Marking/Mechanical requirements/ Material

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Catalogue 7 chapter 2

Marking and mechanical requirements for bolts, screws and studs of steel

Identification

Hexagon and hexalobular head bolts and screws

Hexagon and hexalobular head bolts and screws (including products with flange) shall be marked with the manufacturer´s identification mark and with the marking symbol of the property class given in table 188.

The marking is obligatory for all property classes, preferably on the top of the head by indenting or embossing or on the side of the head by indenting (see the figure below).

In the case of bolts or screws with flange, marking shall be on the flange where the manufacturing process does not allow marking on the top of the head.

Marking is required for hexagon and hexalobular head bolts and screws with nominal diameters $d \geq 5$ mm.

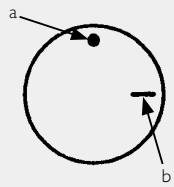
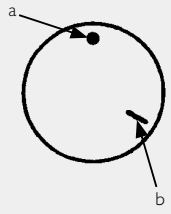
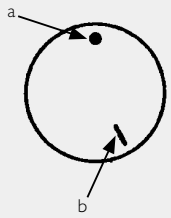
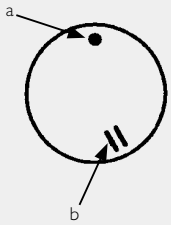
In the case of small screws or when the shape of the head does not allow the marking as given in table 188 the clock face marking symbols as given in table 24 may be used.

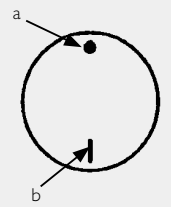
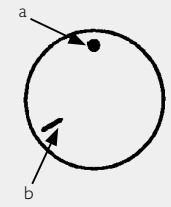
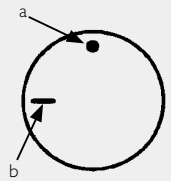
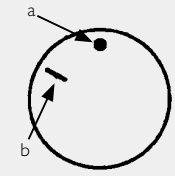
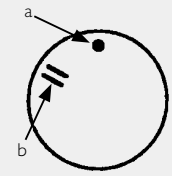
Table 188 Marking symbols

Property class	3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	10.9	12.9
Marking symbol [a,b]	3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	10.9[b]	12.9

[a]The full-stop in the marking symbol may be omitted.
[b]When low carbon martensitic steels are used for property class 10.9 (see table 4).

Table 24 Clock-face system for marking bolts and screws

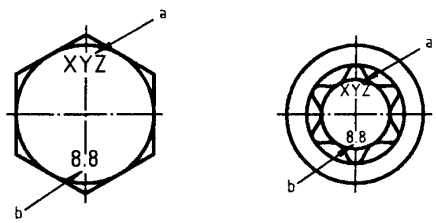
	Property class				
	3.6	4.6	4.8	5.6	5.8
Marking symbols					

	Property class				
6.8	8.8	9.8	10.9	10.9	12.9
					

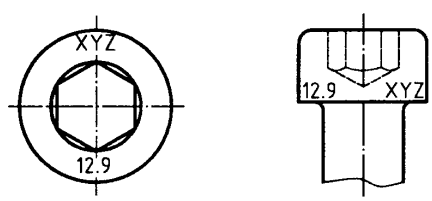
[a]The twelve o´clock position (reference mark) shall be marked either by the manufacturer´s identification mark or by a point.
[b]The property class is marked by a dash or a double dash and in the case of 12.9 by a point.

Examples of marking on hexagon and hexalobular head bolts and screws

a Manufacturer´s identification mark
b Property class

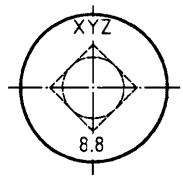


Examples of marking on hexagon socket head cap screws



Source: EN ISO 898-1.

Example of marking cup head square neck bolts



Studs

Studs with nominal thread diameters d ≥ 5 mm, of property class 5.6 and property classes 8.8 and higher shall be marked by indenting with the marking symbol of the property class as given in the table below and the manufacturer´s identification mark on the unthreaded part of the stud (see the figure).

If marking on the unthreaded part is not possible, marking of property class only on the nut end of the stud is allowed, (see the figure). For studs with interference fit, the marking shall be at the nut end with manufacturer´s identification marking only if it is possible.

Marking of studs

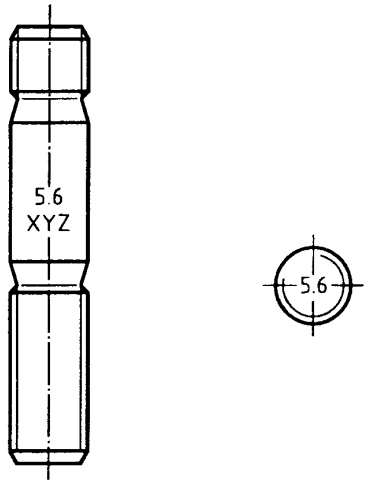


Table 189 Alternative marking symbols for studs

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

The symbols in the table are permissible as an alternative identification of property classes.

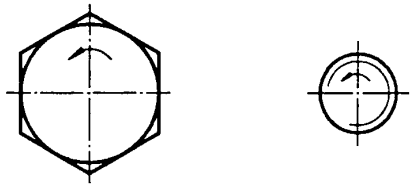
Marking of bolts and screws with left-hand thread

Bolts and screws with a left-hand thread shall be marked with the symbol shown in the figure, either on the top of the head or on the point.

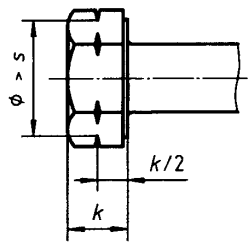
Alternative marking for left-hand thread as shown in the figure may be used for hexagon bolts and screws.

Source: EN ISO 898-1.

Left-hand thread marking



Alternative left-hand thread marking



Screws and stud screws

Table 4 specifies the kind of steel for the different property classes for screws and stud screws.

According to table 4 the min. tempering temperature is compulsory for property classes 8.8 up to 12.9.
The chemical composition is only compulsory for the screws that are not to be tensile tested.

Table 4 Steel Chemical composition

Property class	Material and treatment	Chemical composition limits (check analysis) % (m/m)					Tempering temperature °C
		C		P	S	B[a]	
		min.	max.	max.	max.	max.	min.
3.6[b]	Carbon steel	–	0,20	0,05	0,06	0,003	–
4.6[b]		–	0,55	0,05	0,06	0,003	–
4.8[b]							
5.6		0,13	0,55	0,05	0,06		–
5.8[b]		–	0,55	0,05	0,06	0,003	
6.8[b]							
8.8[c]	Carbon steel with additives (for example B, Mn or Cr), quenched and tempered	0,15[d]	0,40	0,035	0,035	0,003	425
	Carbon steel quenched and tempered	0,25	0,55	0,035	0,035		
9.8	Carbon steel with additives (for example B, Mn or Cr), quenched and tempered	0,15[d]	0,35	0,035	0,035	0,003	425
	Carbon steel quenched and tempered	0,25	0,55	0,035	0,035		
10.9[e f]	Carbon steel with additives (for example B, Mn or Cr), quenched and tempered	0,15[d]	0,35	0,035	0,035	0,003	340
10.9[f]	Carbon steel quenched and tempered	0,25	0,55	0,035	0,035	0,003	425
	Carbon steel with additives (for example B, Mn or Cr), quenched and tempered	0,20[d]	0,55	0,035	0,035		
	Alloy steel quenched and tempered[g]	0,20	0,55	0,035	0,035		
12.9[f h i]	Alloy steel quenched and tempered[g]	0,28	0,50	0,035	0,035	0,003	380

a) Boron content can reach 0,005% provided that non-effective boron is controlled by addition of titanium and/or aluminium.
b) Free cutting steel is allowed for these property classes with the following maximum sulfur, phosphorus and lead contents: sulfur 0,34%, phosphorus 0,11%, lead 0,35%.
c) For nominal diameters above 20 mm the steels specified for property class 10.9 may be necessary in order to achieve sufficient hardenability.
d) In case of plain carbon boron steel with a carbon content below 0,25% (ladle analysis), the minimum manganese content shall be 0,6% for property class 8.8 and 0,7% for 9.8, 10.9 and 10.9.
e) Products shall be additionally identified by underlining the symbol of the property class. All properties of 10.9 as specified in table 11 shall be met by 10.9, however, its lower tempering temperature gives it different stress relaxation characteristics at elevated temperatures.
f) For the materials of these property classes, it is intended that there should 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 class determination is 70% of the sum of the individual limit values shown above for the two, three or four elements concerned.
h) A metallographically detectable white phosphorus enriched layer is not permitted for property class 12.9 on surfaces subjected to tensile stress.
i) The chemical composition and tempering temperature are under investigation.

Source: EN ISO 898-1.

Mechanical properties of fasteners

Set screws and similar threaded fasteners not under tensile stresses.

Set screws shall be made of steel conforming to the requirements specified in table 4.1.

Table 4.1 – Steel specifications

Property class	Material	Heat treatment	Chemical composition, %			
			C		P	S
			max.	min.	max.	max.
14H	Carbon steel [1) 2)]	_	0,50	_	0,11	0,15
22H	Carbon steel [3)]	Quenched and tempered	0,50	_	0,05	0,05
33H	Carbon steel [3)]	Quenched and tempered	0,50	_	0,05	0,05
45H	Alloy steel [3) 4)]	Quenched and tempered	0,50	0,19	0,05	0,05

1) Free-cutting steel may be used, with lead content 0,35% max., phosphorus content 0,11 % max. and sulphur content 0,34% max.
2) Case hardening is allowed in the case of square-head set screws.
3) Steel with lead content 0,35% max. may be used.
4) Shall contain one or more of alloying elements chromium, nickel, molybdenum, vanadin or boron.

Source: SS-ISO 898/5.

Screws with metric ISO-thread

Excerpt from the Swedish and international standard ISO 898-1 for screws with metric ISO-thread.

The international standard ISO 898-1 is intended to simplify the entering of standardised mechanical properties and classes, and also to be a practical aid in the daily work. Presented here are the values for tensile loads, proof loads and yield loads.

All documentation is available in the Swedish standard.

ISO 898-1. Fasteners — Mechanical properties — Part 1: Screws and stud bolts with metric ISO-thread.

It applies to screws and stud bolts.

- With nominal diameter up to 39 mm.
- With triangular ISO-threads and with diameters and splits according to SS 1700, SS 1701 and SS 2160.
- In all existing shapes.
- From non-alloyed or alloyed steel.

It does not apply to set screws and similar fasteners. It does not apply when special demands are made for weldability, corrosion resistance and ability to resist temperatures above +300°C or below -50°C.

Property classes

The property classes are represented with two numbers separated by a dot. The standardised classes are: 3.6, 4.6, 4.8, 5.6, 5.8, 6.8, 8.8, 9.8, 10.9 and 12.9.

The first number indicates 1/100 of the nominal tensile strength (*R*m) in N/mm^2.

The second number indicates 10 times the nominal yield stress (*R*eL or *R*p0,2) and nominal tensile strength (*R*m).

If you multiply the two numbers you get 1/10 of the nominal yield stress in N/mm^2.

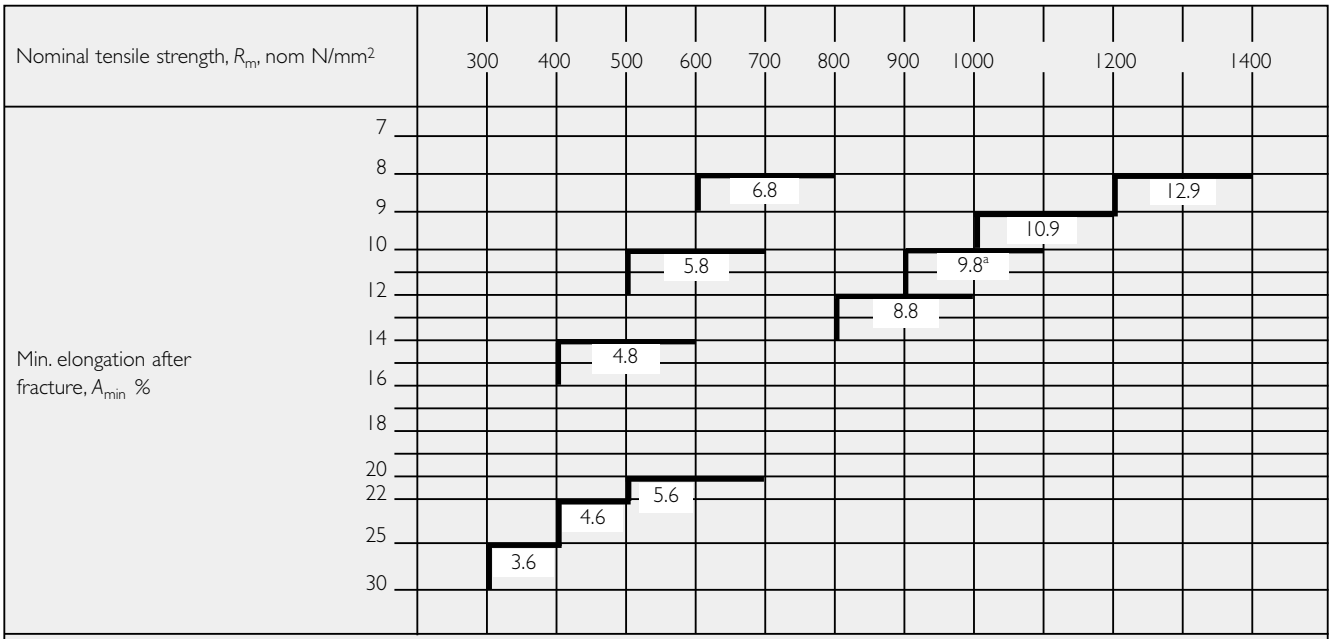
Example for property class 8.8

Nominal tensile strength = 8 · 100 = 800 N/mm^2.

$$\frac{\text{Nominal yield stress}}{\text{Nominal tensile strength}} \cdot 10 = 8$$

Nominal yield stress = 8 · 8 · 10 = 640 N/mm^2.

Table 10 System of coordinates



Relationship between yield stress and tensile strength			
Second figure of symbol	.6	.8	.9
$\frac{\text{Lower yield stress } R_{eL}{}^{b}}{\text{Nominal tensile strength } R_{m,\,nom}} \times 100\ \%$	60	80	90
$\frac{\text{Stress at 0,2\% non-proportional elongation } R_{p0.2}{}^{b}}{\text{Nominal tensile strength } R_{m,\,nom}} \times 100\ \%$			

NOTE Although a great number of property classes are specified in this part of ISO 898, this does not mean that all classes are appropriate for all items. Further guidance for application of the specific property classes is given in the relevant product standards. For non-standard items, it is advisable to follow as closely as possible the choice already made for similar standard items.

[a] Applies only to thread diameter $d \leq 16$ mm.

[b] Nominal values according to table 11 apply.

Source: EN ISO 898-1.

Table 11 Mechanical and physical properties of bolts, screws and studs

Sub-clause number	Mechanical and physical property			Property class										
				3.6	4.6	4.8	5.6	5.8	6.8	8.8[a] $d \leq 16$[c] mm	8.8[a] $d > 16$[c] mm	9.8[b]	10.9	12.9
5.1	Nominal tensile strength, $R_{m,\,nom}$		N/mm²	300	400		500		600	800	800	900	1000	1200
5.2	Minimum tensile strength, $R_{m,\,min}$[d e]		N/mm²	330	400	420	500	520	600	800	830	900	1040	1220
5.3	Vickers hardness, HV $F \geq 98$ N		min.	95	120	130	155	160	190	250	255	290	320	385
			max.	220[f]					250	320	335	360	380	435
5.4	Brinell hardness, HB $F = 30\ D^2$		min.	90	114	124	147	152	181	238	242	276	304	366
			max.	209[f]					238	304	318	342	361	414
5.5	Rockwell hardness, HR	min.	HRB	52	67	71	79	82	89	–	–	–	–	–
			HRC	–	–	–	–	–	–	22	23	28	32	39
		max.	HRB	95,0[f]					99,5	–	–	–	–	–
			HRC	–					–	32	34	37	39	44
5.6	Surface hardness, HV 0,3		max.	–						[g]				180
5.7	Lower yield stress R_{eL}[h], N/mm²		nom.	240	320	300	400	480	–	–	–	–	–	
			min.	190	240	340	300	420	480	–	–	–	–	–
5.8	Stress at 0,2 % non-proportional elongation $R_{p0,2}$[i], N/mm²		nom.	–					–	640	640	720	900	1080
			min.	–					–	640	660	720	940	1100
5.9		S_p/R_{eL} or $S_p/R_{p0,2}$		0,94	0,94	0,91	0,93	0,90	0,92	0,91	0,91	0,90	0,88	0,88
	Stress under proof load, S_p		N/mm²	180	225	310	280	380	440	580	600	650	830	970
5.10	Breaking torque, M_B		Nm min.	–						See ISO 898-7				
5.11	Percent elongation after fracture, A		min.	25	22	–	20	–	–	12	12	10	9	8
5.12	Reduction area after fracture, Z		% min.	–						52		48	48	44
5.13	Strength under wedge loading[e]			The values for full size bolts and screws (no studs) shall not be smaller than the min. values for tensile strength shown in 5.2.										
5.14	Impact strength, KU		J min.	–			25	–		30	30	25	20	15
5.15	Head soundness			No fracture										
5.16	Minimum height of non-decarburized thread zone, E			–						$\frac{1}{2}H_1$			$\frac{2}{3}H_1$	$\frac{3}{4}H_1$
	Maximum depth of complete decarburization, G		mm	–						0,015				
5.17	Hardness after retempering			–						Reduction of hardness 20 HV maximum				
5.18	Surface integrity			In accordance with ISO 6157-1 or ISO 6157-3 as appropriate										

a For bolts of property class 8.8 in diameters $d \leq 16$ mm, there is an increased risk of nut stripping in the case of inadvertent over-tightening inducing a load in excess of proof load. Reference to ISO 898-2 is recommended.

b Applies only to nominal thread diameters $d \leq 16$ mm.

c For structural bolting the limit is 12 mm.

d Minimum tensile properties apply to products of nominal length $l \geq 2{,}5\ d$. Minimum hardness applies to products of length $l < 2{,}5\ d$ and other products which cannot be tensile-tested (e.g. due to head configuration).

e When testing full-size bolts, screws and studs, the tensile loads, which are to be applied for the calculation of R_m, shall meet the values given in tables 14 and 16.

f A hardness reading taken at the end of bolts, screws and studs shall be 250 HV, 238 HB or 99,5 HRB maximum.

g Surface hardness shall not be more than 30 Vickers points above the measured core hardness on the product when readings of both surface and core are carried out at HV 0,3. For property class 10.9, any increase in hardness at the surface which indicates that the surface hardness exceeds 390 HV is not acceptable.

h In cases where the lower yield stress R_{eL} cannot be determined, it is permissible to measure the stress at 0,2 % non-proportional elongation $R_{p0,2}$. For the property classes 4.8, 5.8 and 6.8 the values for R_{eL} are given for calculation purposes only, they are not test values.

i The yield stress ratio according to the designation of the property class and the minimum stress at 0,2 % non-proportional elongation $R_{p0,2}$ apply to machined test specimens. These values if received from tests of full size bolts and screws will vary because of processing method and size effects.

Source: EN ISO 898-1.

