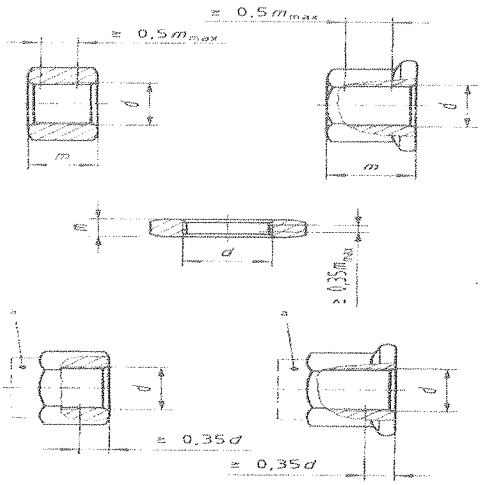
Feature	Tolerance for product grades A	B	C	Notes
4.1.1 Tolerance level				
Bearing surface	close	close	wide	
Other features	close	wide	wide	
4.1.2 Internal thread	6H	6H	7H	For certain products and coatings, other tolerance classes may be specified in the relevant product and coating standards.
 a Profile varies for different types of prevailing torque type nuts. Figure 58	For all nuts of heights $m \geq 0{,}8d$ the minor diameter shall be within the specified tolerances for a minimum of 0,5 m_{max} (only for sizes ≥ M3). For all nuts of heights $0{,}5d \leq m < 0{,}8d$ the minor diameter shall be within the specified tolerances for a minimum of 0,35 m_{max} For prevailing torque type nuts the minor diameter may exceed the specified tolerance for a maximum height of $0{,}35d$ from the non-restricted end which does not contain the prevailing torque feature.			

Table- 3.13 Dimensional tolerances for tapping screws

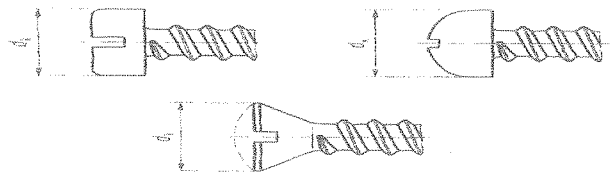
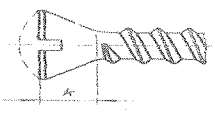
Feature	Tolerance	Notes
5.1.2.2.3 Cross recesses	See ISO 4757 for all dimensions except penetration depths. For penetration depths see appropriate product standard.	
5.1.2.3.4 Hexalobular recess	See ISO 10664 for all dimensions except penetration depths. For penetration depths see appropriate product standard.	
5.1.3 Other features 5.1.3.1 Head diameters  Figure 90	h14	Combined control of diameter and height for countersunk head screws as specified in ISO 7721.
5.1.3.2 Head height  Figure 91	h14	
 Figure 92	For countersunk head screws k is defined in product standards only as a maximum.	Combined control of diameter and height for countersunk head screws as specified in ISO 7721.

Table-3.14 Numerical values of standard tolerance grades IT for basic sizes up to 500 mm

Nominal dimension		Standard tolerance grades					
>	≤	IT12	IT13	IT14	IT15	IT16	IT17
		Tolerances					
	3	0,1	0,14	0,25	0,4	0,6	1
3	6	0,12	0,18	0,3	0,48	0,75	1,2
6	10	0,15	0,22	0,36	0,58	0,9	1,5
10	18	0,18	0,27	0,43	0,7	1,1	1,8
18	30	0,21	0,33	0,52	0,84	1,3	2,1
30	50	0,25	0,39	0,62	1	1,6	2,5
50	80	0,3	0,46	0,74	1,2	1,9	3
80	120	0,35	0,54	0,87	1,4	2,2	3,5
120	180	0,4	0,63	1	1,6	2,5	4
180	250	0,46	0,72	1,15	1,85	2,9	4,6
250	315	0,52	0,81	1,3	2,1	3,2	5,2
315	400	0,57	0,89	1,4	2,3	3,6	5,7
400	500	0,63	0,97	1,55	2,5	4	6,3

Table-3.15 Limit deviations for shaft

Nominal dimension		Limit deviations								
>	≤	h13	h14	h15	h16	h17	js14	js15	js16	js17
	3	0 − 0,14	0 − 0,25	0 − 0,4	0 − 0,6	0 − 1	± 0,125	± 0,2	± 0,3	± 0,5
3	6	0 − 0,18	0 − 0,3	0 − 0,48	0 − 0,75	0 − 1,2	± 0,15	± 0,24	± 0,375	± 0,6
6	10	0 − 0,22	0 − 0,36	0 − 0,58	0 − 0,9	0 − 1,5	± 0,18	± 0,29	± 0,45	± 0,75
10	18	0 − 0,27	0 − 0,43	0 − 0,7	0 − 1,1	0 − 1,8	± 0,215	± 0,35	± 0,55	± 0,9
18	30	0 − 0,33	0 − 0,52	0 − 0,84	0 − 1,3	0 − 2,1	± 0,26	± 0,42	± 0,65	± 1,05
30	50	0 − 0,39	0 − 0,62	0 − 1	0 − 1,6	0 − 2,5	± 0,31	± 0,5	± 0,8	± 1,25
50	80	0 − 0,46	0 − 0,74	0 − 1,2	0 − 1,9	0 − 3,0	± 0,37	± 0,6	± 0,95	± 1,5
80	120	0 − 0,54	0 − 0,87	0 − 1,4	0 − 2,2	0 − 3,5	± 0,435	± 0,7	± 1,1	± 1,75
120	180	0 − 0,63	0 − 1	0 − 1,6	0 − 2,5	0 − 4	± 0,5	± 0,8	± 1,25	± 2
180	250	0 − 0,72	0 − 1,15	0 − 1,85	0 − 2,9	0 − 4,6	± 0,575	± 0,925	± 1,45	± 2,3
250	315	0 − 0,81	0 − 1,3	0 − 2,1	0 − 3,2	0 − 5,2	± 0,65	± 1,05	± 1,6	± 2,6
315	400	0 − 0,89	0 − 1,4	0 − 2,3	0 − 3,6	0 − 5,7	± 0,7	± 1,15	± 1,8	± 2,85
400	500	0 − 0,97	0 − 1,55	0 − 2,5	0 − 4	0 − 6,3	± 0,775	± 1,25	± 2	± 3,15

Table-3.16 Limit deviations for holes

Nominal dimension		Limit deviations												
>	≤	C13	C14	D9	D10	D11	D12	EF8	11	E12	H14	H15	JS9	K9
	3	+ 0,2 + 0,06	+ 0,31 +0,06	+ 0,045 + 0,02	+ 0,06 + 0,02	+ 0,08 + 0,02	+ 0,12 + 0,02	+ 0,024 + 0,01	+ 0,074 + 0,014	+ 0,114 + 0,014	+ 0,25 0	+ 0,4 0	± 0,012 5	0 – 0,025
3	6	+ 0,25 + 0,07	+ 0,37 + 0,07	+ 0,06 + 0,03	+ 0,078 + 0,03	+ 0,105 + 0,03	+ 0,15 + 0,03	+ 0,032 + 0,014	+ 0,095 + 0,02	+ 0,14 + 0,02	+ 0,3 0	+ 0,48 0	± 0,015	0 – 0,03
6	10					+ 0,13 + 0,04	+ 0,19 + 0,04	+ 0,04 + 0,018	+ 0,115 + 0,025	+ 0,175 + 0,025	+ 0,36 0	+ 0,58 0	± 0,018	0 – 0,036
10	18						+ 0,23 + 0,05		+ 0,142 + 0,032	+ 0,212 + 0,032	+ 0,43 0	+ 0,7 0		
18	30						+ 0,275 + 0,065				+ 0,52 0	+ 0,84 0		
30	50						+ 0,33 + 0,08				+ 0,62 0	+ 1 0		
50	80						+ 0,4 + 0,1				+ 0,74 0	+ 1,2 0		
80	120						+ 0,47 + 0,12				+ 0,87 0	+ 1,4 0		
120	180										+ 1 0	+ 1,6 0		
180	250										+ 1,15 0	+ 1,85 0		
250	315										+ 1,3 0	+ 2,1 0		
315	400										+ 1,4 0	+ 2,3 0		
400	500										+ 1,55 0	+ 2,5 0		

Chapter 4 : Description of Nuts

4.1 Designation of nut styles

ISO 898-2 and IS 1367(Pt 6) specifies requirements for three styles of nuts according to their height:

— style 2: high nut with minimum height *m*min ≈ 0,9*D* or *m*min > 0,9*D*;

— style 1: regular nut with minimum height *m*min ≥ 0,8*D*;

— style 0: thin nut with minimum height 0,45*D* ≤ *m*min < 0,8*D*.

4.2 Designation of property classes of Nut

- **Regular nuts (style 1) and high nuts (style 2)**

The symbol for property classes of regular nuts (style 1) and high nuts (style 2) consists of one number. It corresponds to the number to the left of the appropriate maximum property class of bolts, screws and studs with which they can be mated.

- **Thin nuts (style 0)**

The symbol for property classes of thin nuts (style 0) consists of two numbers, specified in the following ways:

a) The first number is zero, indicating that the loadability of the nut is reduced in comparison with the loadability of a regular nut or a high nut according to 4.2.2 of IS 1367-6 and therefore thread stripping can occur when overloaded;

b) The second number corresponds to 1/100 of the nominal stress under proof load on a hardened test mandrel, in megapascals.

4.3 Design of bolt and nut assemblies

Regular nuts (style 1) and high nuts (style 2) shall be mated with externally threaded fasteners according to Table-3.2. However, nuts of a higher property class may replace nuts of a lower property class.