Table 11.1 Mechanical properties of fasteners - set screws and similar threaded fasteners not under tensile stresses

Mechanical properties			Property class*			
			14H	22H	33H	45H
Vickers hardness HV		min.	140	220	330	450
		max.	290	300	440	560
Brinell hardness HB, $F = 30\ D^2$		min.	133	209	314	428
		max.	276	285	418	532
Rockwell hardness	HRB	min.	75	95	–	–
		max.	105	–	–	–
	HRC	min.	–	–	33	45
		max.	–	30	44	53
Minimum height of non-decarburized thread zone, E			–	$\frac{1}{2}H_1$	$\frac{2}{3}H_1$	$\frac{3}{4}H_1$
Maximum depth of complete decarburization, G		mm	–	0,015	0,015	**
Surface hardness HV 0,3		max.	–	320	450	580

* Classes 14H, 22H and 33H are not for hexagon socket set screws.

** No complete decarburization permitted in property class 45H.

Source: SS-ISO 898/5.

Table 14 Min. tensile loads, metric ISO coarse threads

Thread d	Nominal stress area A_s mm²	Property class									
		3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9
		Min. tensile load ($A_s \cdot R_m$), N									
M3	5,03	1 660	2 010	2 110	2 510	2 620	3 020	4 020	4 530	5 230	6 140
M3,5	6,78	2 240	2 710	2 850	3 390	3 530	4 070	5 420	6 100	7 050	8 270
M4	8,78	2 900	3 510	3 690	4 390	4 570	5 270	7 020	7 900	9 130	10 700
M5	14,2	4 690	5 680	5 960	7 100	7 380	8 520	11 350	12 800	14 800	17 300
M6	20,1	6 630	8 040	8 440	10 000	10 400	12 100	16 100	18 100	20 900	24 500
M7	28,9	9 540	11 600	12 100	14 400	15 000	17 300	23 100	26 000	30 100	35 300
M8	36,6	12 100	14 600	15 400	18 300	19 000	22 000	29 200	32 900	38 100	44 600
M10	58,0	19 100	23 200	24 400	29 000	30 200	34 800	46 400	52 200	60 300	70 800
M12	84,3	27 800	33 700	35 400	42 200	43 800	50 600	67 400[1]	75 900	87 700	103 000
M14	115	38 000	46 000	48 300	57 500	59 800	69 000	92 000[1]	104 000	120 000	140 000
M16	157	51 800	62 800	65 900	78 500	81 600	94 000	125 000[1]	141 000	163 000	192 000
M18	192	63 400	76 800	80 600	96 000	99 800	115 000	159 000	—	200 000	234 000
M20	245	80 800	98 000	103 000	122 000	127 000	147 000	203 000	—	255 000	299 000
M22	303	100 000	121 000	127 000	152 000	158 000	182 000	252 000	—	315 000	370 000
M24	353	116 000	141 000	148 000	176 000	184 000	212 000	293 000	—	367 000	431 000
M27	459	152 000	184 000	193 000	230 000	239 000	275 000	381 000	—	477 000	560 000
M30	561	185 000	224 000	236 000	280 000	292 000	337 000	466 000	—	583 000	684 000
M33	694	229 000	278 000	292 000	347 000	361 000	416 000	576 000	—	722 000	847 000
M36	817	270 000	327 000	343 000	408 000	425 000	490 000	678 000	—	850 000	997 000
M39	976	322 000	390 000	410 000	488 000	508 000	586 000	810 000	—	1 020 000	1 200 000

[1] Valid values for structural screws are 70 000, 95 500 and 130 000 N respectively.

Table 16 Min. tensile loads, metric ISO fine threads

Thread d	Nominal stress area A_s mm²	Property class									
		3.6	4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9
		Min. tensile load ($A_s \cdot R_m$), N									
M 8 × 1	39,2	12 900	15 700	16 500	19 600	20 400	23 500	31 360	35 300	40 800	47 800
M 10 × 1	64,5	21 300	25 800	27 100	32 300	33 500	38 700	51 600	58 100	67 100	78 700
M 12 × 1,5	88,1	29 100	35 200	37 000	44 100	45 800	52 900	70 500	79 300	91 600	107 500
M 14 × 1,5	125	41 200	50 000	52 500	62 500	65 000	75 000	100 000	112 000	130 000	152 000
M 16 × 1,5	167	55 100	66 800	70 100	83 500	86 800	100 000	134 000	150 000	174 000	204 000
M 18 × 1,5	216	71 300	86 400	90 700	108 000	112 000	130 000	179 000	–	225 000	264 000
M 20 × 1,5	272	89 800	109 000	114 000	136 000	141 000	163 000	226 000	–	283 000	332 000
M 22 × 1,5	333	110 000	133 000	140 000	166 000	173 000	200 000	276 000	–	346 000	406 000
M 24 × 2	384	127 000	154 000	161 000	192 000	200 000	230 000	319 000	–	399 000	469 000
M 27 × 2	496	164 000	194 000	208 000	248 000	258 000	298 000	412 000	–	516 000	605 000
M 30 × 2	621	205 000	248 000	261 000	310 000	323 000	373 000	515 000	–	646 000	758 000
M 33 × 2	761	251 000	304 000	320 000	380 000	396 000	457 000	632 000	–	791 000	928 000
M 36 × 3	865	285 000	346 000	363 000	432 000	450 000	519 000	718 000	–	900 000	1 055 000
M 39 × 3	1030	340 000	412 000	433 000	515 000	536 000	618 000	855 000	–	1 070 000	1 260 000

Table 58 Min. tensile loads for hot dip galvanized screws and nuts

Thread d	Pitch P	Stress area $A_{s\,min}$ mm²	Property class screw and nut			
			4/4.6	5/5.6	8/8.8	10/10.9
			Min. tensile loads for screw and nut ($A_{s\,min} \cdot R_m$) N			
M 6	1	16,4	6 560	8 200	13 100	17 100
M 8	1,25	31,3	12 500	15 700	25 000	32 600
M 10	1,5	50,9	20 400	25 500	40 700	52 900
M 12	1,75	75,1	30 000	37 600	60 100	78 100
M 14	2	104	41 600	52 000	83 200	108 000
M 16	2	144	57 600	72 000	115 000	150 000
M 18	2,5	177	70 800	88 500	147 000	184 000
M 20	2,5	227	90 800	114 000	188 000	236 000
M 22	2,5	284	114 000	142 000	236 000	295 000
M 24	3	329	132 000	165 000	273 000	342 000
M 27	3	433	173 000	216 000	359 000	450 000
M 30	3,5	530	212 000	265 000	440 000	551 000
M 33	3,5	659	264 000	330 000	547 000	685 000
M 36	4	777	311 000	389 000	645 000	808 000

Our fasteners meet the demands set by DIN 267/10.

Table 190 Minimum ultimate tensile loads for hexagon socket countersunk head screws acc. to ISO 10642 (80% of the values specified in ISO 898-1)

Thread d	Property class 8.8	10.9	12.9
	Minimum ultimate tensile load N		
M3	3 220	4 180	4 910
M4	5 620	7 300	8 560
M5	9 080	11 800	13 800
M6	12 900	16 700	19 600
M8	23 400	30 500	35 700
M10	37 100	48 200	56 600
M12	53 900	70 200	82 400
M14	73 600	96 000	112 000
M16	100 000	130 000	154 000
M20	162 000	204 000	239 000

Table 93 Qualities at increased temperature

Property class	Temperature °C				
	+20	+100	+200	+250	+300
	Lower yield stress, R_{eL}, or Extension limit, $R_{pO,2}$ N/mm^2				
5.6	300	270	230	215	195
8.8	640	590	540	510	480
10.9	940	875	790	745	705
12.9	1100	1020	925	875	825

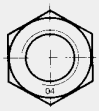
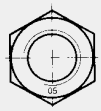
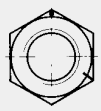
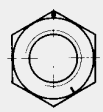
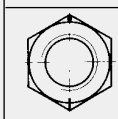
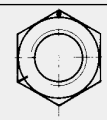
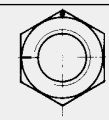
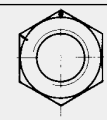
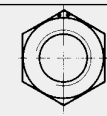
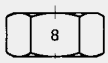
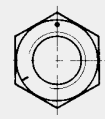
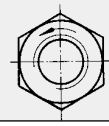
Values specified in the table are only a guideline, and approximate information of the decrease in the mechanical features that could be expected when performing tests of the ultimate tensile stress at increased temperatures. The values should not be used as requirements when testing screws and stud screws.

Table 13 Translation of property (ISO class - Grade class)

ISO-class	Old corresponding property classes in Sweden	Germany	U.K.	U.S.
3.6 4.6	D40 D40	4A 4D, 4P	A, B	SAE grade 1
4.8 5.6		4S 5D		SAE grade 2
5.8 6.8	D60 D60	5S, 6G 6S	P	SAE grade 3
8.8 9.8	D80 D100	6G	S, T	SAE grade 5
10.9 12.9	D120 D140	10K 12K	V X	SAE grade 8 ASTM A574

Marking and mechanical requirements for nuts of steel

Table 25 Nuts in mm (CLOCK MARKING)

Property class	04	05	4	5	6	8	9	10	12
Marking					6 	8 	9 	10 	12 
Example of marking					 left-threaded				

Nuts should be manufactured from steel with the chemical composition according to table 5.

Table 5 Chemical composition

Property class		Chemical composition (check analysis), % C max.	Mn min.	P max.	S max.
4[1] 5[1] 6[1]	—	0,50	—	0,060	0,150
8 9	04[1]	0,58	0,25	0,060	0,150
10[2]	05[1]	0,58	0,30	0,048	0,058
12[2]	—	0,58	0,45	0,048	0,058

1) Nuts in these property classes are possible to manufacture from free cutting steel if nothing else has been agreed between manufacturer and customer. In these cases the following max. proportions of sulphur, phosphorus and lead are allowed: Sulphur 0,34%, phosphorus 0,11% and lead 0,35%.

2) Alloy material can be added if it is necessary to achieve strength requirements.

Nuts with nominal heights ≥0,8 D (effective lengths of thread ≥0,6 D)

Nuts with nominal heights ≥0,8 D (effective lengths of thread ≥0,6 D) are designated by a number to indicate the maximum appropriate property class of bolts with which they may be mated.
It would therefore be desirable to design threaded connections so that their mode of failure would always be by shank fracture but, unfortunately, because of the many variables which govern stripping strength (nut and bolt material strengths, thread clearances, across-flats dimensions, etc.), nuts would have to be objectionably thick to guarantee this mode in all cases.
A bolt or screw of thread M5 to M39 assembled with a nut of the appropriate property class, in accordance with table 84, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occurring.

Nuts with nominal heights ≥0,5 D but <0,8 D (effective heights of thread) ≥0,4 D but <0,6 D)

Nuts with nominal heights ≥0,5 D but <0,8 D (effective height of thread ≥0,4 D but <0,6 D) are designated by a combination of two numbers. A guide for minimum expected stripping strengths of the joints when these nuts are assembled with bolts of various property classes is shown in table 186.

Table 82 Heights of hexagon nuts

Thread	Width across flats mm	Nut height					
		Style 1			Style 2		
		min. mm	max. mm	*m/D*	min. mm	max. mm	*m/D*
M 5	8	4,4	4,7	0,94	4,8	5,1	1,02
M 6	10	4,9	5,2	0,87	5,4	5,7	0,95
M 7	11	6,14	6,5	0,93	6,84	7,2	1,03
M 8	13	6,44	6,8	0,85	7,14	7,5	0,94
M 10	16	8,04	8,4	0,84	8,94	9,3	0,93
M 12	18	10,37	10,8	0,90	11,57	12	1,00
M 14	21	12,1	12,8	0,91	13,4	14,1	1,01
M 16	24	14,1	14,8	0,92	15,7	16,4	1,02
M 18	27	15,1	15,8	0,88	16,9	17,6	0,98
M 20	30	16,9	18	0,90	19	20,3	1,02
M 22	34	18,1	19,4	0,88	20,5	21,8	0,93
M 24	36	20,2	21,5	0,90	22,6	23,9	1,00
M 27	41	22,5	23,8	0,88	25,4	26,7	0,99
M 30	46	24,3	25,6	0,85	27,3	28,6	0,95
M 33	50	27,4	28,7	0,87	30,9	32,5	0,98
M 36	55	29,4	31	0,86	33,1	34,7	0,96
M 39	60	31,8	33,4	0,86	35,9	37,5	0,96

Table 83 Performance and property classes for nuts

Nut	Property class	Size above	Size up to	State
Style 1	4	M16	M39	Not tempered
	5	—	M39	Not tempered
	6	—	M39	Not tempered
	8	—	M16	Not tempered
		M16	M39	Tempered
	10	—	M39	Tempered
	12	—	M16	Tempered
Style 2	8	M16	M39	Not tempered
	9	—	M16	Not tempered
	12	—	M39	Tempered

Source: ISO 898-2.

Table 84 Nuts with nominal height ≥0,8 D (ISO metric coarse thread)

Nut property class	Mating bolts		Nuts	
			Style 1	Style 2
	Property class	Nominal diameter	Nominal diameter	
4	3.6; 4.6; 4.8	d > 16	d > 16	–
5	3.6; 4.6; 4.8	d ≤ 16	d ≤ 39	–
	5.6; 5.8	d ≤ 39		
6	6.8	d ≤ 39	d ≤ 39	–
8	8.8	d ≤ 39	d ≤ 39	d > 16 d ≤ 39
9	9.8	d ≤ 16	–	d ≤ 16
10	10.9	d ≤ 39	d ≤ 39	–
12	12.9	d ≤ 39	d ≤ 16	d ≤ 39

Generally nuts in higher property classes can replace nuts in lower property classes. This is recommended for screw-nut joints that will be loaded beyond yield stress or test tension.

Source: ISO 898-2.

Table 85 Nuts with nominal height ≥0,8 D (ISO metric fine thread)

Nut property class	Mating bolts		Nuts	
			Style 1	Style 2
	Property class	Nominal diameter	Nominal diameter	
5	3.6; 4.6; 4.8 5.6; 5.8	d ≤ 39	d ≤ 39	–
6	6.8	d ≤ 39	d ≤ 39	–
8	8.8	d ≤ 39	d ≤ 39	d ≤ 16
10	10.9	d ≤ 39	d ≤ 16	d ≤ 39
12	12.9	d ≤ 16	–	d ≤ 16

Source: ISO 898-6.

Table 185 Designation system and stresses under proof load for nuts with nominal heights ≥0,5 D but <0,8 D

Property class of nut	Nominal stress under proof load N/mm²	Actual stress under proof load N/mm²
04	400	380
05	500	500

Source: ISO 898-2.

Table 186 Minimum bolt stress when stripping occurs

Property class of the nut	Proof load stress of the nut N/mm²	Minimum stress in the core of bolt when stripping occurs N/mm² for bolts with property class			
		6.8	8.8	10.9	12.9
04	380	260	300	330	350
05	500	290	370	410	480

Table 12 Mechanical properties nuts (coarse thread)

Nominal size (thread diameter) mm		Property class 04					Property class 05					Property class 4				
		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut	
Above	up to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	380	188	302	NQT[1]	thin	500	272	353	QT[2]	thin	–	–	–	–	–
M4	M7															
M7	M10															
M10	M16															
M16	M39											510	117	302	NQT[1]	1

Nominal size (thread diameter) mm		Property class 5[3]					Property class 6					Property class 8									
		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut	
Above	up to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	520	130	302	NQT[1]	1	600	150	302	NQT[1]	1	800	180	302	NQT[1]	1	–	–	–	–	–
M4	M7	580					670					855	200								
M7	M10	590					680					870									
M10	M16	610					700					880									
M16	M39	630	146				720	170				920	233	353	QT[2]		890	180	302	NQT[1]	2

Nominal size (thread diameter) mm		Property class 9[3]					Property class 10					Property class 12									
		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut		Stress under proof load Sp	Vickers hardness HV		Nut	
Above	up to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	900	170	302	NQT[1]	2	1040	272	353	QT[2]	1	1140	295	353	QT[2]	1	1150	272	353	QT[2]	2
M4	M7	915	188				1040					1140					1150				
M7	M10	940					1040					1140					1160				
M10	M16	950					1050					1170					1190				
M16	M39	920					1060					–	–	–	–	–	1200				

1) NQT = Not quenched or tempered.

2) QT = Quenched and tempered.

3) The maximum bolt hardness of property classes 5.6 and 5.8 is 220 HV. This is the maximum bolt hardness in the thread engagement area whereas only the thread end or the head may have a maximum hardness of 250 HV. Therefore the values of stress under proof load are based on a maximum bolt hardness of 220 HV.

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

Source: SS-ISO 898-2.

Proof loads

Proof loads for coarse threads are specified in table 86 and for fine threads in table 87.

Table 86 Proof loads, Metric ISO coarse thread

Thread	Nom. stress area of mandrel A_s mm²	Property class										
		04	05	4	5	6	8		9	10	12	
		Proof loads ($A_s \times S_p$), N										
				Style 1	Style 1	Style 1	Style 1	Style 2	Style 2	Style 1	Style 1	Style 2
M 3	5,03	1910	2500	—	2600	3000	4000	—	4500	5200	5700	5800
M 3,5	6,78	2580	3400	—	3550	4050	5400	—	6100	7050	7700	7800
M 4	8,78	3340	4400	—	4550	5250	7000	—	7900	9150	10000	10100
M 5	14,2	5400	7100	—	8250	9500	12140	—	13000	14800	16200	16300
M 6	20,1	7640	10000	—	11700	13500	17200	—	18400	20900	22900	23100
M 7	28,9	11000	14500	—	16800	19400	24700	—	26400	30100	32900	33200
M 8	36,6	13900	18300	—	21600	24900	31800	—	34400	38100	41700	42500
M 10	58	22000	29000	—	34200	39400	50500	—	54500	60300	66100	67300
M 12	84,3	32000	42200	—	51400	59000	74200	—	80100	88500	98600	100300
M 14	115	43700	57500	—	70200	80500	101200	—	109300	120800	134600	136900
M 16	157	59700	78500	—	95800	109900	138200	—	149200	164900	183700	186800
M 18	192	73000	96000	97900	121000	138200	176600	107900	176600	203500	—	230400
M 20	245	93100	122500	125000	154400	176400	225400	218100	225400	259700	—	294000
M 22	303	115100	151500	154500	190900	218200	278800	269700	278800	321200	—	363600
M 24	353	134100	176500	180000	222400	254200	324800	314200	324800	374200	—	423600
M 27	459	174400	229500	234100	289200	330500	422300	408500	422300	486500	—	550800
M 30	561	213200	280500	286100	353400	403900	516100	499300	516100	594700	—	673200
M 33	694	263700	347000	353900	437200	499700	638500	617700	638500	735600	—	832800
M 36	817	310500	408500	416700	514700	588200	751600	727100	751600	866000	—	980400
M 39	976	370900	488000	497800	614900	702700	897900	868600	897900	1035000	—	1171000

Source: ISO 898-2.

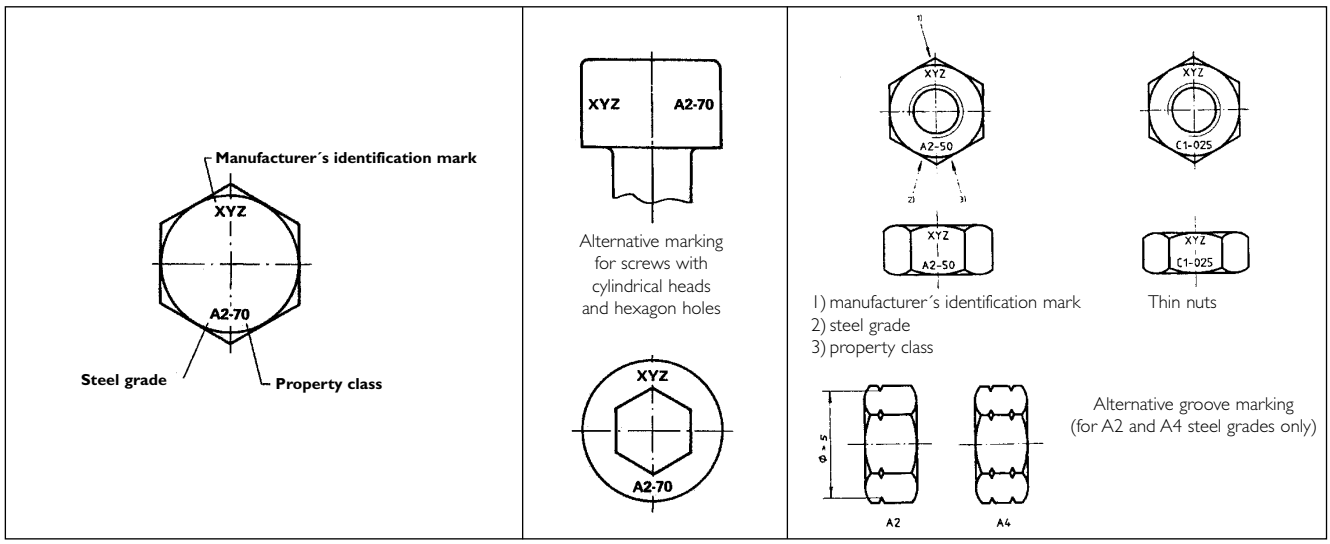
Table 87 Proof loads, Metric ISO fine thread

Thread	Nom. stress area of mandrel A_s mm²	Property class								
		04	05	5	6	8		10		12
		Proof loads ($A_s \times S_p$), N								
				Style 1	Style 1	Style 1	Style 2	Style 1	Style 2	Style 2
M8 X 1	39,2	14900	19600	27000	30200	37400	34900	43100	41400	47000
M10 X 1	64,5	24500	32200	44500	49700	61600	57400	71000	68000	77400
M10 X 1,25	61,2	23300	30600	44200	47100	58400	54500	67300	64600	73400
M12 X 1,25	92,1	35000	46000	63500	71800	88000	82000	102200	97200	110500
M12 X 1,5	88,1	33500	44000	60800	68700	84100	78400	97800	92900	105700
M14 X 1,5	125	47500	62500	86300	97500	119400	111200	138800	131900	150000
M16 X 1,5	167	63500	83500	115200	130300	159500	148600	185400	176200	200400
M18 X 1,5	215	81700	107500	154800	187000	221500	–	–	232200	–
M18 X 2	204	77500	102000	146900	177500	210100	–	–	220300	–
M20 X 1,5	272	103400	136000	195800	236600	280200	–	–	293800	–
M20 X 2	258	98000	129000	185800	224500	265700	–	–	278600	–
M22 X 1,5	333	126500	166500	239800	289700	343000	–	–	359600	–
M22 X 2	318	120800	159000	229000	276700	327500	–	–	343400	–
M24 X 2	384	145900	192000	276500	334100	395500	–	–	414700	–
M27 X 2	496	188500	248000	351100	431500	510900	–	–	535700	–
M30 X 2	621	236000	310500	447100	540300	639600	–	–	670700	–
M33 X 2	761	289200	380500	547900	662100	783800	–	–	821900	–
M36 X 3	865	328700	432500	622800	804400	942800	–	–	943200	–
M39 X 3	1030	391400	515000	741600	957900	1123000	–	–	1112000	–

Source: ISO 898-6.

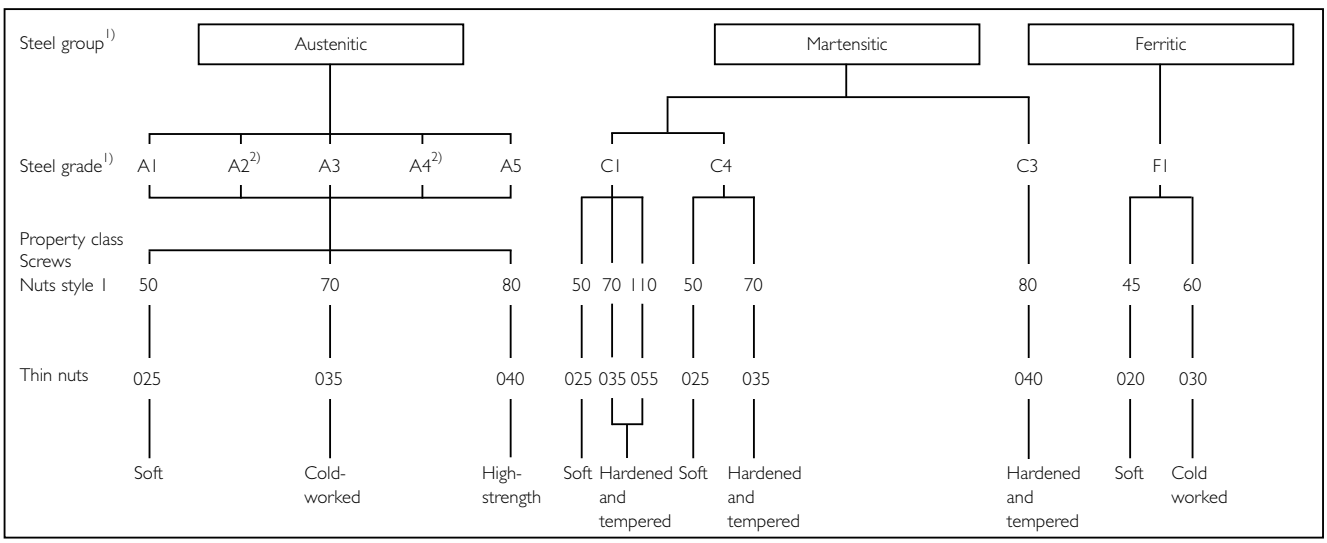
Marking and mechanical requirements for fasteners in stainless steel

Table 191 Stainless steel screws/nuts



Source: EN ISO 3506-1.

Table 192 Designation system for stainless steel grades and property classes for bolts, screws and nuts



1) The steel groups and steel grades classified in the table above are described on page 215 and specified by the chemical composition in table 6.1.

2) Low carbon stainless steels with carbon content not exceeding 0,03% may additionally be marked with an L.
Example: A4L - 80.

Source: EN ISO 3506-2.

Designation

The designation of the steel grade (first block) consists of the letters:

A for austenitic steel or
C for martensitic steel or
F for ferritic steel

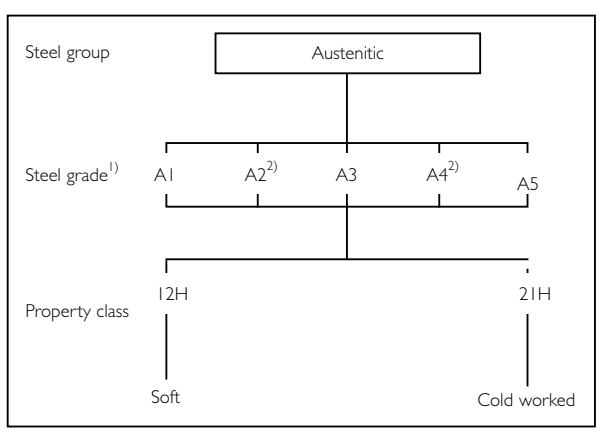
which indicate the group of steel and a digit which indicates a range of chemical compositions within this steel group.

The designation of the property class (second block) consists of 2 digits which indicates 1/10 of the tensile strength of the fastener.

Examples:

1) **A2-70** indicates:
austenitic steel, cold worked, minimum 700 N/mm^2 (700 MPa) tensile strength.
2) **C4-70** indicates:
martensitic steel, hardened and tempered, minimum 700 N/mm^2 (700 MPa) tensile strength.

Table 193 Designation system for stainless steel grades and property classes for set screws and similar fasteners



1) The steel grades classified in the table above are described on page 215 and specified by the chemical composition in table 6.1.

2) Low carbon stainless steels with carbon content not exceeding 0,03% may additionally be marked with an L.
Example: A4L - 21H.

Source: EN ISO 3506-3.

Table 6.1 Stainless steel grades - Chemical composition

Group	Grade	Chemical composition % (m/m) [1]									Notes
		C	**Si**	**Mn**	**P**	**S**	**Cr**	**Mo**	**Ni**	**Cu**	
Austenitic	**A1**	0,12	1	6,5	0,2	0,15 - 0,35	16 - 19	0,7	5 - 10	1,75 - 2,25	2) 3) 4)
	A2	0,1	1	2	0,05	0,03	15 - 20	– [5]	8 - 19	4	7) 8)
	A3	0,08	1	2	0,045	0,03	17 - 19	– [5]	9 - 12	1	9)
	A4	0,08	1	2	0,045	0,03	16 - 18,5	2 - 3	10 - 15	1	8) 10)
	A5	0,08	1	2	0,045	0,03	16 - 18,5	2 - 3	10,5 - 14	1	9) 10)
Martensitic[a]	**C1**	0,09 - 0,15	1	1	0,05	0,03	11,5 - 14	–	1	–	10)
	C3	0,17 - 0,25	1	1	0,04	0,03	16 - 18	–	1,5 - 2,5	–	
	C4	0,08 - 0,15	1	1,5	0,06	0,15 - 0,35	12 - 14	0,6	1	–	2) 10)
Ferritic[a]	**F1**	0,12	1	1	0,04	0,03	15 - 18	– [6]	1	–	11) 12)

1) Values are maximum unless otherwise indicated.
2) Sulfur may be replaced by selenium.
3) If the nickel content is below 8%, the minimum manganese content must be 5%.
4) There is no minimum limit to the copper content provided that the nickel content is greater than 8%.
5) Molybdenum may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this must be stated at the time of ordering by the purchaser.
6) Molybdenum may be present at the discretion of the manufacturer.
7) If the chromium content is below 17%, the minimum nickel content should be 12%.
8) For austenitic stainless steels having a maximum carbon content of 0,03%, nitrogen may be present to a maximum of 0,22%.
9) Must contain titanium ≥ 5 x C up to 0,8% maximum for stabilization and be marked appropriately in accordance with this table, or must contain niobium (columbium) and/or tantalum ≥ 10 x C up to 1,0% maximum for stabilization and be marked appropriately in accordance with this table.
10) At the discretion of the manufacturer the carbon content may be higher where required to obtain the specified mechanical properties at larger diameters, but shall not exceed 0,12% for austenitic steels.
11) May contain titanium ≥ 5 x C up to 0,8% maximum.
12) May contain niobium (columbium) and/or tantalum ≥ 10 x C up to 1% maximum.
a) Not valid for set screws.

Source: EN ISO 3506.

Table 6 Stainless material translations

Description for types of steel according to ISO 3506	Corresponding types of steel according to Swedish material standards
A1	SS-steel 2346
A2	SS-steel 2332, SS-steel 2333, SS-steel 2337, SS-steel 2338, SS-steel 2351
A4	SS-steel 2343, SS-steel 2347, SS-steel 2350, SS-steel 2353
C1	SS-steel 2302, SS-steel 2303, SS-steel 2304
C3	SS-steel 2321
C4	SS-steel 2380
F1	SS-steel 2320, SS-steel 2326

Table 94 Application of stainless steel bolts, screws and studs at low temperatures (austenitic steel only)

Steel grade	**Lower limits of operational temperature at continuous operation**	
A2	-200 °C	
A4	bolts and screws[1]	- 60 °C
	studs	-200 °C

1) In connection with the alloying element Mo the stability of the austenite is reduced and the transition temperature is shifted to higher values if a high degree of deformation during manufacturing of the fastener is applied.

Table 95 Influence of temperature on R_{eL} and $R_{p0,2}$

Steel grade	R_{eL} and $R_{p0,2}$ % Temperature			
	+100 °C	+200 °C	+300 °C	+400 °C
A2 A4	85	80	75	70
C1	95	90	80	65
C3	90	85	80	60

NOTE - This applies to property classes 70 and 80 only.

Source: SS-EN ISO 3506-2.

Lower yield stress or stress at 0,2% permanent strain at elevated temperatures

The values given above are for guidance only. Users should understand that the actual chemistry, loading of the installed fastener and the environment may cause significant variation. If loads are fluctuating and operating periods at elevated temperatures are great or the possibility of stress corrosion is high the user should consult the manufacturer.

Table 176 Mechanical properties for bolts, screws and studs - Austenitic grades

Group	Grade	Property class	Thread diameter range	Tensile strength R_m [1] min. N/mm²	Stress at 0,2% permanent strain $R_{p\,0,2}$ [1] min. N/mm²	Elongation after fracture A [2] min. mm
Austenitic	A1, A2	50	≤M39	500	210	0,6 d
	A3, A4	70	≤M24 [3]	700	450	0,4 d
	A5	80	≤M24 [3]	800	600	0,3 d

1) The tensile stress is calculated on the stress area.
2) To be determined on the actual screw length and not on a prepared test piece; *d* is the nominal thread diameter.
3) For fasteners with nominal thread diameters *d* > 24 mm the mechanical properties shall be agreed upon between user and manufacturer and marked with grade and property class according to this table.

Table 177 Mechanical properties for bolts, screws and studs - Martensitic and ferritic grades

Group	Grade	Property class	Tensile strength R_m [1] min. N/mm²	Stress at 0,2% permanent strain $R_{p\,0,2}$ [1] min. N/mm²	Elongation after fracture A [2] min. mm	Hardness		
						HB	HRC	HV
Martensitic	C1	50	500	250	0,2 *d*	147 - 209	—	155 - 220
		70	700	410	0,2 *d*	209 - 314	20 - 34	220 - 330
		110 [3]	1100	820	0,2 *d*	—	36 - 45	350 - 440
	C3	80	800	640	0,2 *d*	228 - 323	21 - 35	240 - 340
	C4	50	500	250	0,2 *d*	147 - 209	—	155 - 220
		70	700	410	0,2 *d*	209 - 314	20 - 34	220 - 330
Ferritic	F1 [4]	45	450	250	0,2 *d*	128 - 209	—	135 - 220
		60	600	410	0,2 *d*	171 - 271	—	180 - 285

1) The tensile stress is calculated on the stress area.
2) To be determined on the actual screw length and not on a prepared test piece; *d* is the nominal thread diameter.
3) Hardened and tempered at a minimum tempering temperature of 275 °C.
4) Nominal thread diameter *d* ≤ 24 mm.

Table 178 Minimum breaking torque, $M_{B,min}$ for austenitic grade bolts and screws M1,6 - M16 (coarse thread)

Thread	Minimum breaking torque, $M_{B,min}$ Nm		
	Property class		
	50	**70**	**80**
M1,6	0,15	0,2	0,24
M2	0,3	0,4	0,48
M2,5	0,6	0,9	0,96
M3	1,1	1,6	1,8
M4	2,7	3,8	4,3
M5	5,5	7,8	8,8
M6	9,3	13	15
M8	23	32	37
M10	46	65	74
M12	80	110	130
M16	210	290	330

Minimum breaking torque values for martensitic and ferritic grade fasteners shall be agreed upon between manufacturer and user.

Source: EN ISO 3506-1.

Table 179 Mechanical properties for nuts - Austenitic grades

Group	Grade	Property class		Range of thread diameter	Stress under proof load S_p min N/mm²	
		Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	d mm	Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)
Austenitic	A1	50	025	≤39	500	250
	A2, A3	70	035	≤24[1)]	700	350
	A4, A5	80	040	≤24[1)]	800	400

1) For fasteners with nominal thread diameters $d > 24$ mm the mechanical properties shall be agreed upon between user and manufacturer and marked with grade and property class according to this table.

Table 180 Mechanical properties for nuts - Martensitic and ferritic grades

Group	Grade	Property class		Stress under proof load S_p min N/mm²		Hardness		
		Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	Nuts style 1 ($m \geq 0{,}8\ d$)	Thin nuts ($0{,}5\ d \leq m < 0{,}8\ d$)	**HB**	**HRC**	**HV**
Martensitic	C1	50	025	500	250	147 - 209	—	155 - 220
		70	—	700	—	209 - 314	20 - 34	220 - 330
		110[1)]	055[1)]	1100	550	—	36 - 45	350 - 440
	C3	80	040	800	400	228 - 323	21 - 35	240 - 340
	C4	50	—	500	—	147 - 209	—	155 - 220
		70	035	700	350	209 - 314	20 - 34	220 - 330
Ferritic	F1[2)]	45	020	450	200	128 - 209	—	135 - 220
		60	030	600	300	171 - 271	—	180 - 285

1) Hardened and tempered at a minimum tempering temperature of 275°C.

2) Nominal thread diameter $d \leq 24$ mm.

Table 182 Hardness - Set screws shall conform to the hardness requirements given in the table below

Test method	Property class	
	12H	21H
	Hardness	
Vickers hardness HV	125 - 209	210 min
Brinell hardness HB	123 - 213	214 min
Rockwell hardness HRB	70 - 95	96 min

Table 181 Proof torque of hexagon socket set screws

Hexagon socket set screws shall conform to the torque requirements given in table 181

Nominal thread diameter d	Minimum length[1)] of set screws for test mm				Proof torque Nm min	
					Property class	
	Flat point	Cone point	Dog point	Cup point	12H	21H
1,6	2,5	3	3	2,5	0,03	0,05
2	4	4	4	3	0,06	0,1
2,5	4	4	5	4	0,18	0,3
3	4	5	6	5	0,25	0,42
4	5	6	8	6	0,8	1,4
5	6	8	8	6	1,7	2,8
6	8	8	10	8	3	5
8	10	10	12	10	7	12
10	12	12	16	12	14	24
12	16	16	20	16	25	42
16	20	20	25	20	63	105
20	25	25	30	25	126	210
24	30	30	35	30	200	332

1) The minimum lengths to be tested are the lengths having the normal hexagon socket depth.

Source: EN ISO 3506-2 and 3.

Description of the groups and grades of stainless steels

General:
In ISO 3506-1, ISO 3506-2 and ISO 3506-3 reference is made to steel grades A1 to A5, C1 to C4 and F1 covering steels of the following groups:

Austenitic steel	A1-A5
Martensitic steel	C1-C4
Ferritic steel	F1

The characteristics of the above mentioned steel groups and grades are described on this page.
This page also gives some information on the non-standardized steel group FA.

Steel group A (austenitic structure)
Five main grades of austenitic steels, A1 to A5, are included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. They cannot be hardened and are usually non-magnetic. In order to reduce the susceptibility to work hardening copper may be added to the steel grades A1 to A5 as specified in table 6.1.
For non-stabilized steel grades A2 and A4 the following applies.
As chromic oxide makes steel resistant to corrosion, low carbon content is of great importance to non-stabilized steels. Due to the high affinity of chrome to carbon, chrome carbide is obtained instead of chromic oxide which is more likely at elevated temperature.
For stabilized steel grades A3 and A5 the following applies. The elements Ti, Nb or Ta affect the carbon and chromic oxide is produced to its full extent.
For offshore or similar applications, steels with Cr and Ni contents of about 20% and Mo of 4,5% to 6,5% are required. When risk of corrosion is high experts should be consulted.

Steel grade A1
Steel grade A1 is especially designed for machining. Due to the high sulfur content of the steels within this grade have lower resistance to corrosion than corresponding steels with normal sulfur content.

Steel grade A2
Steels of grade A2 are the most frequently used stainless steels. They are used for kitchen equipment and apparatus for the chemical industry. Steels within this grade are not suitable for use in non-oxidizing acid and agents with chloride content, i.e. swimming pools and sea water.

Steel grade A3
Steels of grade A3 are stabilized "stainless steels" with properties of steels in grade A2.