Table 4.1 - Combination of regular nuts (style 1) and high nuts (style 2) with bolt property classes

Table 4.1- Mating property class of Nut & Bolt, screw and stud

Nut property class	Maximum property class of mating bolt, screw and stud
5	5.8
6	6.8
8	8.8
9	9.8
10	10.9
12	12.9/12.9

4.4 Materials for Nut

Table 4.2 specifies materials and heat treatment for the different property classes of nuts. Nuts with coarse thread and property classes 05, 8 [regular nuts (style 1) with D > M16], 10 and 12 shall be quenched and tempered. Nuts with fine pitch thread and property classes 05, 6 (with D > M16), 8 [regular nuts (style 1)], 10 and 12 shall be quenched and tempered. The chemical composition shall be assessed in accordance with the relevant International Standards.

Table 4.2 – Material and chemical composition

Thread	Property class		Material and nut heat treatment	Chemical composition limit (cast analysis %)[a]			
				C max.	Mn min.	P max.	S max.
Coarse thread	04[c]		Carbon steel[d]	0,58	0,25	0,060	0,150
	05[c]		Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	5[b]		Carbon steel[d]	0,58	—	0,060	0,150
	6[b]		Carbon steel[d]	0,58	—	0,060	0,150
	8	High nut (style 2)	Carbon steel[d]	0,58	0,25	0,060	0,150
	8	Regular nut (style 1) $D \leq$ M16	Carbon steel[d]	0,58	0,25	0,060	0,150
	8[c]	Regular nut (style 1) $D >$ M16	Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	9		Carbon steel[d]	0,58	0,25	0,060	0,150
	10[c]		Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	12[c]		Carbon steel, QT[e]	0,58	0,45	0,048	0,058
Fine pitch thread	04[b]		Carbon steel[d]	0,58	0,25	0,060	0,150
	05[c]		Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	5[b]		Carbon steel[d]	0,58	—	0,060	0,150
	6[b]	$D \leq$ M16	Carbon steel[d]	0,58	—	0,060	0,150
	6[b]	$D >$ M16	Carbon steel; QT[e]	0,58	0,30	0,048	0,058
	8	High nut (style 2)	Carbon steel[d]	0,58	0,25	0,060	0,150
	8[c]	Regular nut (style 1)	Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	10[c]		Carbon steel, QT[e]	0,58	0,30	0,048	0,058
	12[c]		Carbon steel, QT[e]	0,58	0,45	0,048	0,058

QT = Quenched and tempered nuts.

"—" No limit specified.

[a] In case of dispute, the product analysis applies.

[b] Nuts of these property classes may be manufactured from free-cutting steel upon agreement between the purchaser and the manufacturer; in such a case, sulfur, phosphorus and lead are permissible with the following maximum contents: S: 0,34 %; P: 0,11 %; Pb: 0,35%.

[c] Alloying elements may be added, provided the mechanical properties required in Clause 7 are fulfilled.

[d] This may be quenched and tempered at the manufacturer's discretion.

[e] For materials of these property classes, there shall be sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the "as-hardened" condition before tempering in the threaded area of the nut as specified in Figure 3.

Note: Clause 7 & Figure 3 referred above are relevant to IS 1367(Pt 6).

4.5 Mechanical properties

When tested by the methods specified in Clause 9 of IS 1367(Pt 6), the nuts of the specified property class shall meet, at ambient temperature, the requirements for the proof load, Tables 4.3 & 4.4 and for the hardness, Tables 4.5 & 4.6, regardless of which tests are performed during manufacturing or final inspection.

Table 4.3 – Proof load values for nuts with course thread

Thread D	Pitch P	Proof load [a], N Property class							
		04	05	5	6	8	9	10	12
M5	0,8	5 400	7 100	8 250	9 500	12 140	13 000	14 800	16 300
M6	1	7 640	10 000	11 700	13 500	17 200	18 400	20 900	23 100
M7	1	11 000	14 500	16 800	19 400	24 700	26 400	30 100	33 200
M8	1,25	13 900	18 300	21 600	24 900	31 800	34 400	38 100	42 500
M10	1,5	22 000	29 000	34 200	39 400	50 500	54 500	60 300	67 300
M12	1,75	32 000	42 200	51 400	59 000	74 200	80 100	88 500	100 300
M14	2	43 700	57 500	70 200	80 500	101 200	109 300	120 800	136 900
M16	2	59 700	78 500	95 800	109 900	138 200	149 200	164 900	186 800
M18	2,5	73 000	96 000	121 000	138 200	176 600	176 600	203 500	230 400
M20	2,5	93 100	122 500	154 400	176 400	225 400	225 400	259 700	294 000
M22	2,5	115 100	151 500	190 900	218 200	278 800	278 800	321 200	363 600
M24	3	134 100	176 500	222 400	254 200	324 800	324 800	374 200	423 600
M27	3	174 400	229 500	289 200	330 500	422 300	422 300	486 500	550 800
M30	3,5	213 200	280 500	353 400	403 900	516 100	516 100	594 700	673 200
M33	3,5	263 700	347 000	437 200	499 700	638 500	638 500	735 600	832 800
M36	4	310 500	408 500	514 700	588 200	751 600	751 600	866 000	980 400
M39	4	370 900	488 000	614 900	702 700	897 900	897 900	1 035 000	1 171 000

[a] For the application of thin nuts, it should be considered that the stripping load is lower than the proof load of a nut with full loadability (see Annex A).

Table 4.4 – Proof load values for nuts with fine pitch thread

Thread $D \times P$	Proof load [a], N Property class						
	04	05	5	6	8	10	12
M8×1	14 900	19 600	27 000	30 200	37 400	43 100	47 000
M10×1,25	23 300	30 600	44 200	47 100	58 400	67 300	73 400
M10×1	24 500	32 200	44 500	49 700	61 600	71 000	77 400
M12×1,5	33 500	44 000	60 800	68 700	84 100	97 800	105 700
M12×1,25	35 000	46 000	63 500	71 800	88 000	102 200	110 500
M14×1,5	47 500	62 500	86 300	97 500	119 400	138 800	150 000
M16×1,5	63 500	83 500	115 200	130 300	159 500	185 400	200 400
M18×2	77 500	102 000	146 900	177 500	210 100	220 300	—
M18×1,5	81 700	107 500	154 800	187 000	221 500	232 200	—
M20×2	98 000	129 000	185 800	224 500	265 700	278 600	—
M20×1,5	103 400	136 000	195 800	236 600	280 200	293 800	—
M22×2	120 800	159 000	229 000	276 700	327 500	343 400	—
M22×1,5	126 500	166 500	239 800	289 700	343 000	359 600	—
M24×2	145 900	192 000	276 500	334 100	395 500	414 700	—
M27×2	188 500	248 000	351 100	431 500	510 900	535 700	—
M30×2	236 000	310 500	447 100	540 300	639 600	670 700	—
M33×2	289 200	380 500	547 900	662 100	783 800	821 900	—
M36×3	328 700	432 500	622 800	804 400	942 800	934 200	—
M39×3	391 400	515 000	741 600	957 900	1 123 000	1 112 000	—

[a] For the application of thin nuts, it should be considered that the stripping load is lower than the proof load of a nut with full loadability, see Annex A.

Table 4.5 – Hardness properties for nuts with course thread

Thread D	Property class															
	04		05		5		6		8		9		10		12	
	Vickers hardness, HV															
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M5 ≤ D ≤ M16	188	302	272	353	130	302	150	302	200	302	188	302	272	353	295[c]	353
M16 < D ≤ M39					146		170		233[a]	353[b]					272	
	Brinell hardness, HB															
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M5 ≤ D ≤ M16	179	287	259	336	124	287	143	287	190	287	179	287	259	336	280[c]	336
M16 < D ≤ M39					139		162		221[a]	336[b]					259	
	Rockwell hardness, HRC															
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M5 ≤ D ≤ M16	—	30	26	36	—	30	—	30	—	30	—	30	26	36	29[c]	36
M16 < D ≤ M39									—	36[b]					26	
Surface integrity shall be in accordance with ISO 6157-2.																
Vickers hardness test is the reference method for acceptance (see 9.2.4).																
[a] Minimum value for high nuts (style 2): 180 HV (171 HB).																
[b] Maximum value for high nuts (style 2): 302 HV (287 HB; 30 HRC).																
[c] Minimum value for high nuts (style 2): 272 HV (259 HB; 26 HRC).																

Table 4.6 – Hardness properties for nuts with fine pitch thread

Thread $D \times P$	Property class													
	04		05		5		6		8		10		12	
	Vickers hardness, HV													
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M8×1 ≤ D ≤ M16×1,5	188	302	272	353	175	302	188	302	250[a]	353[b]	295[c]	353	295	353
M16×1,5 < D ≤ M39×3					190		233		295	353	260		—	—
	Brinell hardness, HB													
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M8×1 ≤ D ≤ M16×1,5	179	287	259	336	166	287	179	287	238[a]	336[b]	280[c]	336	280	336
M16×1,5 < D ≤ M39×3					181		221		280	336	247		—	—
	Rockwell hardness, HRC													
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
M8×1 ≤ D ≤ M16×1,5	—	30	26	36	—	30	—	30	22,2[a]	36[b]	29[c]	36	29	36
M16×1,5 < D ≤ M39×3					—		—		29,2	36	24		—	—
Surface integrity shall be in accordance with ISO 6157-2.														
The Vickers hardness test is the reference method for acceptance (see 9.2.4).														
[a] Minimum value for high nuts (style 2): 195 HV (185 HB).														
[b] Maximum value for high nuts (style 2): 302 HV (287 HB; 30 HRC).														
[c] Minimum value for high nuts (style 2): 250 HV (238 HB; 22,2 HRC).														