Steel grade A4
Steels of grade A4 are "acid proof steels", which are Mo alloyed and give considerably better resistance to corrosion. A4 is used to a great extent by the cellulose industry as this steel grade is developed for boiling sulfuric acid (thus given the name "acid proof") and is, to a certain extent, also suitable in an environment with chloride content.
A4 is also frequently used by the food industry and by the ship-building industry.

Steel grade A5
Steels of grade A5 are stabilized "acid proof steels" with properties of steels in grade A4.

Steel group F (ferritic structure)
The steels within the steel grade F1 cannot be hardened normally and should not be hardened even if possible in certain cases. The F1 steels are magnetic.

Steel grade F1
Steel grade F1 is normally used for simpler equipment with the exeption of the superferrites which have extremely low C and N contents. The steels within grade F1 can, if need be, replace steels of grades A2 and A3 and be used at higher chloride content.

Steel group C (martensitic structure)
Three types of martensitic steel grades, C1, C3 and C4, are included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. They can be hardened to an excellent strength and are magnetic.

Steel grade C1
Steels within the grade C1 have limited resistance to corrosion. They are used in turbines, pumps and for knives.

Steel grade C3
Steels within the grade C3 have limited resistance to corrosion though better resistance than C1. They are used in pumps and valves.

Steel grade C4
Steels within grade C4 have limited resistance to corrosion. They are intended for machining, otherwise they are similar to steels of grade C1.

Steel group FA (ferritic-austenitic structure)
Steel group FA is not included in ISO 3506-1, ISO 3506-2 and ISO 3506-3 but will most probably be included in the future. Steels of this steel group are the so-called duplex steels. The first FA steels to be developed had some drawbacks that have been eliminated in the recently developed steels. The FA steels have better properties than steels of the types A4 and A5 especially as strength is concerned. They also exhibit superior resistance to pitting and crack corrosion.
Examples of composition are shown in the table below.

What is the difference between A4 and A4-2343?
A4-2343 has theoretically a better protection against corrosion (point and slit corrosion), due to a higher molybdenum content.
A4 and A4-2343 are the same in ordinary corrosion. According to Swedish steel grade, the tolerances within the different alloy components are such, that the differences are practically erased. The screw producers choice in material is more an issue of standardisation than corrosion resistance.

Table 194 Ferritic-austenitic steels - Chemical composition

Group	Chemical composition % (*m*/*m*)						
	C max.	Si	Mn	Cr	Ni	Mo	N
Ferritic-austenitic	0,03	1,7	1,5	18,5	5	2,7	0,07
	0,03	<1	<2	22	5,5	3	0,14

Source: EN ISO 3506-1.

Mechanical requirements of fasteners made of non-ferrous metals

Designation system and materials

Table 195 lists the symbols for the material to be used in the designation and for marking purposes, reference is made to the relevant International Standard.

Table 195 Symbols for materials

Symbol	Designation of material	Relevant International Standard		Old SS-number
		ISO	EN	
CU1	Cu-ETP or Cu-FRHC (Copper)	1337	CW004A	5010
CU2	CuZn37 (Brass)	426/1	CW508L	5150
CU3	CuZn39Pb3 (Brass)	426/2	CW614N	5170
CU4	CuSn6 (Tin bronze)	427	CW452K	5428
CU5	CuNi1Si (Tin bronze)	1187	—	—
CU6	CuZn40Mn1Pb (Brass)	—	—	—
CU7	CuAl10Ni5Fe4 (Nickel brass)	428	CC333G	5716
AL1	AlMg3 (Aluminium)	209	AW5754	4125
AL2	AlMg5 (Aluminium)	209	AW5019	—
AL3	AlSi1MgMn (Aluminium)	209	AW6082	4212
AL4	AlCu4MgSi (Aluminium)	209	AW2014	4338
AL5	AlZnMgCu 0,5 (Aluminium)	—	—	—
AL6	AlZn5,5MgCu (Aluminium)	209	AW7075	4425

Source: SS-ISO 8839.

Mechanical properties

When tested at the standard reference temperature of 20°C using the methods described in section about test methods, the bolts, screws, studs and nuts shall have the mechanical properties set out in the table below.

Table 196 Mechanical properties

Material		Nominal thread diameter d	Tensile strength R_m min.	Stress at permanent set limit $R_{p0.2}$ min.	Percentage elongation after fracture A min.
Symbol	Designation		N/mm²	N/mm²	%
CU1	Cu-ETP or Cu-FRHC	d ≤ M39	240	160	14
CU2	CuZn37	d ≤ M6	440	340	11
		M6 < d ≤ M39	370	250	19
CU3	CuZn39Pb3	d ≤ M6	440	340	11
		M6 < d ≤ M39	370	250	19
CU4	CuSn6	d ≤ M12	470	340	22
		M12 < d ≤ M39	400	200	33
CU5	CuNi1Si	d ≤ M39	590	540	12
CU6	CuZn40Mn1Pb	M6 < d ≤ M39	440	180	18
CU7	CuAl10Ni5Fe4	M12 < d ≤ M39	640	270	15
AL1	AlMg3	d ≤ M10	270	230	3
		M10 < d ≤ M20	250	180	4
AL2	AlMg5	d ≤ M14	310	205	6
		M14 < d ≤ M36	280	200	6
AL3	AlSi1MgMn	d ≤ M6	320	250	7
		M6 < d ≤ M39	310	260	10
AL4	AlCu4MgSi	d ≤ M10	420	290	6
		M10 < d ≤ M39	380	260	10
AL5	AlZnMgCu 0,5	d ≤ M39	460	380	7
AL6	AlZn5,5MgCu	d ≤ M39	510	440	7

Source: SS-ISO 8839.

Torsional strength test

In general for torsional strength testing, a full size bolt or screw shall be used and the test shall be carried out as described in ISO 898/7. The accuracy of the measuring device shall lie within ±7% of the minimum breaking torque to be tested. The bolt or screw shall meet the minimum breaking torque laid down in table 197.

Table 197 Minimum breaking torque

Nominal thread diameter d	Symbols for materials										
	CU1	CU2	CU3	CU4	CU5	AL1	AL2	AL3	AL4	AL5	AL6
	Min. breaking torque										
	N • m										
M1,6	0,06	0,10	0,10	0,11	0,14	0,06	0,07	0,08	0,1	0,11	0,12
M2	0,12	0,21	0,21	0,23	0,28	0,13	0,15	0,16	0,2	0,22	0,25
M2,5	0,24	0,45	0,45	0,5	0,6	0,27	0,3	0,3	0,43	0,47	0,5
M3	0,4	0,8	0,8	0,9	1,1	0,5	0,6	0,6	0,8	0,8	0,9
M3,5	0,7	1,3	1,3	1,4	1,7	0,8	0,9	0,9	1,2	1,3	1,5
M4	1	1,9	1,9	2	2,5	1,1	1,3	1,4	1,8	1,9	2,2
M5	2,1	3,8	3,8	4,1	5,1	2,4	2,7	2,8	3,7	4	4,5

Source: SS-ISO 8839.

Test methods

Tensile test applicable to bolts, screws and studs

In general for tensile testing, a full size bolt, screw or stud shall be used and the test shall be carried out as specified in ISO 898-1. For minimum breaking loads, see table 198.

Proof load test applicable to nuts

For proof load testing of nuts the method described in ISO 898-2 shall be used. The nuts shall meet the proof loads which are equal to the minimum breaking loads of the respective bolts, screws or studs laid down in table 198.

Table 198 Minimum breaking loads

Nom. thread diameter d	Pitch of the thread P	Nom. stress area A_s	Symbols for materials												
			CU1	CU2	CU3	CU4	CU5	CU6	CU7	AL1	AL2	AL3	AL4	AL5	AL6
			Min. breaking loads[1] $A_s \cdot R_m$												
	mm	mm^2	N												
M3	0,5	5,03	1210	2210	2210	2360	2970	-	-	1360	1560	1610	2110	2310	2570
M3,5	0,6	6,78	1630	2980	2980	3190	4000	-	-	1830	2100	2170	2850	3120	3460
M4	0,7	8,78	2110	3860	3860	4130	5180	-	-	2370	2720	2810	3690	4040	4480
M5	0,8	14,2	3410	6250	6250	6670	8380	-	-	3830	4400	4540	5960	6530	7240
M6	1	20,1	4820	8840	8840	9450	11860	-	-	5430	6230	6430	8440	9250	10250
M7	1	28,9	6940	10690	10690	13580	17050	12720	-	7800	8960	8960	12140	13290	14740
M8	1,25	36,6	8780	13540	13540	17200	21590	16100	-	9880	11350	11350	15370	16840	18670
M10	1,5	58,0	13920	21460	21460	27260	34220	25520	-	15660	17980	17980	24360	26680	29580
M12	1,75	84,3	20230	31190	31190	39620	49740	37090	-	21080	26130	26130	32030	38780	42990
M14	2	115	27600	42550	42550	46000	67850	50600	73600	28750	35650	35650	43700	52900	58650
M16	2	157	37680	58090	58090	62800	92630	69080	100500	39250	43960	48670	59660	72220	80070
M18	2,5	192	46080	71040	71040	76800	113300	84480	122900	48000	53760	59520	72960	88320	97920
M20	2,5	245	58800	90650	90650	98000	144500	107800	156800	61250	68600	75950	93100	112700	124900
M22	2,5	303	72720	112100	112100	121200	178800	133300	193900	-	84840	93930	115100	139400	154500
M24	3	353	84720	130600	130600	141200	208300	155300	225900	-	98840	109400	134100	162400	180000
M27	3	459	110200	169800	169800	183600	270800	202000	293800	-	128500	142300	174400	211100	234100
M30	3,5	561	134600	207600	207600	224400	331000	246800	359000	-	157100	173900	213200	258100	286100
M33	3,5	694	166600	256800	256800	277600	-	305400	444200	-	194300	215100	263700	319200	353900
M36	4	817	196100	302300	302300	326800	-	359500	522900	-	228800	253300	310500	375800	416700
M39	4	976	234200	361100	361100	390400	-	429400	624600	-	-	302600	370900	449000	497800

[1] For nuts, proof load.

Source: SS-ISO 8839.

Grade identification markings and mechanical requirements for carbon steel threaded fasteners in inch

Table 27 Grade identification markings and mechanical requirements for carbon steel externally threaded fasteners

Grade Identification marking	Specification	Nominal size inch	Mechanical requirements fasteners				
			Yield strength ksi min.	Tensile strength ksi min.	Rockwell hardness		
					Surface max.	Core	
						min.	max.
	ASTM A307 Gr. A	1/4 - 4	—	60	—	B69	B100
	ASTM A307 Gr. B	1/4 - 4	— —	60 min. 100 max.	—	B69	B95
 No mark	SAE J429 Gr. 1	1/4 - 1 1/2	36	60	—	B70	B100
	SAE J429 Gr. 2	1/4 - 3/4 över 3/4 - 1 1/2	57 —	74 60	— —	B80 B70	B100 B100
	SAE J429 Gr. 5	1/4 - 1 1 1/8 - 1 1/2	92 81	120 105	30N54 30N50	C25 C19	C34 C30
	ASTM A449 Type 1	1/4 - 1 1 1/8 - 1 1/2 1 3/4 - 3	92 81 58	120 105 90	— — —	C25 C19 B91	C34 C30 B100
	ASTM A325 Type 1	1/2 - 1 1 1/8 - 1 1/2	92 81	120 105	— —	C24 C19	C35 C31
	SAE J 429 Gr. 5.2	1/4 - 1	92	120	30N56	C26	C36
	ASTM A449 Type 2	1/4 - 1	92	120	—	C25	C34
	ASTM A325 Type 3	1/2 - 1	92	120	—	C24	C35
		1 1/8 - 1 1/2	81	105	—	C19	C31
	SAE J429 Gr. 8	1/4 - 1 1/2	130	150	30N58.6	C33	C39
	ASTM A354 Gr. BD	1/4 - 2 1/2	130	150	—	C33	C39
		2 3/4 - 4	115	140	—	C31	C38
	ASTM A490 Type 1	1/2 - 1 1/2	130	150 min. 170 max.	— —	C33	C38
	SAE J429 Gr. 8.2	1/4 - 1	130	150	30N58.6	C33	C39
	ASTM A490 Type 3	1/2 - 1 1/2	130	150 min. 170 max.	— —	C33	C38

Source: IFI.

Table 28 Grade identification markings and mechanical requirements for carbon steel nuts with UNC, 8 UN, 6 UN and coarser pitch threads

Grade Identification marking	Strength grade of nut	Dimensional style of nut	Nominal nut size inch	Proof load stress ksi		Nut Rockwell hardness	
				Non-zinc coated nuts	Zinc coated nuts	min.	max.
 No mark	ASTM A563 Gr. A	hex	1/4 - 1 1/2	90	68	B68	C32
		heavy hex	1/4 - 4	100	75		
		hex thick	1/4 - 1 1/2				
 No mark	SAE Gr. 2	hex	1/4 - 1 1/2	90	–	–	C32
 No mark	ASTM A563 Gr. B	hex	1/4 - 1	120	90	B69	C32
			1 1/8 - 1 1/2	105	79		
		heavy hex och hex thick	1/4 - 1	133	100	B69	C32
			1 1/8 - 1 1/2	116	87		
	SAE Gr. 5	hex	1/4 - 1	120	–	–	C32
			1 1/8 - 1 1/2	105	–		
 	ASTM A563 Gr. C ASTM A563 Gr. C3	heavy hex	1/4 - 4	144	144	B78	C38
 	ASTM A563 Gr. D	hex	1/4 - 1 1/2	135	135	B84	C38
	ASTM A194 Gr. 2	heavy hex	1/4 - 4	150	150		
	ASTM A563 Gr. D	hex thick	1/4 - 1-1/2	150	150	B84	C38
	SAE Gr. 8	hex	1/4 - 5/8	150	–	C24	C32
			3/4 - 1			C26	C34
			1 1/8 - 1 1/2			C26	C36
 	ASTM A563 Gr. DH ASTM A194 Gr. 2H	hex	1/4 - 1 1/2	150	150	C24	C38
  	ASTM A563 Gr. DH ASTM A563 Gr. DH 3 ASTM A194 Gr. 2H	heavy hex	1/4 - 4	175	175	C24	C38
	ASTM A563 Gr. DH	hex thick	1/4 - 1 1/2	175	175	C24	C38

Source: IFI.

Table 28 Grade identification markings and mechanical requirements for carbon steel nuts with UNF, 12 UN and finer pitch threads

Grade Identification marking	Strength grade of nut	Dimensional style of nut	Nominal nut size inch	Proof load stress ksi		Nuts Rockwell hardness	
				Non-zinc coated nuts	Zinc coated nuts	min.	max.
 No mark	ASTM A563 Gr. A	hex	1/4 - 1 1/2	80	60	B68	C32
		heavy hex	1/4 - 4	90	68		
		hex thick	1/4 - 1 1/2				
 No mark	SAE Gr. 2	hex	1/4 - 1 1/2	90	–	–	C32
 No mark	ASTM A563 Gr. B	hex	1/4 - 1	109	82	B69	C32
			1 1/8 - 1 1/2	94	70		
		heavy hex och hex thick	1/4 - 1	120	90	B69	C32
			1 1/8 - 1 1/2	105	79		
	SAE Gr. 5	hex	1/4 - 1	109	–	–	C32
			1 1/8 - 1 1/2	94	–		
	ASTM A563 Gr. D	hex	1/4 - 1 1/2	135	135	B84	C38
		heavy hex	1/4 - 4	150	150		
		hex thick	1/4 - 1 1/2				
	SAE Gr. 8	hex	1/4 - 5/8	150	–	C24	C32
			3/4 - 1			C26	C34
			1 1/8 - 1 1/2			C26	C36
	ASTM A563 Gr. DH	hex	1/4 - 1 1/2	150	150	C24	C38
		heavy hex	1/4 - 4	175	175		
		hex thick	1/4 - 1 1/2				

Source: IFI.

Type of nut	Hex	Hex Thick	Heavy Hex
Thickness	0.875 D[1]	1 D[1]	1 D[1]
Width across flats	1.5 D[1]	1.5 D[1]	1.5 D[1] + 0.125

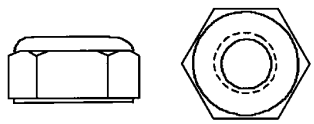
[1] D = thread diameter.

Source: IFI.

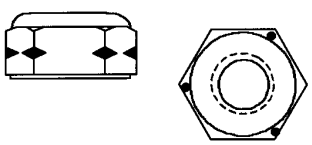
Lock nuts in inch

IFI

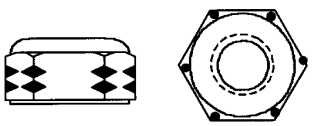
Is marked according to the following example.



IFI Grade A
(no mark)



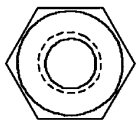
IFI Grade B



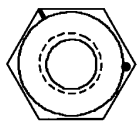
IFI Grade C

SAE

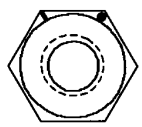
SAE J995 does not require markings. In cases were marking is applied it is done according to the mentioned below.



SAE Grade 2
(no mark)



SAE Grade 5



SAE Grade 8

Table 199 Mechanical properties - Bolts, screws and studs with inch threads (UNC- and UNF-threads)

Mechanical property	Property class				
	4.6 SAE Grade 1 [1]	5.8 SAE Grade 2 [1]	8.8 SAE Grade 5 [1]	10.9 SAE Grade 8 [1]	12.9 ASTM A574 [1]
Tensile strength, R_m, N/mm² min. 1000 lbf/in² min.	414 60	510 74	827 [2] 120	1 034 150	1 240 [2] 180
Vickers hardness HV Rockwell hardness HR HRB Rockwell hardness HR HRC Brinell hardness HB	127 - 254 70 - 100 121 - 241	157 - 254 80 - 100 149 - 241	268 - 336 25 - 34 255 - 319	326 - 382 33 - 39 310 - 363	382 - 446 39 - 45
Surface hardness HV 0,3 max.	–	–	356	402	454
Yield stress, R_e, N/mm² min.[3] 1000 lbf/in² min.	248 36	393 57	–	–	–
Stress at permanent set limit, $R_{p0,2}$, N/mm² min. $R_{p0,2}$, 1000 lbf/in² min.	 –	 –	634[2] 92	896 130	1 117[2] 162
Stress under proof load, S_p, N/mm² min. 1000 lbf/in² min.	228 33	379 55	586[2] 85	827 120	965[2] 140
Elongation after fracture, A_5 %	22	10	12	9	8
Strength under wedge loading, N/mm² min. 1000 lbf/in² min.	414 60	510 74	827[2] 120	1 034 150	1 240[2] 180
Impact strength, KU min.	–	–	30	20	15
Head soundness	No fracture				
Minimum height of non-decarburized thread zone, E	–	–	$\frac{1}{2}H_1$	$\frac{2}{3}H_1$	$\frac{3}{4}H_1$
Maximum depth of complete decarburization, G mm	–	–	0,015	0,015	0,015

[1] = Designation according to SAE and ASTM.
[2] = The corresponding property classes according to SAE and ASTM have in coarser dimensions somewhat lower mechanical properties.
[3] = In a case where the yield stress, R_{eL}, cannot be determined, it is permissible to measure the stress at permanent set limit, $R_{p0,2}$.

Source: SS 2265.