Note: Clause 9.2.4 referred above is relevant to IS:1367(Pt 6)

Prepared by	Checked by	Issued by

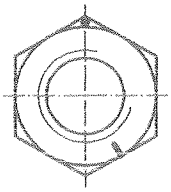
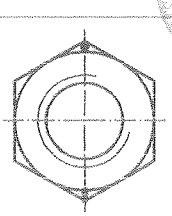
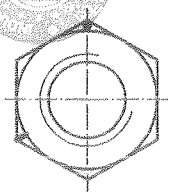
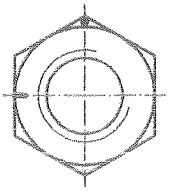
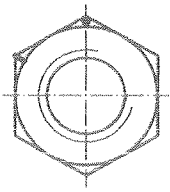
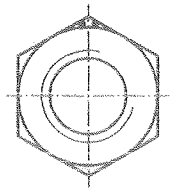
4.6 Marking of property classes on Nuts

The marking symbol in accordance with 10.3.2 to 10.5 of IS 1367(Pt 6) shall be embossed or indented, during the manufacturing process, on all nuts manufactured to the requirements of ISO 898-2 or IS 1367(Pt 6).

Regular nuts (style 1) and high nuts (style 2)

The marking symbols for property classes for regular nuts (style 1) and high nuts (style 2) are specified in the second row of Table 4.7. In the case of small nuts or where the shape of the nut does not allow that marking, the clock face marking symbols given in the third row of Table 4.7 shall be used.

Table 4.7 Marking symbols of property classes for regular nuts(style 1) and high nuts(style 2)

Property class designation symbol	5	6	8	9	10	12
Marking symbol	5	6	8	9	10	12
Alternative clock face marking symbol[a]						

[a] The twelve o'clock position (reference mark) shall be marked either by the identification mark of the manufacturer or by a dot.

Thin Nuts(style 0)

Marking symbols for property classes for thin nuts(style 0) are specified in Table 4.8

Table 4.8
Marking symbols of property classes for Thin nuts(style 0)

Property class	04	05
Marking symbol	04	05

4.7 Identification of Marking of Nuts

Identification of marking has been indicated in Fig 4.1 & 4.2.

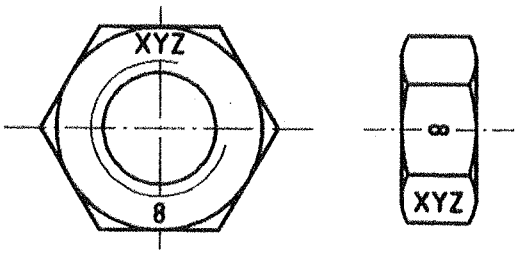
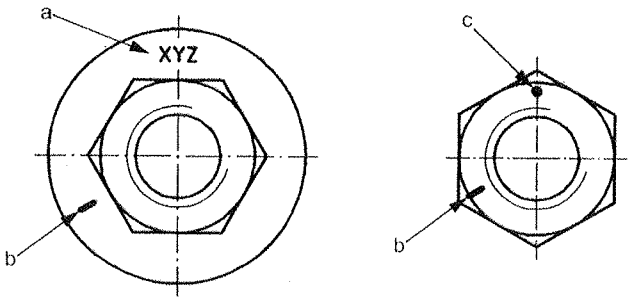


Fig 4.1- Examples of marking symbols



a - Identification mark of the manufacturer
b – Property class
c- The dot may be replaced by the identification mark of the manufacturer

Fig 4.2 – Examples of marking with clock face system(alternative marking)

4.8 Lock nuts

4.8.1 Principle of Locknuts:

Locknuts are a type of prevailing-torque fastener that resists loosening under vibration and torque. They differ from standard nuts because they typically have friction-increasing bearing surfaces (e.g., pitted grooves on flanges) or special internal thread-geometries.

4.8.2 Types of Locknuts

a) Nylock Nuts

b) All metal locknuts

Nylock nuts

Differ from a standard hex nut in that they have a nylon insert secured within the nut. The nylon insert is located in a tapered section located at the back of the nut. When you install the nylon lock nut onto a bolt or threaded stud, the nylon insert wraps around the threads and locks the nut in place. This gives a nylon lock nut a distinct advantage over a lock washer when the bolt or threaded stud is subject to vibration, as the nylon lock nut is unaffected by vibration.

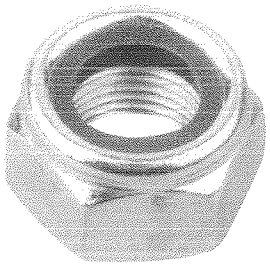


Fig 4.3 – Photo of Nyloc nut

All metal locknuts

All Metal Hex Lock Nuts are designed to increase the resistance to rotation by developing a "prevailing torque" between the bolt (or stud) threads and the threads in the nut. This prevailing torque is developed by "crimping" the nut to create added friction between the threads of the nut and the threads of the bolt. This design features a crowned top that is crimped to create the locking feature. This crowned top design is commonly called a "stover" style lock nut. The style of the locking crimp may be either oval shaped or triangular shaped

(tri-crimp) depending on the size. Both styles of crimps provide the same locking ability and resistance to loosening in high vibration applications.

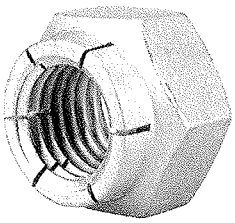


Fig 4.4 - All metal locknut

All metal lock nuts are of two types

i) Single piece metal nuts(Type V)

Single piece metal nuts are nuts without an insert in which increased friction is created by appropriate deformation or the prevailing torque element of the nut.

ii) Two Piece metal nuts with metal prevailing torque element(Type M)

Two piece metal nuts are nuts in which increased friction is created by an additional metal element inserted in the prevailing torque element of the nut. This type does not have full loadability.

4.9 Quantity of All steel Lock nuts in 3-Ph locomotives

In WAP7 / WAG9 loco there are many locations where All steel FS lock nuts have been used. These are being procured from CLW approved sources. Provision of All steel FS Lock nuts in these locomotives is given in Table-4.9.

Table 4.9- Quantity of All steel lock nuts in 3-Ph Locos

Sl. No.	Size of Lock Nut	WAP7 Qty(in nos.)	WAP5 Qty.(in no.)
1.	M-10	64	-
2.	M-12	12	16
3.	M-16	142	162
4.	M-20	56	72
5.	M-24	120	40

4.10 Tightening Torque and its use on Locomotives

As per data available for recommended torque from OEM, as per the size of the nuts are given in Table 4.10 for bolts of property class 8.8 in 3-ph electric locomotives:

Table 4.10 – Tightening Torque for Nuts

S. No.	Size of steel locknut	Location of Nut	Value of Tightening Torque (NM)	
			* 'M' Type (Property class 8)	* 'V' Type (Property class 10)
1.	M-10	Sanders	50	44
2.	M-12	Brake shoe Adjuster	86	77
3.	M-16	Horizontal Damper	215	190
		Vertical Damper		
		Axle Damper		
		Slack Adjuster		
		Cow Catcher		
4.	M-20	Yaw Damper	430	370
		TBU/PBU		
		Traction Bar		
5.	M-24	Wheel Set Guide	735	640
		Neck down bolt		
		Torque Arm		
		Brake Hanger		
		Hanger Slave side		
		Brake Rod		

* Note: These torque values are as recommended by respective OEMs.

Zonal Railways and PUs should tighten the nut at recommended torque as given in table above to ensure proper locking as recommended by OEM.

4.11 Committee Report on 'Use of All steel FS lock nut'

Three members committee report no. RDSO/2011/EL/IR/0150(Rev. '0') dt. 16.08.2012 on 'Use of All steel FS lock nut' had recommended following action:

1) As per RDSO"s SMI 251 and 259 the brake hanger mounting FS lock nut and Traction link FS lock nut should be used only once. Axle guide rod nut also should not be reused being a critical application. Hence for above three

applications FS lock nut should not be reused. It must be replaced with new nut every time it is opened.

2) For All steel FS nuts being used in other locations the replacement cycle should be kept as IOH or POH. New nut should invariably be used during IOH. For intermediate schedule/un-schedule lifting/attention, it may be reused depending upon its condition.

3) While reusing old FS lock nut it should be checked as *"It is mentioned in Carroll Smith"s book " In most applications the rule of thumb is: If there is no visible damage to the thread and you cannot spin the nut with your fingers, it is OK to reuse it obviously this is not true in the case of critical tension applications which require high tensile nuts. I do not reuse critical nuts, locking or not. In my world this includes all connecting rod and most cylinder head and main bearing Caps nuts." Though the guideline is for nylock nut, the same can be applied in FS lock nut also."* If there is no visible damage to the thread and you cannot spin the lock nut with your normal hand application, it is OK to reuse in non-critical locations.

4) The details of location and replacement cycle of Lock nut for WAP-7/WAG-9 will be as below:-

SL. No.	Size of steel Lock Nut	Location of Nut	Qty(in no.)	Replacement cycle
1.	M-10	Sanders(08)	64	IOH
2.	M-12	Brake shoe Adjuster	12	POH
3.	M-16	Horizontal Damper	16	IOH
		Vertical Damper	08	IOH
		Axle Damper	36	IOH
		Slack Adjuster	24	IOH
		Cow Catcher	58	POH
		In case of damage during cattle run over it should be replaced		
4.	M-20	Yaw damper	08	IOH
		TBU/PBU	24	IOH
		Traction Bar	24	Single use
5.	M-24	Wheel set guide rod	24	Single use
		Neck down bolt	24	Single use
		Torque Arm	24	Single use
		Brake hanger	12	Single use
		Hanger Slave side	12	Single use
		Brake rod	24	Single use

5) The details of location and replacement cycle of lock nut for WAP5 will be as below:

SL. No.	Size of steel Lock Nut	Location of Nut	Qty(in no.)	Replacement cycle
1.	M-12	TM Damper	16	IOH
2.	M-16	Horizontal Damper	16	IOH
		Vertical Damper	08	IOH
		Axle Damper	16	IOH
		Brake Disc Bolt	64	POH
		Cow Catcher	58	POH
		In case of damage during cattle run over it should be replaced		
3.	M-20	Yaw damper	16	IOH
		Wheel set guide rod	32	Single use
		Traction Bar	24	Single use
4.	M-24	Gear Box Torque Arm	16	Single use
		Traction motor	24	Single use

6) For the use of M type or V type FS lock nut, the matter has been examined. The technology used for gripping the bolt threads of M type lock nut is satisfactory and there is no failure report due to bad quality of M type FS lock nut. There is no problem of availability also. The catalog of manufacturer is enclosed. The existing practice of using M type all steel FS lock nut as per CLW approved vendor list may continue to be followed.

4.12 Testing of Locknuts

Inspection & testing of Lock nuts may be carried out as per Clause 8 & 9 of IS:1367(Pt.6). Further, acceptance inspection procedure has been elaborated at Para 3.7 of this report and shall be conducted accordingly.

4.13 Causes of loosening of threaded fasteners

The fastener that loosens and falls off has failed as completely as if it had ruptured. A bolt or stud that is strong enough to carry its service load when tight may fall from fatigue if the joint loosens enough to rattle or even if some of the initial clamping force is lost. In fact, in the case of pre-stressed joint failure has occurred as soon as the pre-stress is lost which may be a long time before the bolt rattles.

It is well known that nuts and bolts tend to loosen if the machines they fasten are subjected to vibration or repeated impacts. A generally accepted theory explains how motion of the fastened parts can cause turning of a nut on a bolt. Tightened fasteners loosen for a variety of reasons- shock, vibration, inadequate installation torque, wear between parts, bolt stretch and the ever present human error. To sum up the theory of loosening of fasteners-

i) An analysis of large volumes of vibration test results has provided the substantial basis for a valid casual theory of loosening.

ii) Tightened fasteners on parts subjected to repeated shocks undergo a gradual reduction of bolt tension. This is probably a result of wear at important surfaces induced by vibrations of the fasteners them-selves. When bolt tension has dropped to a critical level in relation to vibration intensity, the nut begins to turn.

iii) For a given type of fastener system, the factors that promote loosening are vibration intensity and total number of impacts.

Chapter: 5 Inspection and Testing

5.1 Applicability of Test methods

Two main groups of test series are established for testing the mechanical & physical properties of fasteners specified in Table 3.3. Group FF is used for testing finished fasteners, group MP is used for testing material properties of the fasteners. The two groups are divided into test series FF1, FF2, FF3 & FF4 and MP1 & MP2 respectively for different type of fasteners. However, not all mechanical & physical properties specified in Table 3.3 can be tested on all types or sizes of fasteners due primarily to dimensional and/or loadability reasons.

5.2 Manufacturer's test/inspection

Fasteners produced in accordance with ISO 898/IS: 1367 shall be capable of conforming to all applicable requirements of Table 3.3 to 3.7 when using the feasible tests specified in Tables 5.1 to 5.4.
In case of dispute, the test methods in accordance with Clause 9 of IS: 1367- Pt 3) shall apply.

5.3 Suppliers test/ inspection

Suppliers may test the fasteners they provide using the methods of their choice, provided the mechanical and physical properties specified in Table 3.3 to 3.7 are met.
In case of dispute, the test methods in accordance with Clause 9 of IS: 1367- Pt 3) shall apply.

5.4 Purchaser's test/ inspection

Purchaser may test the delivered fasteners by the test methods given in Clause 9 of IS: 1363 Pt. 3 using test selected from the relevant test series given in 8.6 of IS: 1363 Pt. 3.
In case of dispute, the test methods in accordance with Clause 9 of IS: 1367- Pt 3) shall apply.

5.5 Feasible tests for groups of fasteners and machined test pieces

The applicability of test series FF1 to FF4 and MP1 to MP2 using the test methods described in Clause 9 of IS:1367 pt. 3 is specified in Table 5.1 to 5.6.

5.5.1 Test series FF1 to FF4 in accordance with Table 5.1 to 5.4 are provided for testing of finished fasteners:

- FF1: These are tests for the determination of the properties of finished bolts and screws with full head strength and full or reduced shank(full loadability), $d_s > d_2$ or $d_s \approx d_2$.
  These Tests are given in Table **5.1**

- FF2: These are tests for the determination of the properties of finished studs with full or reduced shank(full loadability), $d_s > d_2$ or $d_s \approx d_2$.
  These Tests are given in Table **5.2**

- FF3: These are tests for the determination of the properties of finished bolts and screws with $d_s > d_2$ or $d_s \approx d_2$ and reduced loadability due to
  i) low head with or without external driving feature
  ii) low round head or low cyclindrical head with internal driving feature, or
  iii) countersunk head with internal driving feature
  These Tests are given in Table **5.3**

- FF3: These are tests for the determination of the properties of finished bolts, screws and studs especially dfesigned for applications where the full loadability in accordance with ISO 898/IS:1367 is not required or not desired, eg. Fasteners with waisted shank(reduced loadability), $d_s < d_2$
  These Tests are given in Table **5.4**

5.5.2 Test series MP1 and MP2 in accordance with Tables 5.5 & 5.6 are provided for testing the material properties of fasteners and/or for process development. Test series. Test series FF1 to FF4 may also be used for that purpose.

- MP1: These are tests for the determination of the material properties of fasteners and/or for process development using machined test pieces.
  These Tests are given in Table **5.5**

- MP2: These are tests for the determination of the material properties of fasteners with full loadability , $d_s \approx d_2$ or $d_s > d_2$, and/or for process development
  These Tests are given in Table **5.6**

Table 5.1- Test series FF1 - Finished bolt & screws with full loadability

Property		Test method		Property class			
				4.6, 4.8, 5.6, 5.8, 6.8		8.8, 9.8, 10.9, 12.9/12.9	
No. (see Table 3)			Subclause	$d < 3$ mm or $l < 2{,}5d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l \geq 2{,}5d$ and $b \geq 2{,}0d$	$d < 3$ mm or $l < 2{,}5d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l \geq 2{,}5d$ and $b \geq 2{,}0d$
1	Minimum tensile strength, $R_{m,min}$	Tensile test under wedge loading	9.1	NF	a	NF	a
		Tensile test	9.2	NF	a	NF	a
5	Nominal stress under proof load, $S_{p,nom}$	Proof load test	9.6	NF		NF	
8	Minimum elongation after fracture, $A_{f,min}$	Tensile test for full-size fasteners	9.3	NF	bd cd	NF	bd
9	Head soundness	Head soundness test $d \leq 10$ mm	9.8				
		$1{,}5d \leq l < 3d$					
		$l \geq 3d$					
10 or 11 or 12	Hardness	Hardness test	9.9				
13	Maximum surface hardness	Carburization test	9.11	NF	NF		
14	Non-carburization			NF	NF		
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF		
16	Reduction of hardness after retempering	Retempering test	9.12	NF	NF	e	e
17	Minimum breaking torque, $M_{B,min}$	Torsional test 1,6 mm $\leq d \leq$ 10 mm, $b \geq 1d + 2P$[f]	9.13	g	gh		h
19	Surface integrity	Surface discontinuity inspection	9.15				

a For fasteners with $d \geq 3$ mm, $l \geq 2d$ and $b < 2d$, see 9.1.5 and 9.2.5.

b Values for property classes 4.6, 5.6, 8.8 and 10.9 are given in Annex C.

c For property classes 4.8, 5.8 and 6.8.

d $l \geq 2{,}7d$ and $b \geq 2{,}2d$.

e This test is a reference test to be applied in case of dispute.

f For the torsional test, these specific dimensional limits apply instead of the limits specified in the header of this table.

g For property classes 4.6 to 6.8, no values are specified in ISO 898-7.

h May be used instead of tensile test; however, in case of dispute the tensile test applies.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, the test shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

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Table 5.2- Test series FF2 - Finished studs with full loadability

Property		Test method		Property class			
				4.6, 4.8, 5.6, 5.8, 6.8		8.8, 9.8, 10.9, 12.9/12.9	
No. (see Table 3)			Subclause	$d < 3$ mm or $l_t < 3d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l_t \geq 3d$ and $b \geq 2{,}0d$	$d < 3$ mm or $l_t < 3d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l_t \geq 3d$ and $b \geq 2{,}0d$
1	Minimum tensile strength, $R_{m,min}$	Tensile test	9.2	NF	a	NF	a
5	Nominal stress under proof load, $S_{p,nom}$	Proof load test	9.6	NF		NF	
8	Minimum elongation after fracture, $A_{f,min}$	Tensile test for full-size fasteners	9.3	NF	bc bd	NF	bc
10 or 11 or 12	Hardness	Hardness test	9.9				
13	Maximum surface hardness	Carburization test	9.11	NF	NF		
14	Non-carburization			NF	NF		
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF		
16	Reduction of hardness after retempering	Retempering test	9.12	NF	NF	e	e
19	Surface integrity	Surface discontinuity inspection	9.15				

a If fracture occurs in the threaded length of the stud (metal) end, b_m, minimum hardness applies instead of $R_{m,min}$. Alternatively, the tensile strength R_m using machined test pieces in accordance with 9.7 may be determined.

b $l_t \geq 3{,}2d$, $b \geq 2{,}2d$.

c Values for property classes 4.6, 5.6, 8.8 and 10.9 are given in Annex C.

d For property classes 4.8, 5.8 and 6.8.

e This test is a reference test to be applied in case of dispute.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, the test shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

Prepared by	Checked by	Issued by

Table 5.3- Test series FF3 - Finished screws with reduced loadability due to head design

Property		Test method		Property class			
				4.6, 4.8, 5.6, 5.8, 6.8		8.8, 9.8, 10.9, 12.9/12.9	
No. (see Table 3)			Subclause	$d < 3$ mm or $l < 2{,}5d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l \geq 2{,}5d$ and $b \geq 2{,}0d$	$d < 3$ mm or $l < 2{,}5d$ or $b < 2{,}0d$	$d \geq 3$ mm and $l \geq 2{,}5d$ and $b \geq 2{,}0d$
a	Minimum ultimate tensile load	Tensile test for screws which do not break in the free threaded length due to head design	9.4	NF	a	NF	a
10 or 11 or 12	Hardness	Hardness test	9.9				
13	Maximum surface hardness	Carburization test	9.11	NF	NF		
14	Non-carburization			NF	NF		
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF		
16	Reduction of hardness after retempering	Retempering test	9.12	NF	NF	b	b
19	Surface integrity	Surface discontinuity inspection	9.15				

a See relevant product standard for minimum ultimate tensile load.