Table 200 Mechanical properties - Nuts

Characteristic			Property class				
			4	6 SAE Grade 2 [1]	8 SAE Grade 5 [1]	10 SAE Grade 8 [1]	12 ASTM A574 [1]
Proof stress, S_p min.	UNC	N/mm² 1000 lbf/in²	414 60	621 90	827 120[2]	1034 150	1240 180
Proof stress, S_p min.	UNF	N/mm² 1000 lbf/in²	414 60	621 90	752 109[2]	1034 150	1240 180
Hardness	Brinell hardness	HB max	285	302	302	336	354
	Rockwell hardness	HRC max	30	32	32	36[3]	38
	Vickers hardness	HV max	300	318	318	354	373

[1] = Designation according to SAE and ASTM.
[2] = The corresponding property classes according to SAE and ASTM have in coarser dimensions somewhat lower mechanical properties.
[3] = For dimensions below 1", a lower hardness is permitted according to SAE and ASTM.

Source: SS 2268.

Table 201 Mechanical properties - Locknuts in inch

Grade	Locknut size (bolt dia.) inch	Proof load stress psi	Rockwell hardness
A	No. 4 - 1-1/2	90 000	C28 max.
B	No. 4 - 1	120 000	C28 max.
	Over 1 - 1-1/2	105 000	C28 max.
C	No. 4 - 5/8	150 000	C24/32
	Over 5/8 - 1		C26/34
	Over 1 - 1-1/2		C26/36
F	1/4 - 3/4	120 000	C28 max.
G	1/4 - 5/8	150 000	C24/32
	3/4	150 000	C26/34

Source: IFI-100/107 2002.

Table 202 Proof loads - Nuts with inch threads - Coarse threads

Nominal thread diameter inch	Number of threads per inch	Nominal stress area of the mandrel A_s mm²	Property class 4	6 SAE Grade 2	8 SAE Grade 5	10 SAE Grade 8	12 ASTM A574
			Proof load ($A_s \times S_p$), N				
1/4	20	20,5	–	12 700	16 950	21 200	25 400
5/16	18	33,8	–	21 000	27 950	34 950	41 900
3/8	16	50	–	31 000	41 350	51 700	62 000
7/16	14	68,6	–	42 600	56 750	70 900	85 100
1/2	13	91,5	–	56 800	75 700	94 600	113 500
9/16	12	117	–	72 700	96 800	121 000	145 100
5/8	11	146	60 400	90 700	120 700	151 000	181 000
3/4	10	216	89 400	134 100	178 600	223 300	267 800
7/8	9	298	123 400	185 100	246 400	308 100	369 500
1	8	391	161 900	242 800	323 400	404 300	484 800
1 1/8	7	492	203 700	305 500	406 900	508 700	610 100
1 1/4	7	625	258 700	388 100	516 900	646 200	775 000
1 3/8	6	745	308 400	462 600	616 100	770 300	923 800
1 1/2	6	907	375 500	563 200	750 100	937 800	1 124 700

Source: SS 2268.

Table 203 Min. ultimate tensile loads - Bolts, screws and studs with inch threads - Coarse threads

Nominal thread diameter inch	Number of threads per inch	Nominal stress area mm²	Property class 4.6 SAE Grade 1	5.8 SAE Grade 2	8.8 SAE Grade 5	10.9 SAE Grade 8	12.9 ASTM A574
			Minimum ultimate tensile load ($A_s \times R_m$), N				
1/4	20	20,5	8 500	10 450	16 950	21 200	25 400
5/16	18	33,8	14 000	17 250	27 950	34 950	41 900
3/8	16	50	20 700	25 500	41 350	51 700	62 000
7/16	14	68,6	28 400	34 900	56 750	70 900	85 100
1/2	13	91,5	37 900	46 700	75 700	94 600	113 500
9/16	12	117	48 400	59 700	96 800	121 000	145 100
5/8	11	146	60 400	74 400	120 700	151 000	181 000
3/4	10	216	89 400	110 200	178 600	223 300	267 800
7/8	9	298	123 400	152 000	246 400	308 100	369 500
1	8	391	161 900	199 400	323 400	404 300	484 800
1 1/8	7	492	203 700	250 900	406 900	508 700	610 100
1 1/4	7	625	258 700	318 700	516 900	646 200	775 000
1 3/8	6	745	308 400	380 000	616 100	770 030	923 800
1 1/2	6	907	375 500	462 600	750 100	937 800	1 124 700

Source: SS 2265.

Table 204 Min. ultimate tensile loads - Bolts, screws and studs with inch threads - Fine threads

Nominal thread diameter inch	Number of threads per inch	Nominal stress area mm²	Property class 4.6 SAE Grade 1	5.8 SAE Grade 2	8.8 SAE Grade 5	10.9 SAE Grade 8	12.9 ASTM A574
			Min. ultimate tensile load ($A_s \times R_m$), N				
1/4	28	23,5	9 700	12 000	19 400	24 300	29 100
5/16	24	37,5	15 500	19 100	31 000	38 800	46 500
3/8	24	56,7	23 500	28 900	46 900	58 600	70 300
7/16	20	76,6	31 700	39 100	63 300	79 200	95 000
1/2	20	103	42 600	52 500	85 200	106 500	127 700
9/16	18	131	54 200	66 800	108 300	135 400	162 400
5/8	18	165	68 300	84 200	136 500	170 600	204 600
3/4	16	241	99 800	122 900	199 300	249 200	298 800
7/8	14	329	136 200	167 800	272 100	340 200	408 000
1	12	428	177 200	218 300	353 900	442 500	530 700
1 1/8	12	552	228 500	281 500	456 500	570 800	684 500
1 1/4	12	692	286 500	352 900	572 300	715 500	858 100
1 3/8	12	848	351 100	432 500	701 300	876 800	1 051 500
1 1/2	12	1 020	422 300	520 200	843 500	1 054 700	1 264 800

Source: SS 2265.

Marking and mechanical requirements for fasteners of stainless steel in inch

Table 205 Mechanical property requirements for bolts, hex cap screws and studs in stainless steel

Stainless alloy Group	Condition [B]	Alloy mech. property marking	Nominal diameter inch	Full-Size tests		
				Tensile strength ksi	Yield strength ksi	Rockwell hardness
Austenitic alloys						
1 (303, 304, 304L, 305, 384, XM1, 18-9LW, 302HQ, 303Se)	AF	F593A	1/4 - 1 1/2	65 - 85	20	B85 max.
	A	F593B	1/4 - 1 1/2	75 - 100	30	B65 - 95
	CW1	F593C	1/4 - 5/8	100 - 150	65	B95 - C32
	CW2	F593D	3/4 - 1 1/2	85 - 140	45	B80 - C32
	SH1	F593A	1/4 - 5/8	120 - 160	95	C24 - C36
	SH2	F593B	3/4 - 1	110 - 150	75	C20 - C32
	SH3	F593C	1 1/8 - 1 1/4	100 - 140	60	B95 - C30
	SH4	F593D	1 3/8 - 1 1/2	95 - 130	45	B90 - C28
2 (316, 316L)	AF	F593E	1/4 - 1 1/2	65 - 85	20	B85 max.
	A	F593F	1/4 - 1 1/2	75 - 100	30	B65 - 95
	CW1	F593G	1/4 - 5/8	100 - 150	65	B95 - C32
	CW2	F593H	3/4 - 1 1/2	85 - 140	45	B80 - C32
	SH1	F593E	1/4 - 5/8	120 - 160	95	C24 - C36
	SH2	F593F	3/4 - 1	110 - 150	75	C20 - C32
	SH3	F593G	1 1/8 - 1 1/4	100 - 140	60	B95 - C30
	SH4	F593H	1 3/8 - 1 1/2	95 - 130	45	B90 - C28
3 (321, 347)	AF	F593J	1/4 - 1 1/2	65 - 85	20	B85 max.
	A	F593K	1/4 - 1 1/2	75 - 100	30	B65 - 95
	CW1	F593L	1/4 - 5/8	100 - 150	65	B95 - C32
	CW2	F593M	3/4 - 1 1/2	85 - 140	45	B80 - C32
	SH1	F593J	1/4 - 5/8	120 - 160	95	C24 - C36
	SH2	F593K	3/4 - 1	110 - 150	75	C20 - C32
	SH3	F593L	1 1/8 - 1 1/4	100 - 140	60	B95 - C30
	SH4	F593M	1 3/8 - 1 1/2	95 - 130	45	B90 - C28
Ferritic alloys						
4 (430, 430F)	AF	F593X	1/4 - 1 1/2	55 - 75	30	B85 max.
	A	F593N	1/4 - 1 1/2	55 - 75	30	B85 max.
	CW1	F593V	1/4 - 5/8	60 - 105	40	B75 - 98
	CW2	F593W	3/4 - 1 1/2	55 - 100	30	B65 - 95
Martensitic alloys						
5 (410, 416, 416Se)	H	F593P	1/4 - 1 1/2	110 - 140	90	C20 - 30
	HT	F593R	1/4 - 1 1/2	160 - 190	120	C34 - 45
6 (431)	H	F593S	1/4 - 1 1/2	125 - 150	100	C25 - 32
	HT	F593T	1/4 - 1 1/2	180 - 220	140	C40 - 48
Precipitation hardening alloys						
7 (630)	AH	F593U	1/4 - 1 1/2	135 - 170	105	C28 - 38

[A] Minimum values, except where shown as maximum or as a range.
[B] Legend of conditions.

Source: Abstract of ASTM F593 2002.

A = Machined from annealed or solution annealed stock thus retaining the properties of the original material, or hot-formed and solution annealed.
AF = Headed and rolled from annealed stock and then reannealed.
AH = Solution annealed and age-hardened after forming.
CW = Headed and rolled from annealed stock thus acquiring a degree of cold work; sizes 0.75 in. and larger may be hot worked and solution annealed.
H = Hardened and tempered at 1050°F min.
HT = Hardened and tempered at 525°F min.
SH = Machined from strain-hardened stock or cold worked to develop the specified properties.

Table 206 Marking and mechanical requirements for nuts of stainless steel

Stainless alloy Group	Condition[B]	Alloy mechanical property marking	Nominal diameter inch	Proof stress ksi, min	Rockwell hardness
Austenitic alloys					
1 (303, 304, 304L, 305, 384, XM1, 18-9LW, 302HQ, 303Se)	AF	F594A	1/4 - 1 1/2	70	B85 max.
	A	F594B	1/4 - 1 1/2	75	B65 - 95
	CW1	F594C	1/4 - 5/8	100	B95 - C32
	CW2	F594D	3/4 - 1 1/2	85	B80 - C32
	SH1	F594A	1/4 - 5/8	120	C24 - C36
	SH2	F594B	3/4 - 1	110	C20 - C32
	SH3	F594C	1 1/8 - 1 1/4	100	B95 - C30
	SH4	F594D	1 3/8 - 1 1/2	85	B90 - C28
2 (316, 316L)	AF	F594E	1/4 - 1 1/2	70	B85 max.
	A	F594F	1/4 - 1 1/2	75	B65 - 95
	CW1	F594G	1/4 - 5/8	100	B95 - C32
	CW2	F594H	3/4 - 1 1/2	85	B80 - C32
	SH1	F594E	1/4 - 5/8	120	C24 - C36
	SH2	F594F	3/4 - 1	110	C20 - C32
	SH3	F594G	1 1/8 - 1 1/4	100	B95 - C30
	SH4	F594H	1 3/8 - 1 1/2	85	B90 - C28
3 (321, 347)	AF	F594J	1/4 - 1 1/2	70	B85 max.
	A	F594K	1/4 - 1 1/2	75	B65 - 95
	CW1	F594L	1/4 - 5/8	100	B95 - C32
	CW2	F594M	3/4 - 1 1/2	85	B80 - C32
	SH1	F594J	1/4 - 5/8	120	C24 - C36
	SH2	F594K	3/4 - 1	110	C20 - C32
	SH3	F594L	1 1/8 - 1 1/4	100	B95 - C30
	SH4	F594M	1 3/8 - 1 1/2	85	B90 - C28
Ferritic alloys					
4 (430, 430F)	A	F594N	1/4 - 1 1/2	55	B85 max.
	CW1	F594V	1/4 - 5/8	60	B75 - 98
	CW2	F594W	3/4 - 1 1/2	55	B65 - 95
Martensitic alloys					
5 (410, 416, 416Se)	H	F594P	1/4 - 1 1/2	100	C20 - 30
	HT	F594R	1/4 - 1 1/2	160	C34 - 45
6 (431)	H	F594S	1/4 - 1 1/2	125	C25 - 32
	HT	F594T	1/4 - 1 1/2	180	C40 - 48
Precipitation hardening alloys					
7 (630)	AH	F594U	1/4 - 1 1/2	135	C28 - 38

[A] Minimum values except where shown as maximum or as a range.
[B] Legend of conditions.

Source: Abstract of ASTM F594 2002.

A = Machined from annealed or solution annealed stock, thus retaining the properties of the original stock; or hot formed and solution annealed.
AF = Annealed after all threading is completed.
AH = Solution annealed and age hardened after forming.
CW = Annealed and cold worked. Sizes 0.75 in. and larger may be hot worked and solution annealed.
H = Hardened and tempered at 1050°F min.
HT = Hardened and tempered at 525°F min.
SH = Machined from strain hardened stock.

Material translations

Translation table for international material standards
Structural steel

Table 7

Germany		France	U.K.	Italy	Japan	Sweden	Russia	Spain	U.S.
W.-NR.	DIN	AFNOR	B.S.	UNI	JIS	SS	GOST	UNE	AISI/SAE/ASTM
1.0028	S250G1T/USt 34-2	A 34-2	-	Fe 330 Fe 330 B FU	SS 330	-	-	-	-
1.0034	S25OG2T/RSt 34-2	A 34-2 NE	1449 34/20 HR,HS,CR,CS	Fe 330 B FN	-	-	St2sp; St2ps	-	-
1.0035	S185 (Fe 310-0) St 33	A 33	Fe 310-0 1449 15 HR, HS	Fe 320	-	1300	St0	A310-0 Fe 310-0	A 283 Gr. A
1.0036	S235JRG1 (Fe 360 B) USt 37-2	-	Fe 360 B 4360-40 B	Fe 360 B FU	-	1311 1312	16D 18kp St3kp	AE 235 B Fe 360 B	A 283 Gr. C A 570 Gr. 33, 36
1.0037	S235JR (Fe 360 B) St 37-2	E 24-2	Fe 360 B; 6323-ERW3, CEW 3 1449 37/23 HR	Fe 360 B; C; D	STKM 12 A; C	1311	-	AE 235 B Fe 360 B	1015 A 283 Gr. C
1.0038	S235JRG2 (Fe 360 B) RSt 37-2	E 24-2 NE	Fe 360 B FU 1449 27/23 CR 4360-40 B; 6323-HFW 3, HFS 3	Fe 360 B FN	-	1312	St3ps; sp	AE 235 B FN; FU Fe 360 B FN; FU	A 570 Gr. 36
1.0044	S275JR (Fe 430 B) St 44-2	E 28-2	Fe 430 B FN; 1449 43/25 HR, HS 4360-43 B; 6323-HFW 4, HFS4, ERW 3, CEW 4, SAW 4	Fe 430 B Fe 430 B FN	SM 400 A; B; C	1412	St4ps; sp	AE 275 B Fe 430 B FN	1020 A 570 Gr. 40 A 572 Gr. 42
1.0045	S355JR	E 36-2	4360-50 B	Fe 510 B	-	2172	-	AE 355 B	-
1.0050	E295 (Fe 490-2) St 50-2	A 50-2	Fe 490-2 FN 4360-50 B	Fe 490	SS 490	1550 2172	St5ps; sp	A 490-2 Fe 490-2 FN	A 570 Gr. 50 A 572 Gr. 50
1.0060	E335 (Fe 590-2) St 60-2	A 60-2	Fe590-2 FN 4360-55 E; 55 C	Fe 60-2 Fe 590	SM 570	1650	St6ps; sp	A 590-2 Fe 590-2 FN	A 572 Gr. 65
1.0070	E360 (Fe 690-2) St 70-2	A 70-2	Fe 690-2 FN	Fe 70-2 Fe 690	-	1655	-	A 690-2 Fe 690-2 FN	-
1.0112	P235S (SPH 235)	A37AP	1501-164-360B LT20	Fe 360 C	-	-	-	AE 235 C	-
1.0114	S235JO; St 37-3 U	E 24-3	4360-40C	Fe 360 C	-	-	-	AE 235 C	-
1.0116	S235J2G3 (Fe 360 D1) St 37-3	E 24-3 E 24-4	Fe 360 D1 FF 1449 37/23 CR 4360-40 D 6323-HFW 4, HFS 4	Fe 360 C; D Fe 360 C FN Fe 360 D FF Fe 37-2	-	1312 1313	St3kp; ps; sp 16D	AE 235 D Fe 360 D1 FF	A 284 Gr. D A 573 Gr. 58 A 570 Gr. 36; C A 611 Gr. C
1.0130	P265S (SPH 265)	A 42 AP	1501-164-400B LT 20	-	-	-	-	SPH 265	-
1.0143	S275JO; St 44-3 U	E 28-3	4360-43C	Fe 430 D	-	1414-01	-	AE 275 D	A 572 Gr. 42
1.0144	S275J2G3 (Fe 430 D1) St 44-3	E 28-3 E 28-4	Fe 430 D1 FF 4360-43 C; 43 D	Fe 430 B Fe 430 C (FN) Fe 430 D (FF)	SM 400 A; B; C	1411 1412 1414	St4kp; ps; sp	AE 275 D Fe 430 D1 FF	A 573 Gr. 70 A 611 Gr. D A 572 Gr. 42
1.0149	S275JOH; RoSt 44-2	-	4360-43C	Fe 430 C	-	1412-04	-	Fe 430 C	-
1.0226	DX51D (St 02 Z)	GC	Z2	FeP 02 G	-	1151-10	-	FeP 02 G	-
1.0301	C10	C 10 AF 34 C 10 XC 10	040 A 10 045 M 10 1449 10 CS	C10 1 C 10	S 10 C	-	10	F.1511 F. 151.A	1010
1.0330	DC 01 St 2; St 12	TC	1449 4 CR 1449 4 CS	FeP 00 FeP 01	SPCC; CR 1	1142	-	AP 01	A 366 (1012) 1008
1.0332	DD 11; StW 22	1 C	1449 4 HR; 14 HR	FeP 11	SPHD; HR 1	-	15kp	AP 11	A 621 (1008)
1.0333	USt 3 (DC03G1) USt 13	E	1449 2 CR; 3 CR	FeP02	SPCD	-	-	AP 02	A 619 (1008)
1.0334	UStW 23 (DD12G1)	2 C	-	FeP 12	SPHE	-	10kp	AP 12	A 621 (1008)
1.0335	DD13; StW 24	3 C	1449 1 HR	FeP 13	SPHE	-	08kp	AP 13	A 622 (1008)
1.0338	DC04 St 4; St 14	ES	1449 1 CR; 2 CR	FeP 04	SPCE; HR 4	1147	08Ju; JuA	AP 04	A 620 (1008)
1.0345	P235GH HI	A 37 CP; AP	1501 Gr. 141-360 1501 Gr. 161-360; 151-360 1501 Gr. 161-400; 154-360 1501 Gr. 164-360; 161-360	FeE235 Fe 360 1 KW;KG Fe 360 2 KW;KG	SGV 410 SGV 450 SGV 480 SPV 450;SPV 480	1331 1330	-	A37 RC 1 RA II	A 516 Gr. 65;55 A 515 Gr. 65;55 A 414 Gr. C A 442 Gr. 55
1.0347	DC03 RRSt 3; RRSt 13	E	1449 3 CR 1449 2 CR	FeP 02	CR 3	1146	08Ju	AP 02	A 619
1.0401	C15	C 18 AF 37 C 12 XC 18	080 A 15 080 M 15 1449 17 CS	C 15 C 16 1 C 15	S 15 C	1350	-	F.111	M 1015 M 1016 M 1017
1.0402	C22	AF 42 C 20 XC 25 1 C 22	055 M 15 070 M 20 1449 22 HS, CS	C 20 C 21 C 25	S 20 C S 22 C	1450	20	1 C 22 F. 112	(M) 1020 M 1023
1.0406	C25	1 C 25	070 M 26	C 25 1 C 25	-	-	-	-	(M) 1025
1.0425	P265GH HII	A 42 CP; AP	1501 Gr. 161-400; 151-400 1501 Gr. 164-360; 161-400 1501 Gr. 164-400; 154-400	Fe 410 1 KW; KG; KT Fe 410 2 KW;KG	SPV 315; SPV 355 SG 295; SGV 410 SGV 450; SGV 480	1431 1430 1432	16K 20K	A 42 RC 1 A 42 RC II	-
1.0473	P355GH 19 Mn 6	A 52 CP; AP	-	Fe E 355-2	SGV 410 SGV 450 SGV 480	2101 2102	-	A 52 RC 1 RA II	A 537 Cl. 1 A 414 Gr. G A 612
1.0481	P295GH 17 Mn 4	A 48 Cp;AP	1501 Gr. 224 3059-440	Fe 510-1 KG; KT;KW Fe 510-2 KG;KT;KW FeE 295	SG 365 SGV 410 SGV 450 SGV 480	-	14G2	A 47 RCI RA II	A 516 Gr. 70 A 515 Gr. 70 A 414 Gr. F;G
1.0501	C35	C 35 1 C 35 AF 55 C 35 XC 38	080 A 32 080 A 35 080 M 36 1449 40 CS	C 35 1 C 35	S 35 C	1572 1550	35	F.113	1035
1.0503	C45	C 45 1 C 45 AF 65 C 45	060 A 47 080 M 46 1449 50 HS, CS	C 45 1 C 45	S 45 C	1672 1650	45	F.114	1045
1.0511	C40	1 C 40 AF 60 C 40	080 M 40	C 40 1 C 40	-	-	-	F.114.A	1040
1.0535	C55	C 54; 1 C 55 AF 70 C 55	070 M 55 5770-50	C 55 1 C 55	S 55 C	1655	55	F.115	1055
1.0539	S355NH (StE 335)	TSE 355-4	-	Fe 510 B	-	2134-04	-	Fe 355 KGN	-
1.0540	C 50	C 50	-	C 50	-	1674	-	1 C 50	-
1.0545	S355N (StE 355)	E 355 R	4360-50E	FeE 355 KG	-	2334-01	-	AE 355 KG	-
1.0546	S355NL (TStE 355)	E 355 FP	4360-50EE	FeE 355 KT	-	2135-01	-	AE 355 KT	-
1.0547	S355JOH	TSE 355-3	4360-50C; 6323-HFW 5 ,HFS 5	Fe 510 C	-	2172-04	-	Fe 510 C	-