b This test is a reference test to be applied in case of dispute.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out, either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

Table 5.4- Test series FF4 - Finished bolts, screws & studs with reduced loadability due to shank design(eg. waisted shank)

Property		Test method		Property class			
				4.6, 5.6		8.8, 9.8, 10.9, 12.9/12.9	
No. (see Table 3)			Subclause	$d < 3$ mm or waist length $<3d_s$ or $b < d$	$d \geq 3$ mm and waist length $\geq 3d_s$ and $b \geq d$	$d < 3$ mm or waist length $<3d_s$ or $b < d$	$d \geq 3$ mm and waist length $\geq 3d_s$ and $b \geq d$
1	Minimum tensile strength, $R_{m,min}$	Tensile test for bolts and studs with waisted shank	9.5	NF	a	NF	a
10 or 11 or 12	Hardness	Hardness test	9.9				
13	Maximum surface hardness	Carburization test	9.11	NF	NF		
14	Non-carburization			NF	NF		
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF		
16	Reduction of hardness after retempering	Retempering test	9.12	NF	NF	b	b
19	Surface integrity	Surface discontinuity inspection	9.15				

a R_m is related to the cross-sectional area of the waisted shank, $A_{ds} = \frac{\pi}{4} d_s^2$.

b This test is a reference test to be applied in case of dispute.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out, either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

Table 5.5-Test series MP1 - Material properties determined on machined test pieces

No. (see Table 3)	Property	Test method	Sub-clause	Property class: 4.6, 5.6 — $3 \le d < 4{,}5$ mm and $d_0 < d_{3,min}$ and $b \ge d$ and $l \ge 6{,}5d$[a]	Property class: 4.6, 5.6 — $d \ge 4{,}5$ mm and $d_0 \ge 3$ mm and $b \ge d$ and $l \ge d + 26$ mm[a]	Property class: 8.8, 9.8, 10.9, 12.9/12.9 — $3 \le d < 4{,}5$ mm and $d_0 < d_{3,min}$ and $b \ge d$ and $l \ge 6{,}5d$ abc	Property class: 8.8, 9.8, 10.9, 12.9/12.9 — $4{,}5 \le d \le 16$ mm and $d_0 \ge 3$ mm and $b \ge d$ and $l \ge d + 26$ mm ade	Property class: 8.8, 9.8, 10.9, 12.9/12.9 — $d > 16$ mm and $d_0 \ge 0{,}75d_s$ and $b \ge d$ and $l \ge 5{,}5d + 8$ mm afg
1	Minimum tensile strength, $R_{m,min}$	Tensile test for machined test pieces	9.7					
2	Minimum lower yield strength, $R_{eL,min}$			[h]	[h]	NF	NF	NF
3	Minimum stress at 0,2 % non-proportional elongation, $R_{p0,2\,min}$			NF[h]	NF[h]			
6	Minimum elongation after fracture, A_{min}							
7	Minimum reduction of area after fracture, Z_{min}			NF	NF			
10 or 11 or 12	Hardness	Hardness test	9.9					
13	Maximum surface hardness	Carburization test	9.11	NF	NF			
14	Non-carburization			NF	NF			
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF			
18	Minimum impact strength, $K_{v\,min}$	Impact test $d \ge 16$ mm and l[i] or $l_t \ge 55$ mm[j]	9.14	NF	[k]	NF		
19	Surface integrity[l]	Surface discontinuity inspection	9.15					

[a] To determine the minimum total length, l_t, for studs, add $1d$ to the length formula.

[b] For bolts and screws $l \ge 5d$ to determine Z_{min}.

[c] For studs $l_t \ge 6d$ to determine Z_{min}.

[d] For bolts and screws $l \ge d + 20$ mm to determine Z_{min}.

[e] For studs $l_t \ge 2d + 20$ mm to determine Z_{min}.

[f] For bolts and screws $l \ge 4d + 8$ mm to determine Z_{min}.

[g] For studs $l_t \ge 5d + 8$ mm to determine Z_{min}.

[h] In cases where the lower yield strength, R_{eL}, cannot be determined, it is permissible to measure the stress at 0,2 % non-proportional elongation $R_{p0,2}$.

[i] The solid part of the head may be included.

[j] For the impact test, these specific dimensional limits apply instead of the limits specified in the header of this table.

[k] Only for property class 5.6.

[l] To be evaluated before machining.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out, either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

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Table 5.6- Test series MP2 - Material properties determined on finished fasteners with full loadability

No. (see Table 3)	Property	Test method	Subclause	Property class: 4.6, 5.6	Property class: 4.8, 5.8, 6.8	Property class: 8.8, 9.8, 10.9, 12.9/12.9
				$d \geq 3$ mm and $l \geq 2{,}7d^a$ and $b \geq 2{,}2d$		
1	Minimum tensile strength, $R_{m,min}$	Tensile test for finished fasteners	9.2	d	d	d
4	Minimum stress at 0,0048d non-proportional elongation, $R_{pf,min}$	Tensile test for full-size fasteners	9.3	b		c
5	Nominal stress under proof load, $S_{p,nom}$	Proof load test for finished fasteners	9.6	d	d	d
8	Minimum elongation after fracture, $A_{f,min}$	Tensile test for full-size fasteners	9.3	e		e
10 or 11 or 12	Hardness	Hardness test	9.9			
13	Maximum surface hardness	Carburization test	9.11	NF	NF	
14	Non-carburization			NF	NF	
15	Maximum decarburized zone	Decarburization test	9.10	NF	NF	
16	Reduction of hardness after retempering	Retempering test	9.12	NF	NF	f
19	Surface integrity	Surface discontinuity inspection	9.15			

a For studs with metal end stronger than the nut end, or for fully threaded studs with $l_t \geq 3{,}2d$.

b For property classes 4.6 and 5.6, the stress at 0,0048d non-proportional elongation, R_{pf}, is not specified in Table 3.

c No values available.

d $l \geq 2{,}5d$ and $b \geq 2{,}0d$.

e Values for A_f are given in Annex C for information.

f This test is a reference test to be applied in case of dispute.

	Feasible: the test is able to be carried out in accordance with Clause 9 and, in case of dispute, shall be carried out in accordance with Clause 9.
	Feasible, but carried out only when explicitly specified: the test is able to be carried out in accordance with Clause 9 as an alternative test for a given property (e.g. torsional test when tensile test is possible), or as a particular test if required in a product standard or by the purchaser at the time of the order (e.g. impact test).
NF	Not feasible: the test cannot be carried out, either because of the form and/or dimension of the fastener (e.g. length too short to test, no head), or because it applies only to a particular category of fasteners (e.g. test for quenched and tempered fasteners).

Note: Clause, Sub-clauses, Table & Annexures referred in this table are from IS:1367(Pt.3).

5.6 Test methods

Test methods, test applicability, testing apparatus/devices for tests referred in Table 3.1 to 3.6 are specified in Clause 9 of IS:1367(Pt. 3).

5.7 Inspections, sampling and acceptance procedure

ISO 3269 or IS:1367(Pt 17) specifies the acceptance inspection procedure that the purchaser of fasteners must follow in order to determine whether a lot of fasteners will be accepted or rejected in case where no other such procedure was agreed with the supplier at the time the fasteners were ordered.
Few terms are defined below to understand the acceptance inspection procedure:

Lot size

N, numbers of fasteners contained in a lot.

Sample

One or more fasteners drawn at random from an inspection lot in such a way that all fasteners in the lot have an equal chance of being drawn.

Sample size

N, number of fasteners in a sample.

Characteristics

Dimensional element, mechanical property or other recognizable product feature for which limits are specified. For exp. Head height, body diameter, tensile strength or hardness.

Nonconformity

Deviation of a characteristic from a particular requirement

Acceptance number

Ac, Maximum number of nonconformities of the same characteristic in any given sample which when exceeded causes the lot to be rejected.

Acceptance Quality Level

AQL, Quality level in a sampling plan corresponding to a high probability of acceptance. For example: "**AQL 1.5**" means "no more than **1.5**% defective items in the whole order quantity, on average over several production runs with that supplier.

Limiting quality

LQ, Quality level in a sampling plan corresponding to a low probability of acceptance. LQ_{10} is the percentage of fasteners that do not confirm in respect of product characteristic, having one chance in ten of being accepted under the sampling plan; often refers to as the consumer's risk.

5.7.1 Acceptance inspection procedure for fastener characteristics

i) The purchaser may test the delivered fasteners for function and usability, when judged by the purchaser to be necessary or economically justifiable, provided the supplier's risk is no greater than than 5% and when no prior agreement has been reached.

ii) Find the description of the fastener to be inspected for dimensional characteristics in Table 5.7. Note all characteristics appropriate for inspection and the AQL value associated with each. For characteristics other than dimensional ones, note all those to be inspected as well as associated values given in Table 5.9.

iii) Choose the appropriate LQ_{10} value in accordance with Table 5.8. The LQ_{10} shall correspond to the fastener's function or use or both. For more important fastener functions or uses, the LQ_{10} value may be smaller, but this will require greater sample size and higher inspection cost. It may be possible to reduce the proportion of fasteners inspected if the lot is from known sources production control. In this case, if the lot inspected up to that point have shown good quality, choose a greater LQ_{10} value. Conversely, if the lot cannot be presumed to be uniform or is supplied by more than one manufacturer it may be necessary to increase the proportion of fasteners inspected. The choice of the LQ_{10} value shall be left solely to the discretion of the purchaser.

iv) Knowing the AQL and with the LQ_{10} value chosen, find the sample size and the acceptance number from Table 5.8.

v) Select the sample for each characteristics, carry out the inspection, note the number of nonconforming fasteners and accept the lot if their number is less than or equal to the acceptance number. If, in

any case of non-destructive testing, the size is less than that of the required sample, 100% inspection shall be carried out.

vi) In the event of rejection, suitable disposal of the lot shall be agreed upon by purchaser and supplier.