Material translations

Translation table for international material standards
Structural steel

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W.-NR.	DIN	AFNOR	B.S.	UNI	JIS	SS	GOST	UNE	AISI/SAE/ASTM
1.0549	S355NLH;TStE 355	-	-	Fe 510 D	-	2135	-	FeE 355 KTN	-
1.0553	S355JO; St 52-3U	E 36-3	4360-50C	Fe 510 C	-	-	-	-	A 572 Gr. 50
1.0562	P355N StE 355	FeE 355 KG N E355R/FP;A510AP	1501 Gr. 225-490 A LT 20	FeE 355 KG; KW	SM490A;B;C;YA;YB	2106	15GF	AE 355 KG; DD	A 633 Gr. C A 588
1.0565	P355NH (WStE 355)	A 510 AP	1501-225-490BLT20;3602-500Nb	FeE 355-2	-	2106	-	-	-
1.0566	P355NL1 (TStE 355)	A 510 FP	1501-225-490A LT 50	FeE 355-3	-	2107-01	-	-	-
1.0570	S355J2G3 St 52-3 N	E 36-3 E 36-4	Fe 510 D1 FF 1449 50/35 HR, HS 4360-50 D 6323-ERW 5, CEW 5, SAW 5	Fe 510 C FN Fe 510 B; C; D Fe 510 B FN	SM 490A;B;C;YA;YB	2132 2133 2134 2174	17GS 17G1S	AE 355 D Fe 510 D1 FF	1024;1524 A 572 Gr. 50
1.0577	S355J2G4 (Fe 510 D 2)	A 52 FP	Fe 510 D2 FF 1501 Gr. 224-460 1501 Gr. 224-490	-	-	2174	-	A 52 RB II AE 355 D	A 738
1.0601	C60	C60; 1 C 60 AF 70 C 55	060 A 62; 5770-60 1449; 60 HS, CS	C 60 1 C 60	S 58 C	-	60(G)	-	1060
1.0603	C67	C 68 XC 65	080 A 67 1449 70 HS; 5770-70	C 67	-	-	-	-	1070
1.0605	C75	C75	1449 80 HS	C 75	-	-	75	-	1074 1075
1.0614	C 76 D (D 75-2)	XC 75	-	-	-	-	75	-	1074
1.0616	C 86 D (D 85-2)	XC 80	1449 80 HS, CS	C 85	-	-	85	-	1086
1.0618	C 92 D (D 95-2)	XC 90	1449 95 HS, CS	-	-	-	-	-	1095
1.0715	9 SMn 28 (11SMn30)	S 250	230 M 07	CF 9 SMn 28	SUM 22	1912	-	F.2111-11 SMn 28	1213
1.0718	9 SMnPb 28 (11SMnPb30)	S 250 Pb	-	CF 9 SMnPb 28	SUM 22 L SUM 23 L SUM 24 L	1914	-	F.2112-11 SMnPb 28	12 L 13
1.0721	10 S 20	10 F 2	(210 M 15)	CF 10 S 20	-	-	-	F.2121-10 S 20	1108 1109
1.0722	10 SPb 20	10 PbF 2	-	CF 10 SPb 20	-	-	-	F.2122-10 SPb 20	11 L 08
1.0723	15 S 22 15 S 20	-	210 A 15 210 M 15	-	SUM 32	1922	-	F.210.F	-
1.0726	35 S 20	35 MF 6	212 M 36	-	-	1957	-	F.210.G	1140
1.0727	45 S 20 (46S20)	45 MF 4	-	-	-	-	-	-	1146
1.0736	9 SMn 36 (11SMn37)	S 300	-	CF 9 SMn 36	SUM 25	-	-	F.2113-12 SMn 35	1215
1.0737	9 SMnPb 36 (11SMnPb37)	S 300 Pb	-	CF 9 SMnPb 36	-	1926	-	F.2114-12 SMnPb 35	12L 14
1.0972	S315MC (QStE 300 TM)	E 315 D	1449-43F30	-	-	-	-	-	-
1.0976	S355MC (QStE 360 TM)	E 355 D	1449-43F35; 46F40	FeE355TM	-	2642	-	-	-
1.0982	S460MC (QStE 460 TM)	E 445 D	1449-50F45; 50/45	-	-	-	-	-	-
1.0984	S500MC (QStE 500 TM)	E 490 D	-	FeE 490 TM	-	2662	-	-	-
1.0986	S550MC (QStE 550 TM)	E 560 D	1449 60/55, 60F55	FeE 560 TM	-	-	-	-	-
1.1121	C10E/ Ck 10	C 10 XC 10	040 A 10	C 10 2 C 10 2 C 15	S 9 CK S 10 C	1265	08; 10	F.1510-C 10 k	1010
1.1133	20Mn5	20 M 5	120 M 19	G 22 Mn 3 20 Mn 7	SMnC 420	2132	20GSL	F.1515-20 Mn 6	1022 1518
1.1141	C15E/ Ck 15	XC 12 XC 15 C 18; XC 18	040 A 15 080 M 15	C 15 C 16	S 15 S 15 CK	1370	15	F.1110-C 15 k F.1511-C 16 k	1015
1.1151	C22E Ck 22	2 C 22 XC 18 XC 25	055 M 15 (070 M 20)	C 20 C 25	S 20 C S 20 CK S 22 C	1450	20	F.1120-C 25 k	1020 1023
1.1157	40Mn4	35 M 5 40 M 5	150 M 36	-	-	-	40G	-	1035 1041
1.1158	C25E Ck 25	2 C 25 XC 25	(070 M 26)	C 25	S 25 C S 28 C	-	25	F.1120-C 25 k	1025
1.1165	30Mn5	35 M 5	120 M 36 (150 M 28)	-	SMn 433 H SCMn 2	-	27ChGSNMDTL 30GSL	F.8211-30 Mn 5 F.8311-AM 30 Mn 5	1036 1330
1.1166	34Mn5	-	-	-	SMn 433 H	-	-	TO.B	1536
1.1167	36Mn5	35 M 5 40 M 5	150 M 36	-	SMn 438 (H) SCMn 3	2120	35G2 35GL	F.1203-36 Mn 6 F.8212-36 Mn 5	1335
1.1170	28Mn6	20 M 5 28 Mn 6	(150 M 28) (150 M 19)	C 28 Mn	SCMn 1	-	30G	28 Mn 6	1330
1.1178	C30E; Ck 30	XC 32	080M30	C 30	S 30 CM	-	-	2 C 30	-
1.1180	C35R Cm 35	3 C 35 XC 32	080 A 35	-	-	1572	-	F.1135-C 35 k-1	1035
1.1181	C35E Ck 35	C 35; 2 C 35 XC 32 XC 38 H 1	080 A 35 (080 M 36)	C 35	S 35 C	1550 1572	35	F.1130-C 35 k	1035 1038
1.1183	Cf 35 (C35G)	XC 38H 1 TS	080 A 35	C 36; C 38	S 35 C	1572	35	-	1035
1.1186	C40E Ck 40	2 C 40 XC 42 H 1	060 A 40 080 A 40 080 M 40	C 40	S 40 C	-	40	-	1040
1.1191	C45E Ck 45	C 45; 2 C 45 XC 42 H 1 XC 45 XC 48 H 1	080 M 46 060 A 47	C 45 C 46	S 45 C S 48 C	1672	45	F.1140-C 45 k F.1142-C 48 k	1045
1.1193	Cf 45 (C45G)	XC 42 H 1 TS	060 A 47 080 M 46	C 43 C 46	S 45 C	1672	45	-	1045
1.1201	C45R Cm 45	3 C 45 XC 42 H 1 XC 48 H 1	080 M 46	C 45	S 50 C	1660	-	F.1145-C 45 k-1 F.1147-C 48 k-1	1049
1.1203	C55E Ck 55	2 C 55 XC 55 H 1; XC 54	060 A 57 070 M 55	C 55	S 55 C	1655	55	F.1150-C 55 k	1055
1.1206	C50E Ck 50	2 C 50 XC 48 H1;XC50 H1	080 M 50	C 50	-	1674	50	-	1049 1050
1.1209	C55R Cm 55	3 C 55 XC 55 H 1	070 M 55	C 55	-	-	-	F.1155-C 55 k-1	1055
1.1213	Cf 53 (C53G)	XC 48 H 1 TS	070 M 55	C 53	S 50 C	1674	50	-	1050 1055

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1.1221	C60E Ck 60	C 60 2 C 60 XC 60 H 1;XC 60	060 A 62	C 60	S58 C	1665 1678	60 60G 60GA	-	1060 1064
1.1231	C67E/ Ck 67	C68 XC 68	060 A 67	C 70	-	1770	65GA 68GA 70	-	1070
1.1248	C75E/ Ck 75	C 75 XC 75	060 A 78 5770-80	C 75	-	1774	75(A)	-	1074 1075 1078
1.1269	C85E/Ck 85	C 90; XC 90	-	C 90	-	-	85(A)	-	1086
1.1274	C101E/Ck 101	C 100;XC 100	5770-95	C 100	SUP 4	1870	-	-	1095
1.3401	X120Mn12	Z 120 M 12	-	GX 120 Mn 12	SCMnH 1 SCMnH 11	2183	110G13L	F.8251-AM-X120 Mn12	A 128 (A)
1.3505	100Cr 6	100 C 6 100Cr 6	2 S 135 535 A 99	100 Cr 6	SUJ 2	2258	SchCh 15	F.1310-100 Cr 6	52100
1.5024	46Si7	45S7;Y46S7;46Si7	-	-	-	-	-	F.1451-46 Si 7	-
1.5025	51Si7	51 S 7 51 Si 7	-	48 Si 7 50 Si 7	-	2090	-	F.1450-50 Si 7	9255
1.5026	55Si7	55 S 7; 56 Si 7; 55 Si 7; 56 SC 7	251 A 58	55 Si 7	-	2085 2090	55S2	F.1440-56 Si 7	9255
1.5027	60Si7	60 Si 7 60 S 7	251 A 60 251 H 60	60 Si 7	-	-	60S2	F.1441-60 Si 7	9260
1.5028	65Si7	60 S 7	-	-	50 P 7 SUP 6	-	-	-	9260 H
1.5415	16Mo 3 15Mo 3	15 D 3	1503-243B;3606-243;3059-243	16 Mo 3 (KG; KW)	-	2912	-	F.2601-16 Mo 3	A 204 Gr. A 4017
1.5419	22Mo 4	-	1503-243-430	G 20 Mo 5 G 22 Mo 5	SCPH 11	(2512)	-	-	4419
1.5423	16Mo 5	-	-	16 Mo 5 KG; KW	SB 450 M SB 480 M	-	-	F.2602-16 Mo 5	4520
1.5622	14Ni 6	16 N6	-	14 Ni 6 KG; KT	-	-	-	F.2641-15 Ni 6	A 350-LF 5
1.5637	12Ni14 10 Ni 14	2 N 14 3,5 Ni 355	3603-503 LT 5 S 15	-	SL 3 N 26 45	-	-	F. 152	A 350-LF 3
1.5662	X8Ni9	9 Ni 490	3603-509 LT 1502-502-650, 509-690 1503-509-690	X 10 Ni 9 X 12 Ni 09	SL 9 N 53 60	-	-	F.2645-X 8 Ni 09	A 353
1.5680	X12Ni5 12 Ni 19	Z 18 N 5 5 Ni 390	-	-	-	-	-	-	2515 2517
1.5711	40NiCr6	-	-	-	-	-	40ChN	-	(X) 3140
1.5713	13NiCr6	10 NC 6	-	-	-	-	-	-	3115
1.5732	14NiCr10	14 NC 11	-	16 NiCr 11	SNC 415 (H)	-	-	F.1540-15 NiCr 11	3415
1.5736	36NiCr10	30 NC 11	-	-	SNC 631 (H)	-	-	-	3435
1.5752	14NiCr14 15NiCr13	12 NC 15 14 NC 12 13NiCr 14	655 H 13 655 M 13	-	SNC 815 (H)	-	-	-	3310 3415 9314
1.5919	15CrNi6	16 NC 6	-	-	-	-	-	-	3115
1.6511	36CrNiMo4	36 CrNiMo 4 35 NCD 5 40 NCD 3	817 M 37	38 NiCrMo 4 (KB)	-	-	40ChN2MA 40ChGNM	F.1280-35 NiCrMo 4	4340 9840
1.6523	21NiCrMo2	20 NCD 2 22 NCD 2	805 H 20 805 M 20 806 M 20	20 NiCrMo 2	SNCM 220 (H)	2506	20ChGNM	F.1522-20 NiCrMo 2 F.1534-20 NiCrMo 31	8620
1.6546	40NiCrMo 2-2	40 NCD 2	3111-Type 7	40 NiCrMo 2 (KB)	SNCM 240	-	38ChGNM	F.1204-40 NiCrMo 2 F.1205-40 NiCrMo 2DF	8740
1.6562	40NiCrMo 8-4	-	817 M 40	40 NiCrMo 7 (KB)	SNB 24-1-5	-	-	-	E 4340
1.6565	40NiCrMo 6	-	817 A 37 818 M 40	-	SNCM 439	-	40Ch2N2MA	F.1272-40 NiCrMo 7	4340 9850
1.6580	30CrNiMo 8	30 CrNiMo 8 30 CND 8	823 M 30	30 NiCrMo 8	SNCM 431	-	-	30 CrNiMo 8	-
1.6582	34CrNiMo 6	34 CrNiMo 8 35 NCD 6	816 M 40 817 M 40	35 NiCrMo 6 KB	SNCM 447	2541	38Ch2N2MA	F.1272-40 NiCrMo 7 34 CrNiMo 6	4337 4340
1.6587	17CrNiMo6/18CrNiMo 7-6	18 NCD 6	-	(18 NiCrMo 7)	-	-	-	F.1560-14 NiCrMo13	-
1.6657	14NiCrMo 13-4	16 NCD 13	832 H 13 832 M 13 S 157	15 NiCrMo 13	-	-	-	F.1560-14 NiCrMo13 F.1569-14 NiCrMo13 1	9310
1.6746	32NiCrMo 14-5	35 NCD 14	-	-	-	-	-	F.1262-32 NiCrMo 12	-
1.6747	30NiCrMo16-6	35 NCD 16	835 M 30	-	-	-	-	F.1260-32 NiCrMo 16	-
1.7003	38Cr2	38 C 2 38 Cr 2	120 M 36	38 Cr 2 41 Cr 2 KB	-	-	-	F.1200-38 Cr 3	-
1.7006	46Cr2	42 C 2 46 Cr 2	-	45 Cr 2	-	-	-	-	5045 5046
1.7015	15Cr3	12 C 3; 15 Cr 2; 18 C 3	523 M 15	-	SCr 415 (H)	-	15Ch	-	5015 5115
1.7030	28Cr 4	-	530 A 30	-	-	-	30Ch	-	5130
1.7033	34Cr 4	32 C 4 34 Cr 4	530 A 32 530 H 32 530 M 32	34 Cr 4 (KB)	SCr 430 (H)	-	35Ch	F.8221-35 Cr 4	5132
1.7034	37Cr 4	37 Cr 4 38 C 4	31111-3/1 530 A 36 530 H 36 530 M 36	36 CrMn 4 36 CrMn 5 38 Cr 4 KB 38 CrMn 4 KB	SCr 435 H	-	SchCh 10 40Ch	F.1210-38 Cr 4 DF F.1201-38 Cr 4	5135
1.7035	41Cr 4	41 Cr 4 42 C 4	530 A 40 530 H 40 530 M 40	41 Cr 4 41 Cr 4 KB	SCr 440 (H)	-	40Ch	F.1211-41 Cr 4 DF F.1202-42 Cr 4	5140
1.7045	42Cr 4	42 C 4 TS	530 A 40	41 Cr 4	SCr 440	2245	40Ch	F.1202-42 Cr 4	5140
1.7108	60SiCr7	60 SC 7	-	60 SiCr 8	-	-	-	F.1442-60 SiCr 8	9262
1.7131	16 MnCr 5	16 MC 4 16 MnCr 5	527 M 17 590 H 17 590 M 17	16 MnCr 5	-	2173	18ChG	F.1516-16 MnCr 5 F.1517-16 MnCr 5	5115