Table 5.7- Dimensional characteristics of threaded fasteners

Dimensional characteristics	Product group					
	1	2	3	4	5	6
	Bolts, screws and studs of grades A and B[a]	Bolts, screws and studs of grade C[a]	Nuts of grades A and B[a]	Nuts of grade C[a]	Self-tapping screws[b] and wood screws	All thread-forming screws not covered in column 5, self-drilling screws and chip-board screws
	AQL					
Width across flats	1	1,5	1	1,5	1,5	1
Width across corners	1	1,5	1	1,5	1,5	1
Nut height	—	—	1	1,5	—	—
Width of slot	1	—	—	—	1,5	1
Depth of slot	1	—	—	—	1,5	1
Recess penetration	1	—	—	—	1,5	1
Socket, GO gauge	1	—	—	—	—	—
Socket, NOT GO gauge	1	—	—	—	—	—
Configuration under head	1	—	—	—	—	1
GO thread gauge	1	1,5	1	1,5	—	1[c]
NOT GO thread gauge	1	1,5	1	1,5	—	1[c]
Major diameter	—	—	—	—	2,5	1
Geometric tolerances[d]	1	1,5	1	1,5	2,5	1
All others	1,5	2,5	1,5	2,5	2,5	1,5
Nonconforming fasteners	2,5	4	2,5	4	4	2,5

a The product grades refer to the classification of the product with regard to fit and tolerances (see ISO 4759-1).

b Screws with threads to ISO 1478.

c For certain products (for example, thread-rolling screws) this characteristic is assessed on the basis of the thread produced in the mating component.

d Each geometric tolerance shall be individually assessed.

Table 5.8- Examples of sampling Plans

Ac	AQL				
	0,65	1,0	1,5	2,5	4,0
	n^b / LQ_{10}				
0	**8** 25	**5** 37	**3** 54	—	—
1	**50** 7,6	**32** 12	**20** 18	**13** 27	**8** 42
2	**125** 4,3	**80** 6,5	**50** 10	**32** 17	**20** 25
3	**200** 3,3	**125** 5,4	**100** 6,6	**50** 13	**32** 20
4	**315** 2,6	**200** 3,9	**125** 6,2	**80** 9,6	**50** 15
5	**400** 2,4	**250** 3,7	**160** 5,8	**100** 9,3	—
6	—	**315** 3,4	**200** 5,2	**125** 8,4	**80** 13
7	—	**400** 3,0	**250** 4,7	**160** 7,3	**100** 11,5
8	—	—	**315** 4,2	**200** 6,6	**125** 10
10	—	—	**400** 3,9	**250** 6,0	**160** 9,5
12	—	—	—	**315** 5,6	**200** 8,8
14	—	—	—	**400** 5,0	**250** 8,0
18	—	—	—	—	**315** 7,8
22	—	—	—	—	**400** 7,3

NOTE For all sampling plans the supplier's risk is less than or equal to 5 %.

[a] Sampling plans are derived from ISO 2859-1:1999, either directly or, in some cases, by interpolation.

[b] In the case of non-destructive testing, if the lot size is less than the required sample size, 100 % inspection shall be carried out.

Table 5.9- Characteristics of threaded fasteners

Characteristics		AQL	Reference standards
Mechanical characteristics and surface integrity	Non-destructive tests[a]	0,65	ISO 898[c] ISO 2320 ISO 2702 ISO 3506[c] ISO 6157[c] ISO 7085 ISO 8839 etc.
	Destructive tests	1,5	
Chemical composition		1,5	
Metallurgical characteristics		1,5	
Functional (performance) characteristics		1,5	
Coating		1,5	ISO 4042 ISO 10683
Others[b]		1,5	

[a] If non-permitted surface discontinuities (for example, quench cracks) are found during surface discontinuity inspection (non-destructive test), regardless of their size, the inspection lot shall be rejected.

[b] Other characteristics may be required according to applicable specifications.

[c] See the applicable parts of these standards.

Chapter: 6 Important Fasteners used in 3-Ph Locos

6.1 List of fasteners M10 and above for 3-ph drive locomotives appearing in Category Book (M & L) Doc. no. ELDD/3637 of CLW which are being procured as per Indian Standards is attached as Annexure-A.

6.2 List of fasteners M10 and above for 3-ph drive locomotives appearing in Category Book (M & L) Doc. no. ELDD/3637 of CLW which are being procured as per CLW specifications is attached as Annexure-B.

Annexure-A

FASTNERS M10 and Above for WAG 9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.)	
			G/9 class	P/7
1	**SELF TAPPING SCREW**			
	SELF TAPPING SCREW CSK.RAISED HD.NO 10x15	IS:7169	70	70
	SELF TAPPING SCREW PAN HD. NO 10x19	IS:7173	470	470
2	**SCREW HEX.HEAD.**			
	HEX. HEAD SCREW M10x20x1.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8	8
	HEX. HEAD SCREW M10x25x1.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8 32 20	8 32 20
	HEX. HEAD SCREW M10x40x1.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	4 4	4 4
	HEX. SCREW M12x20x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8 8 8 8	8 8 8 8
	HEX. SCREW M12x25x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 32	12 32
	HEX. SCREW M12x30x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 32	24
	HEX.Head SCREW M12x35 Gr. 10.9 Zinc plated passivated	IS:1364 Pt. 2 1209-01.113-001 Alt.5	12 32	48
	HEX. SCREW M16x35x2P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 32 Nil	24 24 8
	HEX. SCREW M16x40x2P	IS:1364-S-8.8 Gr. A to IS:1367	12 32	2
	HEX. SCREW M10x35x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 32	32 32
	HEX. SCREW M14x45x2P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 32	4 4
	Hex hd. Screw M10x25x1.5p zn plated (passivated)	1209-02.327-402 Alt.2 ref.3 IS:1364-S-8.8 Gr. A to IS:1367	12 32	8

Annexure-A

FASTNERS M10 and Above for WAG 9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.) G/9 class	QTY.(Nos.) P/7
3	**Bolts Hex. Head**			
	HEX. HEAD BOLT M10x35/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8	Nil
	HEX. HEAD BOLT M10x50/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	4 32	Nil
	HEX. HEAD BOLT M10x60/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	4	Nil
	HEX. HEAD BOLT M12x35/30x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8 64 32	Nil
	HEX. HEAD BOLT M12x50/30x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8	Nil
	HEX. HEAD BOLT M12x50 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	46 58	Nil
	HEX. HEAD BOLT M12x55 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8	Nil
	HEX. HEAD BOLT M16x45/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	4	Nil
	HEX. HEAD BOLT M16x50/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	24	Nil
	HEX. HEAD BOLT M16x60/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8 8	Nil
	HEX. HEAD BOLT M16x65/38x2 P Zn. Plated (Passivated)	IS:1364-S-10.9 Gr. A to IS:1367	16	Nil
	HEX. HEAD BOLT M16x70/38x2 P Zn. Plated (Passivated)	IS:1364-S-10.9 Gr. A to IS:1367	24 8	Nil
	HEX. HEAD BOLT M16x120/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	24 2	Nil
	HEX. HEAD BOLT M16x130/44x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	3	Nil
	HEX. HEAD BOLT M20x60/46x2.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8	Nil

Annexure-A

FASTNERS M10 and Above for WAG 9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.)	
			G/9 class	P/7
	BOLT HEX. HD. M20x80/46x2.5P (10.9)	IS:1364-S-10.9Gr. A to IS:1367	8 8	Nil
	HEX. HEAD BOLT M24x70/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12 12	Nil
	HEX. HEAD BOLT M24x85/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12	Nil
	HEX. HEAD BOLT M24x90/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	8 8	Nil
	HEX. HEAD BOLT M24x100/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12	Nil
	HEX. HEAD BOLT M24x300/73x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	24	Nil
	HEX. HEAD BOLT M30x160/72x3.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	48	Nil
	HEX. HEAD BOLT M24x120 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12	Nil
	HEX. HEAD BOLT M24x75 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12	Nil
4	HEX. HEAD BOLT M27x200/134x3P Grade 10.9	IS:1364-S-10.9 Gr. A to IS:1367	16	Nil
	HEX. HEAD BOLT M24x110/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	12	Nil
	HEX. HEAD BOLT M16x35 Lg	CDD-HL-P71-022 Alt.4 Ref.8	3	Nil
5	**Bolts Hex. Head**			
	HEX. HEAD BOLT M10x35/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8
	HEX. HEAD BOLT M10x50/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	4 32
	HEX. HEAD BOLT M10x60/26x1.5P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	4
	HEX. HEAD BOLT M12x35/30x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8 64 32
	HEX. HEAD BOLT M12x50/30x1.75P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8
	HEX. HEAD BOLT M12x50 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	46 58
	HEX. HEAD BOLT M12x55 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8

Annexure-A

FASTNERS M10 and Above for WAG 9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.)	
			G/9 class	P/7
	HEX. HEAD BOLT M16x45/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	4
	HEX. HEAD BOLT M16x50/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	24
	HEX. HEAD BOLT M16x60/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8 8
	HEX. HEAD BOLT M16x65/38x2 P Zn. Plated (Passivated)	IS:1364-S-10.9 Gr. A to IS:1367	Nil	16
	HEX. HEAD BOLT M16x70/38x2 P Zn. Plated (Passivated)	IS:1364-S-10.9 Gr. A to IS:1367	Nil	24 8
	HEX. HEAD BOLT M16x120/38x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	2
	HEX. HEAD BOLT M16x130/44x2 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	3
	HEX. HEAD BOLT M20x60/46x2.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8
	BOLT HEX. HD. M20x80/46x2.5P (10.9)	IS:1364-S-10.9Gr. A to IS:1367	Nil	8 8
	HEX. HEAD BOLT M24x70/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	12 12
	HEX. HEAD BOLT M24x85/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	12
	HEX. HEAD BOLT M24x90/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	8 8
	HEX. HEAD BOLT M24x100/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	12
	HEX. HEAD BOLT M24x300/73x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	24
	HEX. HEAD BOLT M30x160/72x3.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	48
	HEX. HEAD BOLT M24x120 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	12
	HEX. HEAD BOLT M24x75 Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	12

Annexure-A

FASTNERS M10 and Above for WAG 9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.) G/9 class	QTY.(Nos.) P/7
	HEX. HEAD BOLT M27x200/134x3P Grade 10.9	IS:1364-S-10.9 Gr. A to IS:1367	Nil	16
	HEX. HEAD BOLT M16x35 long Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	Nil	3
	HEX. HEAD BOLT M24x110/54x3 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	nil	12
	NUT HEX. M4 x 0.7 P Zn. Plated (Passivated)	IS : 1364-S- 8 Gr.-A to IS : 1367	24	Nil
	NUT HEX. M5 x 0.8 P Zn. Plated (Passivated)	IS : 1364-S- 8 Gr.-A to IS : 1367	32 1	Nil
	NUT HEX. M8 x 1.25 P Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	24 8 8 24 20 20 8 8 8 1	Nil
	NUT HEX. M10 Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	8 20 4	Nil
	NUT HEX. M12 Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	8	Nil
	NUT HEX. M14 B Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	4 4	Nil
	HEX. NUT M16	CDD-HL-P71-022 Alt.4 Ref.9	3	Nil
6	**Nuts Hex.**			
	NUT HEX. M10 Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	Nil	8 20 4
	NUT HEX. M12 Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	Nil	8
	NUT HEX. M14 B Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	Nil	4 4
	NUT HEX. M16 Zn. Plated (Passivated)	IS:1364-S-8 Gr. A to IS:1367	Nil	3

Note:
Passivated: The process of chromate conversion coating of zinc plated parts is called passivation. Chromate conversion coatings are applied for increased corrosion resistance.

Annexure-B

List - 1

FASTNERS M10 and Above for WAG9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.)	
			G/9 class	P/7
1	**CAPTIVE BOLT**			
	CAPTIVE BOLT M10 X 50	1209-08.330-191 Ref.1 Alt. 1	8	8
	BOLT M12 X 80 MACHINED	1209-08.330-191 Ref.2 Alt. 1	16	16
2	**DISTANCE BOLT**	CLW/ES/3/184 Alt.-F		
	STUD BOLT M10x150 SST	3EHP179000P0013	4	4
	STUD BOLT M10x40 SST		3	3
3	**Hex.Socket CSK. Hd. Screw M12x25 Lg.**			
	HEX.SOCKET CSK.HD.SCREW M12 x 25 Lg.	1209-01.415-023 Alt-2	8	8
4	**Hex.Bolt(fine pitch)**			
	HEX. BOLT M16 x 50 (FINE PITCH)	1209-01.415-024 Alt.2	8	8
5	Bolts Ø 12	1209-01.413-011 Alt.1	8	8
6	**Split pin**	CLW/MS/3/093 Alt.3		
	COTTER PIN Ø10x80	182-00494-006	2	2
	COTTER PIN Ø10x100	182-00494-008	2	2
7	**Stn. steel Hardware Items**	CLW/MS/3/040 Alt. 13		
	SCREW HEX. HD. M10x25x1.5 P	182-00057-002 182-00051-002	72	72
	SCREW HEX. HD. M12x50x1.75 P	182-00058-007	48	48
	SCREW HEX. HD. M16x50x2 P	182-00059-005	9	9
	BOLT HEX. HD. M12x75/30x1.75 P	182-00052-012	2	2
	BOLT HEX. HD. M12x130/36x1.75 P	182-00052-018	2	2

Annexure-B

List - 1

FASTNERS M10 and Above for WAG9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.)	
			G/9 class	P/7
	BOLT HEX. HD. M16x70/38x2 P	182-00053-010	4	4
	Hex. Hd. Screw M12x35 Lg. (SS)	182-00058-004	16	16
	Bolt Hex. M12x1.75 -25 Lg	1209-08.406-363 Ref-2	16 Nil	Nil 16
8	**Stn.steel Hardware Items**	CLW/MS/3/040 Alt. 13		
	Hex. Nut M10	182-00047-005	4	4
	HEX NUT 0.8D M10 SST	NB332600P0513	245	245
	HEX NUT 0.8 D, M12 SST	NB332600P0514	72	72
	HEX SCREW M10 X 16 SST	3EHP416001P1016	95	95
	HEX SCREW M10 X 20 SST	3EHP416001P1020	52	52
	HEX SCREW M10 X 25 SST	3EHP416001P1025	54	54
	HEX SCREW M10 X 30 SST	3EHP416001P1030	51	51
	HEX SCREW M10X35 SST	3EHP416001P1035	91	91
	HEX SCREW M10 X 40 SST	3EHP416001P1040	76	76
	HEX SCREW . M12 x 20 SST	3EHP416001P1220	38	38
	HEX SCREW M12X25 SST	3EHP416001P1225	64	64
	HEX SCREW M12X30 SST	3EHP416001P1230	142	142
	HEX SCREW M12X35 SST	3EHP416001P1235	182	182
	HEX SCREW M12X40 SST	3EHP416001P1240	72	72
	HEX SCREW M12X45 SST	3EHP416001P1245	46	46
	HEX SCREW M16X40 SST	3EHP416001P1640	24	24
	HEX SCREW M16X60 SST	3EHP416001P1660	14	14
	HEX BOLT M10X50/26 SST	3EHP416001P1050	56	56
	HEX SCREW M16 x 20 SST	3EHP416001P1620	6	6
	HEX SCREW M10 x 45 SST	3EHP416001P1045	16	16
	HEX SCREW M10 x 60 SST	3EHP416001P1060	33	33
	HEX SCREW M10 x 80 SST	3EHP416001P1080	20	20
	HEX SCREW M12 x 15 SST	3EHP416001P1215	26	26
	HEX SCREW M18 x 40 SST	3EHP416001P1840	16	16
	HEXAGONAL SCREW M10 x 50	3EHP130170P0001	18	18
	HEX NUT 0.8 D, M16 SST	NB332600P0515	14	14
	HEX SCREW M10 X 12 SST	3EHP416001P1012	18	18
	HEX SCREW M16X30 SST	3EHP416001P1630	4	4
	HEX SCREW M16X50 SST	3EHP416001P1650	16	16
	HEX. SCR. M12 x 60 SST	3EHP416001P1260	18	18
	HEX NUT 0.8 D M 20 SST	NB332610P0116	2	2
9	**Stn.steel Hardware Items for WAP-7**	CLW/MS/3/040 Alt. 13		
	Hex nut M12	CDD-HL-P71-002A Alt 3 Ref.26	Nil	8
	HEX SCREW M12X40 LG	CDD-HL-P71-002A Alt 3 Ref.32	Nil	8

Annexure-B

List - 1

FASTNERS M10 and Above for WAG9H/WAG 9HC and WAP7

SL. No.	Category No. & Description	Drg./Specn. Details	QTY.(Nos.) G/9 class	QTY.(Nos.) P/7
10	**Stn.steel Hardware Items**	CLW/MS/3/040 Alt. 13		
	HEX.HD. BOLT M12X20 LG(S.S)	182-00052-001	48	48
	HEX.HD. BOLT M10X20 LG(S.S)	182-00051-001 ALT.1	48	48
11	**CAP SCREWS SOCKET HEAD**	CLW/MS/3/081 Alt.5		
	CAP BOLT SOCKET HD.M16x100/44x2 P	182-00078-014	4	4
12	**Scrs.Counter Sunk Slotted**	CLW/MS/3/082 Alt.3		
	SCREW CSK HD. SLOTTED M10x16x1.5P	182-00335-003	8	8
13	**Bolts Hex. Head**			
	HEX. HEAD BOLT M16x35 Lg	CDD-HL-P71-022 Alt.4 Ref.8	3	Nil
14	**Bolts Hex. Head**			
	HEX. NUT M16	CDD-HL-P71-022 Alt.4 Ref.9	3	Nil
15	**F.S.All Steel Lock Nut**	CLW/MS/3/089 (Rev - 1 April 2007).Alt.3		
	F.S.All Steel Lock Nut M10	182-00493-003 Alt. 3	32 32	32 32
	F.S.All Steel Lock Nut M12 - 8	182-00493-004 Alt. 3	16 16	16 16
	F.S.All Steel Lock Nut M16 - 8	182-00493-005 Alt. 3	16 40	16 40
	F.S.All Steel Self Lock Nut M20 - 8	182-00493-006 Alt. 3 1209-01.113-001 alt.3 ref-9	8 24	8 24
	F.S.All Steel Lock Nut M24	182-00493-007 Alt. 3	24 48	24 48
16	**UNCOMMON S. S. HARDWARE FOR MOUNTING OF LEATHERR BELLOW**	CLW/MS/3/040 ALT.13		
	CSK. HD. SCREW(S.S) M10X20 LONG	182-00573-004	48	48
	HEX HD. BOLT M12X20 LONG(S.S)	182-00052-001	48	48