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1.7147	20MnCr5	20 MC 5	-	20 MnCr 5	SMnC 420 H	-	18ChG	F.150.D	5120
1.7176	55Cr3	55 Cr 3 55 C 3	525 A 58 525 A 60 525 H 60	55 Cr 3	SUP 9 (A)	2253	50ChGA	F.1431-55 Cr 3	5155 5160
1.7218	25CrMo4	25 CD 4 25 CrMo 4	708 A 25	25 CrMo 4 (KB)	SCM 420 SCM 430 SCCrM 1	2225	20ChM 30ChM	F.8372-AM 26 CrMo 4 F.8330-AM 25 CrMo 4 F.1256-30 CrMo 4-1	4130
1.7220	34CrMo4	34 CrMo 4 35 CD 4	708 A 37	34 CrMo 4 KB 35 CrMo 4 35 CrMo 4 F	SCM 432 SCCrM 3 SCM 435 H	2234	AS38ChGM 35 ChM 35 ChML	F.8331-AM 34 CrMo 4 F.8231-34 CrMo 4 F.1250-35 CrMo 4 F.1254-35 CrMo 4 DF	4135 4137
1.7223	41CrMo4	42 CD 4 TS	708 M 40 3111-5/1	41 CrMo 4	SCM 440	2244	40ChFA	F.8332-AM 42 CrMo 4 F.8232-42 CrMo 4 F.1252-40 CrMo 4	4140 4142
1.7225	42CrMo4	42 CD 4 42 CrMo4	708 A 42 708 M 40 709 M 40	38 CrMo 4 KB 42 CrMo 4 G 40 CrMo 4	SCM 440 (H) SNB 7	2244	-	F.8332-AM 42CrMo 4 F.8232-42 CrMo 4 F.1252-40 CrMo 4	4140 4142
1.7228	50CrMo4	50 CrMo 4	708 A 47	-	SCM 445 (H)	-	-	-	4150
1.7242	16CrMo4	-	-	18 CrMo 4	SCM 418 H	-	-	F.1550-18 CrMo 4	-
1.7262	15CrMo5	12 CD 4	-	-	SCM 415 (H)	-	-	F.1551-12 CrMo 4	-
1.7264	20CrMo5	18 CD 4	-	-	SCM 420 H SCM 421	-	-	F.1559-18 CrMo 4-1	-
1.7335	13CrMo4-5 13 CrMo4-4	15 CD 3.5 15 CD 4.05	1502 620-440; 1503-620-440 1502 620-470; 3606-620 1502 620-540 3604-620-440	14 CrMo 3 16 CrMo 3	SFVA F 12	2216	12ChM 15ChM	F.2631-14 CrMo 45	A 182-F 11; F 12 A 387 Gr. 12 Cl. 2
1.7337	16 CrMo4-4	15 CD 4.5	-	18 CrMo 4 5KW; KG	-	2216	15ChM	-	A 387 Gr. 12Cl. 2
1.7361	32CrMo12	30 CD 12	722 M 24	32 CrMo 12	-	2240	-	F.124.A	-
1.7380	10CrMo9-10	12 CD 9-10 10 CD 9.10	3059-622-490 3606-622 1502-622; 3604-622	12CrMo 9 10; KW;KG G14 CrMo 9 10	SFVA F 22 A; B SCMV 4 SCPH 32-CF	2218	12Ch8	TU.H	A.182 F 22 A 387 Gr. 22 Cl. 2
1.7715	14 MoV6-3	-	1503-660-460; 3604-660	-	-	-	-	F.2621-13 MoCrV 6	-
1.8159	51 CrV4 50 CrV 4	51 CV 4 51 CrV 4; 50 CrV 4	735 A 51 735 H 51; 735 M 50	50 CrV 4	SUP 10	2230	50ChGFA 50ChFA	F.1430-51 CrV 4	6145 6150
1.8507	34CrAlMo5	30 CAD 6.12	-	34 CrAlMo 7	-	-	-	F.1741-34 CrAlMo 5	A 355 Cl.D
1.8509	41CrAlMo 7	40 CAD 6.12	905 M 39	41 CrAlMo 7	SACM 645	2940	38Ch2MJuA	F.1740-41 CrAlMo 7	A 355 Cl. A E 71400 G 71406
1.8515	31CrMo12	30 CD 12	722 M 24	30 CrMo 12 31 CrMo 12	-	2240	-	F.1712-31 CrMo 12	-
1.8523	39CrMoV13-9	-	897 M 39 3 S. 132	-	-	-	-	-	-
1.8902	S420N (StE 420)	FeE 420 KG N E 420 RIFP	-	FeE 420 KG; KW	SM 490 A;B;C;YA;YB	2143	16G2AF	AE 420 KG	A 633 Gr. E
1.8903	S460NL (TStE 460)	E 460 FP	4360-55 EE	FeE 460 TD	-	-	-	AE 460 KT	-
1.8905	P460N (StE 460)	FeE 460 KG N E 460 RIFP	4360-55 F	FeE 460 KG; KW	SM 520 B	2143	18G2AF	AE 460 KG	A 633 Gr. E
1.8906	S460QL (TStE 460V)	S 460 Q	4360-55 F	FeE 460 VKT	-	-	-	-	-

Material translations

Translation table for international material standards
Stainless, acidproof and heat resistant steel

Table 8

Germany		France	U.K.	Italy	Japan	Sweden	Russia	Spain	U.S.
W.-NR.	DIN	AFNOR	B.S.	UNI	JIS	SS	GOST	UNE	AISI/SAE
1.4000 1.4001	X6Cr 13 X7 Cr 14	Z 8 C 12 Z 8 C 13 FF	403 S 17	X 6 Cr 13	SUS 403 SUS 410 S SUS 429	2301	08 Ch 13	F.3110-X 6 Cr 13 F.8401-AM-X 12 Cr 13	403 410 S 429
1.4002	X6CrAl13	Z8 CA 12	405 S17	X 6 CrAl 13	SUS 405	-	-	F.3111-X 6 CrAl 13	405
1.4005	X12CrS 13	Z 11 CF 13	416 S 21	X12 CrS 13	SUS 416	2380	-	F.3411-X 12 CrS13	416
1.4006	X12Cr 13 X10 Cr 13 GX 12 Cr 13	Z 10 C 13	410 S 21 410 C 21 ANC 1A	X 12 Cr 13 X 10 Cr 13	SUS 410	2302	12 Ch 13 15 Ch 13 L	F.3401-X 10 Cr 13	410 CA-15
1.4008	GX 8CrNi13/GX7CrNiMo12-1	Z 12 CN 13 M	410 C 21	GX 12 Cr 13	SCS 1	-	-	-	-
1.4016	X6 Cr 17	Z 8 C 17	430 S 17 430 S 18	X 8 Cr 17	SUS 430	2320	12 Ch 17	F.3113-X 6 Cr 17	430
1.4021	X20Cr13	Z 20 C 13	420 S 37	X 20 Cr 13	SUS 420 J 1	2303	20 Ch 13	F.3402-X 20 Cr 13	420
1.4024	X15Cr13	Z 13 C 13	420 S 29	-	SUS 410 J 1	-	-	F.3415-X 15 Cr 13	-
1.4027	GX20Cr14	Z 20 C 13 M	ANC 1 B; C 420 C 24 420 C 29	-	SCS 2	-	20 Ch 13 L	-	-
1.4028	X30Cr13	Z 30 C 13 Z 33 C 13	420 S 45	(G) X 30 Cr 13	SUS 420 J 2	2304	30 Ch 13	F.3403-X 30 Cr 13	420 F
1.4031	X39Cr13/X38Cr13	Z 40 C 14	-	X 40 Cr 14	SUS 420 J 2	(2304)	40 Ch 13	F.3404-X 40 Cr 13	-
1.4034	X46Cr13	Z 44 C 14 Z 38 C 13 M	(420 S 45)	X 40 Cr 14	-	-	40 Ch 13	F.3405-X 45 Cr 13	-
1.4057	X17CrNi16-2	Z 15 CN 16-02	431 S 29; 6 S. 80	X 16 CrNi 16	SUS 431	2321	20 Ch 17 N 2	F.3427-X 19 CrNi 17 2	431
1.4104	X14CrMoS 17	Z 13 CF 17	-	X 10 CrS 17	SUS 430 F	2383	-	F.3117-X 10 CrS 17 F.3413-X 14 CrMoS 17	430 F
1.4113	X6CrMo17-1	-	434 S 17	X 8 CrMo17	SUS 434	-	-	F.3116-X 6 CrMo 17 1	434
1.4125	X105 CrMo 17	Z 100 CD 17	-	-	SUS 440 C	-	(95 Ch 18)	-	440 C
1.4301	X 5 CrNi 18 10 (X 4 CrNi 18-10)	Z 4 CN 19-10 FF Z 5 CN 17-08 Z 6 CN 18-09 Z 7 CN 18-09	304 S 11; 304 S 15 304 S 16 304 S 17; LW 21 LWCF 21 304 S 31	X 5CrNi 18 10	SUS 304	2332 2333	08 Ch 18N10	F.3504-X 5 CrNi 18 10	304 304 H
1.4303	X 4 CrNi 18-12 (X 5 CrNi 18 12)	Z 5 CN 18-11 FF	305 S 17 305 S 19	X 7 CrNi 18 10 X 8 CrNi 19 10	SUS 305 J 1 SUS 305	-	06 Ch 18N11	F.3513-X 8 CrNi 18-12	305 308
1.4305	X 8 CrNiS 18-9 (X 10 CrNiS 18 9)	Z 8 CNF 18-09	303 S 22 303 S 31	X 10 CrNiS 18 09	SUS 303	2346	-	F.3508-X10 CrNiS18-09	303
1.4306	X2CrNi 19-11 GX 2CrNiN 18-9	Z 1 CN 18-12 Z2CN18-10;Z3CN19.10M Z3CN18-10;Z3CN19-11 Z3CN19-11 FF	304 S 11; LW 20 LWCF 20 S.536 T.74 304 C 12 (LT 196) 305 S 11	X 3 CrNi 18 11 X 2 CrNi 18 11 GX 2 CrNi 19 10	SCS 19 SUS 304 L	2352	03 Ch 18N 11	F.3503-X2 CrNi 18 10	304 L
1.4308	GX5CrNi19-10/G-X6CrNi18 9	Z 6CN18.10 M	304 C 15(LT 196)	-	SCS 13	2323	07Ch18N9L	-	CF-8
1.4310	X 10 CrNi18-8 (X 12 CRNi17 7)	Z 11 CN 17-08 Z 11 CN 18-08 Z 12 CN 18-09	301 S 21 301 S 22	X 12 CrNi 17 07	SUS 301	2331	-	F.3517-X12 CrNi 17 7	301
1.4311	X 2CrNiN 18-10	Z 3 CN 18-07 Az Z 3 CN 18-10 Az	304 S 61	X 2 CrNiN 18 11	SUS 304 LN	2371	-	F.3541-X2CrNiN 18 10	304 LN
1.4312	GX 10 CrNi 18-8	Z 10 CN 18.9 M	302 C 25 ANC 3A	-	SCS 12 SCS 13A	-	10 Ch 18N9L	-	-
1.4313	X3CrNiMo13-4(X4 CrNi13 4) GX5 CrNi 13-4	Z4CND13.4M;Z6CN13-4 Z 8 CD 17-01	425 C 11 425 C 12	GX 6 CrNi 13 04	SCS 5 SCS 6	2384	-	-	- CA 6-NM
1.4319	X3CrNiN 17-8	-	301 S 26; 302 S 26	X 10 CrNi 18 09	SUS 302	-	-	F.3507-X10 CrNi 18-09	302
1.4401	X5CrNiMo 17 12 2 (X4 CrNiMo 17-12-2)	Z 3CND 17-11-01 Z 6CND 17-11 Z 6CND 17-11-02 FF Z 7CND 17-11-02 Z 7CND 17-12-02	316 S 13 316 S 17 316 S 19 316 S 31 316 S 33	X 5 CrNiMo 17 12	SUS 316	2347	-	F.3534-X5CrNiMo1712 2	316
1.4404	X2 CrNiMo 17-12-2 (X 2 CrNiMo 17 13 2) GX 2 CrNiMoN 18-10	Z 2CND 17-12 Z 2CND 18-13 Z 3CND 17-11-02 Z 3CND 17-12-02 FF Z 3CND 18-12-02 Z 3CND 18-12-03 Z 3CND 19.10 M	316 S 11 316 S 13 316 S 14 316 S 31;316 S 42 S.537;316 C 12 T.75 S.161	X 2 CrNiMo 17 12 G-X 2 CrNiMo 19 11	SUS 316 L	2348	-	F.3533-X2CrNiMo17 13 2 F.3537-X2CrNiMo17 13 3	316 L
1.4406	X2CrNiMoN 17-11-2 (X2CrNiMoN 17 12 2)	Z 3CND 17-11 Az	316 S 61 316 S 63	X 2 CrNiMoN 17 12	SUS 316 LN	-	-	F.3542-X2CrNiMoN 17 12 2	316 LN
1.4408	GX 5 CrNiMo 19-11-2 G-X 6 CrNiMo 18 10	-	316 C 16(LT 196) ANC 4 B	-	SCS 14	(2343)	07Ch18N10G2S2M2L	F.8414-AM-X7CrNiMo 20 10	CF-8M
1.4429	X2CrNiMoN 17-13-3	Z 3CND 17-12 Az	316 S 63	X 2 CrNiMoN 1713	(SUS 316 LN)	2375	-	F.3543-X2CrNiMoN17 13 3	316 LN
1.4435	X2CrNiMo 18-14-3	Z 3CND 17-12-03 Z 3CND 18-14-03	316 S 11; 316 S 13 316 S 14; 316 S 31 LW 22 LWCF 22	X 2 CrNiMo 17 13	SUS 316 L	2353	03Ch17N14M3	F.3533-X2CrNiMo17132	316 L
1.4436	X 3CrNiMo 17-13-3 (X 5 CrNiMo 17 13 3)	Z 6CND 18-12-03 Z 7CND 18-12-03	316 S 19;316 S 31 316 S 33 LW 23 LWCF 23	X 5 CrNiMo 17 13 X 8 CrNiMo 17 13	SUS 316	2343	-	F.3534-X5CrNiMo17 12 2 F.3538-X5CrNiMo17 13 3	316
1.4438	X 2CrNiMo 18-15-4 (X 2CrNiMo 18 16 4)	Z 2CND 19-15-04 Z 3CND 19-15-04	317 S 12	X 2 CrNiMo 18 16	SUS 317 L	2367	-	F.3539-X2CrNiMo18 16 4	317 L
1.4449	X 5CrNiMo 17 13	-	317 S 16	X 5 CrNiMo 18 15	SUS 317	-	-	-	317
1.4460	X 3CrNiMoN 27-5-2 (X 4CrNiMoN 27 5 2)	(Z 3CND 25-07 Az) Z 5CND 27-05 Az	-	-	SUS 329 J1	2324	-	F.3309-X 8 CrNiMo 27-05 F.3552-X 8 CrNiMo 26 6	329
1.4462	X 2CrNiMoN 22-5-3	Z 3CND 22-05 Az (Z 2CND 24-08 Az) (Z 3CND 25-06-03 Az)	318 S 13	-	SUS 329 J3L	2377	-	-	-
1.4510	X 3CrTi 17 (X 6CrTi 17)	Z 4 CT 17	-	X 6 CrTi 17	SUS 430 LX	-	08 Ch 17T	F.3115-X 5 CrTi 17	XM 8 430 Ti 439
1.4511	X 3CrNb 17 (X6CrNb 17)	Z 4 CNb 17	-	X 6 CrNb 17	SUS 430 LX	-	-	F.3122-X 5 CrNb 17	-

Material translations

Translation table for international material standards
Stainless, acidproof and heat resistant steel

Table 8

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W.-NR.	DIN	AFNOR	B.S.	UNI	JIS	SS	GOST	UNE	AISI/SAE
1.4512	X 6 CrTi 12 (X 2 CrTi 12)	Z 3 CT 12	LW 19 409 S 19	X 6 CrTi 12	SUH 409	-	-	-	409
1.4521	X 2 CrMoTi 18-2	-	-	-	SUS 444	2326	-	F.3123-X 2CrMoTiNb 18 2	443 444
1.4539	X 1NiCrMoCuN 25-20-5	Z 2 NCDU 25-20	-	-	-	2562	-	-	UNS N 08904
1.4541	X 6 CrNiTi 18-10	Z 6 CNT 18-10	321 S 31 321 S 51 (1010;1105) LW 24 LWCF 24	X 6 CrNiTi 18 11	SUS 321	2337	06 Ch 18N10T 08 Ch 18N10T 09 Ch 18N10T 12 Ch 18N10T	F.3523-X 6 CrNiTi 18 10	321
1.4542	X 5 CrNiCuNb 16-4 (X 5 CrNiCuNb 17 4)	Z 7 CNU 15-05 Z 7 CNU 17 -04	-	-	SCS 24 SUS 630	-	-	-	630
1.4544	-	-	S. 524 S. 526	X 6 CrNiTi 18 11	-	-	08 Ch 18N12T	-	-
1.4546	X 5 CrNiNb 18-10	-	347 S 31 2 S. 130 2 S. 143/144/145 S.525/527	X 6 CrNiNb 18 11	-	-	-	-	348
1.4550	X 6 CrNiNb 18-10	Z 6 CNNb 18-10	347 S 20 347 S 31 347 S 51 ANC 3 B	X 6 CrNiNb 18 11 X 8 CrNiNb 18 11	SUS 347	2338	08 Ch 18N12B	F.3524-X6 CrNiNb 18 10	347 348
1.4552	GX5CrNiNb19-11(G-X5CrNiNb 18 9)	Z 6 CNNb 18.10 M	347 C 17	-	SCS 21	-	-	-	-
1.4568	X7CrNiAl 17-7	Z 9 CNA 17-07	301 S 81	-	-	2388	09 Ch 17N7 Ju1	-	-
1.4571	X6CrNiMoTi 17-12-2	Z 6 CNDT 17-12	320 S 18 320 S 31	X 6 CrNiMoTi 17 12	SUS 316 Ti	2350	10 Ch 17N13M2T	F.3535-X 6 CrNiMoTi 17 12 2	316 Ti
1.4573	X10CrNiMoTi 18 12	-	320 S 33	X 6 CrNiMoTi 17 13	SUS 316 Ti	-	10 Ch 17N13M3T 08 Ch 17N13M2T	F.3535-X 6 CrNiMoTi 17 12 2	316 Ti
1.4580	X6CrNiMoNb 17-12-2	Z 6 CNDNb 17-12	318 S 17	X 6 CrNiMoNb 17 12	-	-	08 Ch 16N13M2B	F.3536-X 6 CrNiMoNb 17 12 2	(316 Cb)
1.4581	GX 5 CrNiMoNb 19-11-2 (G-X 5 CrNiMoNb 18 10)	Z 4 CNDNb 18.12 M	318 C17 ANC 4 C	GX 6 CrNiMoNb 20 11	SCS 22	-	-	-	-
1.4583	X 10CrNiMoNb 18-12	-	-	X 6 CrNiMoNb 17 13	-	-	-	-	318
1.4718	X 45 CrSi9-3	Z 45 CS 9	401 S 45	X 45 CrSi 8	SUH 1	-	40 Ch9 S 2	F.3220-X 4 SCrSi 09-03	HNV 3
1.4724	X 10CrAl13/X10CrAlSi13	Z 13 C 13	-	X 10 CrAl 12	-	-	10 Ch13SJu	F.3152-X 10CrAl13	-
1.4731	X 40CrSiMo10-2	Z 40 CSD 10	-	-	SUH 3	-	40 Ch10S2M	F.3221-X 40CrSiMo 10-02	-
1.4742	X 10CrAl18/X10CrAlSi18	Z 12 CAS 18	-	(X 8 Cr 17)	SUH 21	-	15 Ch18SJu	F.3153-X 10CrAl 18	-
1.4747	X 80 CrNiSi 20	Z 80 CNS 20-02	443 S 65	X 80 CrSiNi 20	SUH 4	-	-	F.3222- X 80CrSiNi 20-02	HNV 6
1.4762	X 10CrAl24/X10CrAlSi25	Z 12 CAS 25	-	(X 16 Cr 26)	(SUH 446)	(2322)	-	F.3154-X 10CrAl 24	(446)
1.4828	X 15CrNiSi 20-12	Z 9 CN 24-13 Z17 CNS 20-12	309 S 24	X 16 CrNi 23 14	SUH 309	-	20Ch20N14S2	F.3312-X 15 CrNiSi 20-12	309
1.4833	X 12 CrNi24-12 X 12 CrNi23-13 X 7 CrNi23-14	Z 15 CN 23-13 Z 15 CN 24-13 Z 20 CN 24-13	-	X 6 CrNi 23 14	SUS 309 S	-	-	-	309 S
1.4837	GX 40 CrNiSi 25-12	-	309 C 30	GX 35 CrNi 25 12	SCH 13 A SCH 17 SCS 17	-	40 Ch24N12SL	-	-
1.4841	X 15 CrNiSi 25-20 X 15 CrNiSi 25-21	Z 15 CNS 25-20 Z 15 CNS 25-20	314 S 25	X 16 CrNiSi 25 20	SUH 310	-	20 Ch25N20 S2	F.3310-X 15 CrNiSi 25-20	314 310
1.4842	X 12 CrNi 25-20	Z 12 CN 26-21	-	(X 6 CrNi 25 20)	SUS 310 S	2361	-	-	310 S
1.4845	X 12 CrNi 25-21 X 8 CrNi 25-21	Z 8 CN 25-20 Z 12 CN 25-20 Z 12 CN 26-21	310 S 16 310 S 24 310 S 25 310 S 31	X 6 CrNi 25 21 (X 6 CrNi 25 20)	SUH 310 SUS 310 S	2361	20 Ch23N18	-	310 S
1.4848	GX 40 CrNiSi 25-20	-	310 C 40 310 C 45	GX 40 CrNi 26 20	SCH 21 SCH 22	-	-	F.8452-AM-X 40 CrNi 25 20	HK
1.4864	X 12 NiCrSi36-16/X12NiCrSi 35-16	Z 20 NCS 33-16	NA 17	-	SUH 330	-	-	F.3313-X 12 CrNiSi 36-16	330
1.4865	GX 40NiCrSi 38-18	-	330 C 11 330 C 40 331 C 40	GX 50 NiCr 39 19	SCH 15 SCH 16	-	-	-	-
1.4871	X 53 CrMnNiN 21-9	Z 53 CMNS 21-09 Az Z 53 CMN 21-09 Az	349 S 54	X 53 CrMnNiN 21 9	SUH 35 SUH 36	-	55 Ch20G9AN4	F.3217-X 53 CrMnNiN 21-09	EV 8
1.4873	X 45 CrNiW 18-9	Z 35 CNWS 14-14 Z 45 CNW 18-09	-	X 45 CrNiW 18 9	SUH 31	-	-	F.3211-X 45 CrNiSiW 18-09	-
1.4876	X 10 NiCrAlTi 32-20 X 10 NiCrAlTi 32-21	Z 8 NC 33-21 Z 10 NC 32-21	NA 15 (H)	-	NCF 800 (TP)	-	-	F.3545-X 9 NiCr 33-21 F.3314-X 10NiCrAlTi 32-20	B 163
1.4878	X 12 CrNiTi18-9/X 10CrNiTi18-10	Z 6 CNT 18-10	321 S 51	(X 6 CrNiTi 18.11)	SUS 321	(2337)	-	-	321
1.4922	X 20 CrMoV 12-1	-	-	X 20 CrMoNi 12 01	-	2317	-	-	-
1.4944	-	Z 6 NCTDV 25-15 B	HR 51	-	-	-	-	-	660