Annexure-B

List-2

FASTNERS M10 and Above for WAP5

SL. No.	Category No. & Description	Drg./Specn. Details	QTY. (Nos.) P/5
1	**Nut Hex**	CLW/MS/10/ 063 Alt. 4	
	Unistrut Nut M12	1209-18.406-179	4
2	**Root Nut**	CLW/MS/10/ 064 Alt. 2	
	Root Nut M12	182-00407-007	16
3	**CAPTIVE BOLT**	CLW/MS/10/ 066 Alt. 1	
	CAPTIVE BOLT M10 X 50	1209-08.330-191 Ref.1 Alt. 1	8
4	**Weld Nut Hex.**	CLW/MS/3/093 Alt. 2	
	COTTER PIN Ø10x100	182-00494-008	2
5	**Necked Down bolt**		
	Necked Down Bolt M20x100	IA016-00270	16
	Necked Down Bolt M20x135	IA016-00271	16
6	**Bolt Ø12**	1209-01.413-011. Alt.1	8
7	**F.S.All Steel Lock Nut**	CLW/MS/3/089(REV.1) APRIL 2007 Alt.3	
	F.S.All Steel Lock Nut M 12 - 8	182-00493-004 Alt-3	16
	F.S.All Steel Lock Nut M16 - 8	182-00493-005 Alt-3	16 16
	F.S.All Steel Self Lock Nut M20 - 8	182-00493-006 Alt-3	40 8 24
	F.S.All Steel Lock Nut M24	182-00493-007 Alt-3	40
8	**Lock Nut Hex**	CLW/MS/10/059 ALT.4	
	Lock Nut Hex Dia-20	182-00097-002 IS:1367(PART-3) 2002 AND ISO 898-1:1999	8
9	**St.Steel Hardware Items**	CLW/MS/10/053 Alt. 5	
	Hex Hd. Bolt M16x70/38x2p	182-00053-10	12
	St. Steel Nyloc Hex. Nut (304) M10	182-00063-007 Alt.1	32
	Hex. Hd. Bolt M10x20 (304)	IS:3063; Type-B SST	24
	Set Screw Hex. Hd. M12x50	IS:3063; Type-B Matl. SS(304)	32
	Hex. Hd. Bolt M12x40 (304)	IS:2016 SS(304)	24
	Hex Hd. Bolt M12x40 lg. SST	IS:1367 A2-70	8

Annexure-B

List-2

FASTNERS M10 and Above for WAP5

SL. No.	Category No. & Description	Drg./Specn. Details	QTY. (Nos.)
			P/5
	BOLT HEX. HD. M10x40/26x1.5 P	DIN Matl.Spring Steel 35 Gr. Mol-7	16
	SELF TAPPING CSK SCREW (POZI) STD.NO.-10 M10x19	182-00322-002	10
	Nylock Nut Hex. M12 SST 304	182-00063-008	24
	Set Screw Hex. Hd. M12x30 SST 304	182-00058-003	16
	SET SCREW HEX HD M12X30	182-0058-003	16
	HEX SET SCREW M10X25 LG	182-00057-002	24
10	**St.Steel Hardware Items**	CLW/MS/10/053 Alt. 5	
	HEX SCREW M10 X 16 SST	3EHP416001P1016	71
	HEX SCREW M10 X 20 SST	3EHP416001P1020	20
	HEX SCREW M10 X 25 SST	3EHP416001P1025	108
	HEX SCREW M10 X 30 SST	3EHP416001P1030	49
	HEX SCREW M10X35 SST	3EHP416001P1035	81
	HEX SCREW M10 X 40 SST	3EHP416001P1040	41
	HEX SCREW . M12 x 20 SST	3EHP416001P1220	60
	HEX SCREW M12X25 SST	3EHP416001P1225	104
	HEX SCREW M12X30 SST	3EHP416001P1230	346
	HEX SCREW M12X35 SST	3EHP416001P1235	204
	HEX SCREW M12X40 SST	3EHP416001P1240	142
	HEX SCREW M12X45 SST	3EHP416001P1245	32
	HEX SCREW M16X40 SST	3EHP416001P1640	34
	HEX SCREW M16X60 SST	3EHP416001P1660	72
	HEX NUT 0.8D M10 SST	NB332600P0513	262
	HEX NUT 0.8 D, M12 SST	NB332600P0514	406
	HEX BOLT M10X50/26 SST	3EHP416001P1050	56
	HEX SCREW M16 x 20 SST	3EHP416001P1620	6
	HEX SCREW M10 x 45 SST	3EHP416001P1045	14
	HEX SCREW M10 x 60 SST	3EHP416001P1060	12
	HEX SCREW M10 x 80 SST	3EHP416001P1080	6
	HEX SCREW M12 x 15 SST	3EHP416001P1215	40
	HEXAGONAL SCREW M10 x 50	3EHP130170P0001	15
	HEX NUT 0.8 D, M16 SST	NB332600P0515	88
	HEX SCREW M10 X 12 SST	3EHP416001P1012	10
	HEX SCREW M16X30 SST	3EHP416001P1630	16
	HEX SCREW M16X50 SST	3EHP416001P1650	31
	HEX. SCR. M12 x 60 SST	3EHP416001P1260	2
	HEX NUT 0.8 D M 20 SST	NB332610P0116	2
	Hex Screw M12X12 SST	182-00058-016	2
	Hex Head Bolt M16x35	182-00053-003	8

Annexure-B

List-2

FASTNERS M10 and Above for WAP5

SL. No.	Category No. & Description	Drg./Specn. Details	QTY. (Nos.) P/5
11	**Screw Hex. Head**	CLW/MS/10/ 054 Alt. 4	
	HEX. HEAD SCREW M10x20x1.5 P Zn. Plated (Passivated)	IS: 1364 to IS:1367,P-8.8 Gr.-A	8
	HEX. HEAD SCREW M10x25x1.5 P Zn. Plated (Passivated)	IS: 1364 to IS:1367,P-8.8 Gr.-A	8
	Hex.Hd. Screw M10x50 Lg.	IS: 1364 to IS:1367,P-8.8 Gr.-A	4
	HEX. SCREW M12x20x1.75P Zn. Plated (Passivated)	IS:1367,P-8.8 Gr.-A Zn plated Passivated by Chromate Treatment	8
	HEX. SCREW M12x25x1.75P Zn. Plated (Passivated)	IS: 1364 to IS:1367,P-8.8 Gr.-A	4
	HEX. SCREW M12x30x1.75P Zn. Plated (Passivated)	IS: 1364 to IS:1367,P-8.8 Gr.-A	16 80 16 8 32
	HEX.Hd. SCREW M16x35x2P Zn. Plated (Passivated)	IS: 1364 to IS:1367,P-8.8 Gr.-A	8
	HEX.Head SCREW M12x35 Gr. 10.9 Zinc plated passivated	IS: 1364 Pt. II 1209-01.113-001 Alt.5	48
	HEX. SCREW M16x40x2P	IS: 1364 to IS:1367,P-8.8 Gr.-A	16 2
	HEX. HEAD SCREW M10x40x1.5 P Zn. Plated (Passivated)	IS:1364-S-8.8 Gr. A to IS:1367	4
12	**Socket Hd. Cap Screw**	CLW/MS/10/ 055 Alt. 2	
	CAP BOLT SOCKET HD.M16x100/44x2 P	182-00078-014	4
13	**Scrs.Counter Sunk Slotted**	CLW/MS/3/082 Alt. 3	
	SCREW CSK HD. SLOTTED M10x16x1.5P	182-00335-003	8
14	**Bolt Hex. Hd.**	CLW/MS/10/051 Alt. 4	
	Hex Hd.Bolt M10x30/26xP8.8	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	HEX. HEAD BOLT M10x35/26x1.5P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	16
	Hex Hd. Bolt M10x40	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	4
	Hex Hd.Bolt M10x55	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8 16

Annexure-B

List-2

FASTNERS M10 and Above for WAP5

SL. No.	Category No. & Description	Drg./Specn. Details	QTY. (Nos.)
			P/5
	Hex Hd. Bolt M12x35 lg (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	HEX. HEAD BOLT M12x35/30x1.75P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	8 96
	HEX. HEAD BOLT M12x50/30x1.75P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	NIL 8
	HEX. HEAD BOLT M12x55 Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	8
	Hex Hd. Bolt M12x60 (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	16
	Bolt Machined M12x80x30	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	16
	Hex Hd. Bolt M14x45	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	HEX. HEAD BOLT M16x45/38x2 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	4
	HEX. HEAD BOLT M16x50/38x2 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	32
	HEX. HEAD BOLT M16x60/38x2 P Zn. Plated (Passivated)	IS:1364 S-10.9 Gr. A to IS:1367	8
	Hex Hd. Bolt M16x65 Lg. (8.8) Zn Plated	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	HEX. HEAD BOLT M16x70/38x2 P Zn. Plated (Passivated)	IS:1364 S-10.9 Gr. A to IS:1367	8
	Hex Hd. Bolt (ISO 4014)M16x80 (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	Hex hd. Bolt M16x80 Class-10.9	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	46
	HEX. HEAD BOLT M16x120/38x2 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	2
	HEX. HEAD BOLT M16x130/44x2 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	2
	HEX. HEAD BOLT M16x150 Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	6

Annexure-B

List-2

FASTNERS M10 and Above for WAP5

SL. No.	Category No. & Description	Drg./Specn. Details	QTY. (Nos.)
			P/5
	Hex Hd. Bolt M20x70 Lg.(8.8) Zn Plated	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	Hex Hd. Bolt(ISO 4014) M20x150 (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	HEX. HEAD BOLT M20x160 (10.9)	IS:1364 S-10.9 Gr. A to IS:1367	16
	HEX. HEAD BOLT M24x120 Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	12
	Hex Hd. Bolt(ISO 4017) M24x55	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	16
	HEX. HEAD BOLT M24x70/54x3 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	12
	HEX. HEAD BOLT M24x90/54x3 P Zn. Plated (Passivated)	IS:1364 S-8.8 Gr. A to IS:1367	8
	Hex Hd. Bolt M24x110	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	12
	Hex Hd. Bolt M24x110/75	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	4
	Hex Hd. Bolt (ISO 4014) M24x140 (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	32
	Hex Hd. Bolt (ISO 4014) M24x160 (8.8)	IS:1364 Gr.-A Zn plated (Steel) Passivated by Chromate Treatment	8
	Hex Hd. Bolt M27X130/64X3P GRADE 10.9	IS:1364-S-10.9 Gr. A to IS:1367	16
15	**Hex. Nut**	CLW/MS/10/057 Alt. 3	
	NUT HEX. M10 Zn. Plated (Passivated)	IS:1364 (PT-3)S - 8 Gr. A to IS: 1367	4 8 4
	NUT HEX. M12 Zn. Plated (Passivated)	IS:1364 (PT-3)S - 8 Gr. A to IS: 1367	8 8
	Hex. Nut M16	CLW/MS/10/057 Alt. 3	2