Chemical durability in accordance with manufacturer's info

Acid resistant joint elements

Austenitic manganese steel A1, A2, A4 get their corrosion resistance through a surface protecting oxide layer. If this is damaged, it is reformed by the oxygen in the air.
If the oxygen is prevented from reaching the surface due to the design or fouling, even these steels corrode!

Avoid: Cuts, divided designs, accumulations of water, bad ventilation, dirt sediments.

Rules of thumb:
- A2 Above water surface, inland climate.
- A4 Under water surface, coastal climate.
- A1 To achieve a good shaping ability this steel contains small amounts of sulphur. Its corrosion resistance is lower than for A2 steels. This is also the case for C1-C4.

The corrosion resistance can be negatively affected if the surface has been treated (no air reaches the steel), chemically blackened or buffed.

Chloric mediums can under certain conditions cause dangerous corrosion due to non-visible intercrystalline corrosion, which can result in that the steel component suddenly collapses.

The tables below give rules of thumb for the corrosion resistance for steel groups A2 and A4. The facts are based on laboratory results which in critical cases must absolutely be confirmed by performing practical tests on the final design. For these tests we gladly provide you with sample screws.

Table 81

Group	Weight loss g/m²h	Wear mm/year	Remarks
0	0,1	Less than 0,1	Completely durable (see also L)
1	0,1-1	0,11-1,1	Small attacks, usable in some cases
2	1-10	1,1-11	Hardly durable, almost useless
3	More than 10	More than 11	Completely useless
L	Risk of hole corrosion, also when durable		

The presented durability values are only guide values, but give good possibility to comparisons.

Table 81.1

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group A2	Steel group A4
Acetone	CH_3COCH_3		all concentrations	20°	0	0
Acetyl chloride	CH_3COCl	L		20° and boiling	1	0
Aluminium	Al		melted	750°	3	3
Aluminium chloride	AlCl3, $6H_2O$	L	5%	50°	2	1
Aluminium nitrate	$Al(NO_3)_3$ $+9H_2O$			20°	0	0
Aluminium sulphate	$Al_2(SO_4)_3$		20%	20° boiling	0 1	0 0
Ammonia alum (Potassium aluminium sulphate)	$KAl(SO_4)_2$ $+12H_2O$		10% varm saturated	20° boiling boiling	0 1 2	0 0 1
Ammonium	NH_3				0	0
Ammonium water solution	NH_4OH		all concentrations	20° and boiling	0	0
Ammonium bicarbonate	$(NH_4)HCO_3$		all concentrations	20°	0	0
Ammonium hydroxide	NH_4OH		every	20° boiling	0	0
Ammonium	NH_3OH		all concentrations	20° and boiling	0	0
Ammonium carbonate	$(NH_4)_2CO_3$		cold saturated	20° and boiling	0	0
Ammonium chloride	NH_4Cl	L L L L	10% 50% saturated saturated	boiling boiling 20° boiling	0 1 0 1	0 0 0 0
Ammonium chloride with Cu and Zn chlorides	NH_4Cl	L	cold saturated		3	3
Ammonium nitrate	NH_4NO_3		cold saturated charge	20° and boiling 169°	0 1	0 0
Ammonium perchlorate	NH_4ClO_4	L	10%	20° boiling	0 0	0 0
Ammonium sulphate	$(NH_4)_2SO_4$		all concentrations	20° boiling	0 0	0 0
Ammonium sulphite	$(NH_4)_2SO_3$+ H_2O		saturated	20° boiling	0 0	0 0
Ammonium hydrogen difluoride	$NH_4F{\cdot}HF$	L	cold saturated	20°	1	0
Aniline	$C_6H_5NH_2$			20°	0	0
Anilinehydrochloride	$C_6H_5{\cdot}NH_2{\cdot}$ HCl	L		20°	3	3
Antimony(III)chloride	$SbCl_3$			20°	3	3
Exhaust with sulphuric acid				up to 40°	0	0
Exhaust without sulphuric acid				up to 40°	0	0
Benzene	C_6H_6			20° and boiling	0	0
Benzine			all concentrations	20°	0	0
Benzoic acid (Benzol acid)	C_6H_5 CO OH		all concentrations	20°	0	0
Blood					0	0
Lead nitrate	$Pb(NO_3)_2$			20°	0	0
Ink (Ferro gallic ink)					0	0
Boric acid	H_3BO_3		all concentrations	20° boiling	0 0	0 0
Bromine	Br	L		20° boiling	3 3	3 3
Lemon juice				20°	0	0

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group	
					A2	A4
Citric acid			1% 10% 25% 50%	20° 20° 20° 20°	0 0 0 0	0 0 0 0
Dinatrium Hydrogen phosphate	Na_2HPO_4+ $12H_2O$			20° and boiling	0	0
Drinking and fresh water				20° and boiling	0	0
Ethanol (alcohol)	C_2H_5OH		all concentrations	20° and boiling	0	0
Ether Diethyl ether	$(C_2H_5)_2O$			20° and boiling	0	0
Phenol	C_6H_5OH		pure +10% H_2O raw=90% phenol	boiling boiling 20° boiling	0 0 0 0	0 0 0 0
Fatty acid (Oleic acid) technical	$C_{17}H_{33}COOH$		at 30 bar	150° 180° 235° 300°	0 0 1 2	0 0 0 0
Fixing solution		L		20°	0	0
Waterborne				20°	0	0
Hydrofluoric acid	HF	L	10%	20° 100°	2 3	2 3
Floating soap				20°	0	0
Formaldehyde	HCHO		40%	20° and boiling	0	0
Phosphoric acid, chemically pure	H3PO4		1% 10% 45% 60%	20° 20° 20° 20°	0 0 0 0	0 0 0 0
Developing fluid (Agfa-glycerine-developer)				20°	0	0
Fruit stone (SO_2-bearing)					0	0
Fruit juices and fruit acids				20°	0	0
Spinning bath			up to 10% H_2SO_4	70°	2	1
Colour bath, alcalic or neutral				20° boiling	0 0	0 0
Colour bath, organic, sour				20° boiling	0 0	0 0
Colour bath, weakly sulphuric acid reacting			below 1% H_2SO_4	20° boiling	0 1	0 0
Tannic acid= tannin			5%	20°	0	0
Glycerol	$C_3H_5(OH)_2$		concentrated	20° and boiling	0	0
Pit water			sour	20°	0	0
Pit water, sour				20° and boiling	0	0
Vegetables				boiling	0	0
Sea water (Local conditions have conclusive importance)		L		20°	0	0
Fluorosilicic acid	H_2SiF_6		steam	100°	1	1
Crystalline acetic acid			100%	20° boiling	0 1	0 1
Iodine	J	L	dry damp	20° 20°	0 1	0 0
Iron phosphate (Bonder solution)				98°	0	0
Iron (III)-chloride	$FeCl_3$+$6H_2O$	L	10%	20°and boiling	3	3

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group	
					A2	A4
Iron (III)-nitrate	$Fe(NO_3)_3$+$9H_2O$		all concentrations		0	0
Iron (III)-sulphate	$Fe_2(SO_4)_3$		10%	20° boiling	0 0	0 0
Coffee				20° and boiling	0	0
Calcium chloride	$CaCl_2$	L		20° and boiling	0	0
Potash alum (Potassium alum. sulphate)	$KAl(SO_4)_2$+ H_2O		10% hot saturated	20° boiling boiling	0 1 2	0 0 1
Potash lye (Hydrate of potash)	KOH		25% hot saturated charge	20° and boiling boiling 360°	0 0 3	0 0 3
Potash nitrate	KNO_3		50% charge	20° boiling 550°	0 0 0	0 0 0
Potassium acetate	CH_3·COOK		charge	292°	0	0
Potassium hydrogenfluoride	KHF_2	L	cold saturated	20°	0	0
Potassium dichromate	$K_2Cr_2O_7$		25%	20° boiling	0 0	0 0
Potassium hydrogentartrate	$KC_4H_5O_6$		cold saturated at 110 degrees saturated	20° boiling	0 2	0 1
Potassium hydrogensulphate	$KHSO_4$		2% 5%	90° 20° 90°	3 2 2	2 0 2
Potassium bromide	KBr	L		20°	0	0
Potassium cyanate	KCNO			20°	0	0
Potassium cyanide	KCN		all concentrations	20°	0	0
Potassium carbonate (Neutral potash)	K_2CO_3		50°C	20° boiling	0 0	0 0
Potassium chlorate	$KClO_3$		hot saturated	boiling	0	0
Potassium chloride	KCl	L	hot saturated	20° and boiling	0 0	0 0
Chromic potassium sulphate	$KCr(SO_4)_2$ +$12H_2O$		saturated	20° boiling	1 3	0 3
Potassium nitrate (Salpetre)	KNO_3		25 and 50% charge	20° boiling 550°	0 0 0	0 0 0
Mineral chameleon	$KMnO_4$		10%	20° boiling	0 0	0 0
Potassium sulphate	K_2SO_4		all concentrations	20° and boiling	0	0
Lime water (Calcium hydroxide)	$Ca(OH)_2$			20° boiling	0 2	0 1
Chloramine-T	CH_3·C_6H_4·SO_2·NNaCl+$3H_2O$	L		20° and boiling	1	0
Chlorobenzene	C_6H_5Cl			boiling	0	0
Chlorine gas, dry, damp	Cl_2	L L		20° 20°	0 3	0 3
Chloride of lime, dry damp	3CaCl(OCl)· $Ca(OH)_2$·$5H_2O$	L L		20° 20°	0 1	0 1
Chloroform	$CHCl_3$			20° and boiling	0	0
Chlorosulfonic acid	$ClSO_2$·OH	L L	10% concentrated	20° 20°	3 0	3 0
Sulphur monochloride	S_2Cl_2	L L	concentrated	20° boiling	0 0	0 0
Chloric acid	$HClO_2$	L		20°	3	3
Chlorine water		L	saturated	20°	1	1
Hydrochloric acid gas	HCl	L L L L		20° 50° 100° 400°	1 1 2 3	1 1 1 3

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group A2	Steel group A4
Chloroacetic acid (mono-)	$CH_2Cl\cdot COOH$		50% and concentrated	20°	3	3
Carbon dioxide (Carbon acid)	CO_2		dry damp	hot hot	0 0	0 0
Carbon disulphide	CS_2		pure	20° and boiling	0	0
Carbon tetra-chloride	($C\ Cl_4$)		 dehydrated	20° and boiling 20°	0 0	0 0
Copal varnish					0	0
Copper (II)-chloride	$CuCl_2$	L	all concentrations	20°	3	3
Verdigris	$Cu(CH_3\cdot COO)_2 +H_2O$			20° and boiling	0	0
Cupric nitrate	$Cu(NO_3)_2+6H_2O$		50%	20° and boiling	0	0
Copper(II)oxide saturated in 50% ammonia solution	$Cu(NH_3)_4O$			20°	0	0
Sulphate of copper (Blue vitriol)	$CuSO_4\cdot 5H_2O$		saturated 50% + 3% H_2SO_4 +10% H_2SO_4 up to 5 bar	20° and boiling boiling boiling 20° 20°	0 0 0 0 0	0 0 0 0 0
Creosote			 +3% salt	20° boiling 20°	0 0 0	0 0 0
Chromic acid	CrO_3		10% pure 50% pure	20° 20°	0 1	0 1
Aqua regalis	$3HCl+HNO_3$	L		20°	3	3
Mercury	Hg			20° and 50°	0	0
Buttermilk				20°	0	0
Meat					0	0
Linseed oil			+3% H_2SO_4	20° and hot 20° 200°	0 0 0	0 0 0
Lysoform (soap and formalin)				20° and boiling	0	0
Maleic acid	$HOOC\cdot CH\cdot CH\cdot COOH$		50%	100°	0	0
Manganese chloride	$MnCl_2+4H_2O$	L L	10% 50%	boiling boiling	0 0	0 0
Manganous sulphate	$MnSO_4+7H_2O$		all concentrations	20°	0	0
Methyl alcohol (Methanol) Wood alcohol	CH_3OH		all concentrations	20° 65°	0 0	0 0
Methylene chloride, dehydrated	CH_2Cl_2	L		20° and boiling	0	0
Milk			fresh sour	up to 70° up to 70°	0 0	0 0
Lactic acid	$CH_3CHOH\ COOH$		1.5% 80%	20° 20°	0 0	0 0
Lactic acids (Nitric sulphiric acid)	50% H_2SO_4 +50% HNO_3 75% H_2SO_4 +25% HNO_3 20% H_2SO_4 +15% HNO_3 70% H_2SO_4 +10% HNO_3 30% H_2SO_4 + 5% HNO_3			50° 50° 50° 50° 90°	0 1 0 0 0	0 0 0 0 0
Chloroacetic acid	$CH_2Cl\ COO\ H$	L	50%	20°	1	1

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group A2	Steel group A4
Formic acid	$H\cdot COOH$		10% 50% 100%	20° 20° 20°	0 0 0	0 0 0
Sodium acetate	$CH_3COO\ NA+3H_2O$		varm saturated	boiling	0	0
Sodium bicarbonate	$NaHCO_3$		all concentrations	20°	0	0
Sodium bisulphate	$NaHSO_4H_2O$		10%	20° boiling	0 1	0 0
Sodium bisulphite	$NaHSO_3$		50%	20° and boiling	0	0
Sodium citrate	$Na_3C_6H_5O_7+2H_2O$		3.5%	20°	0	0
Sodium fluoride	NaF		5%		–	0
Caustic soda (Sodium hydrate)	NaOH		30% 50% charge	20° boiling 20° boiling 320°	0 1 0 2 2	0 1 0 2 2
Sodium carbonate, soda	Na_2CO_3		cold saturated charge	20° and boiling 900°	0 0	0 0
Sodium chlorate	$NaClO_3$	L	30%	20° and boiling	0	0
Sodium chloride (Salt)	NaCl	L L L	cold saturated hot saturated	20° 100° 100°	0 0 1	0 0 1
Sodium nitrate (Chile nitre)	$NaNO_3$		concentrated charge	20° and boiling 360°	0 0	0 0
Sodium nitrite	$NaNO_2$		varm saturated	boiling	0	0
Sodium perborate	$NaBO_2\cdot H_2O_2\ 3H_2O$		saturated	20°	0	0
Sodium perchlorate	$NaC10_4+H_2O$		10%	20° boiling	0 0	0 0
Sodium peroxide	Na_2O_2		10%	20° 100°	0 0	0 0
Salicylic acid, sodium salt	$NaC_7H_5O_3$		saturated	20°	0	0
Sodium silicate	Na_2S1O_3		saturated	20° and boiling	0	0
Sodium sulphate	$Na_2SO_4+10H_2SO_4+$		saturated 5%	20° boiling	0 0	0 0
Sodium sulphide	Na_2S+9H_2O		20% 50% varm saturated	20°+boiling boiling 100°	0 1 2	0 0 2
Sodium sulphite	$Na_2SO_3+7H_2O$		50%	20° and boiling	0	0
Sodiumtetraborate (Borax)	$Na_2B_4O_7+10H_2O$		saturated charge	20° and boiling	0 3	0 3
Sodiumthiosulphate	$Na_2S_2O_3+5H_2O$	L	25%	20° and boiling	0	0
Nickel chloride	$NiCl_2+6H_2O$	L		20°	0	0
Nickel nitrate	$Ni(NO_3)_2+6H_2O$		5-10%	20°	0	0
Nickel sulphate	$NiSO_4+7H_2O$		varm saturated	boiling	0	0
Novocain				20°	0	0
Oil (lubricating oil)				20°	0	0
Oil (vegetable)				20°	0	0
Quick lime (Calcium oxide)	CaO			20° and boiling	0	0
Cheese				20°	0	0
P3-detergent				95°	0	0
Paraffin, melted					0	0

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group	
					A2	A4
Petrol				20° and boiling	0	0
Crude oil					0	0
Salicylic acid	$HO{\cdot}C_6H_4{\cdot}COOH$			20°	0	0
Nitrous acid	HNO_2		concentrated	20°	0	0
Nitric acid	HNO_3		up to 25% 25– 40% 40– 60% 60– 80% 80–100% 5% 10% 25% 50% 65% 99%	20-80° 20-70° 20-60° 20-55° 20-50° boiling boiling boiling boiling boiling boiling	0 0 0 0 0 0 0 0 0 1 2	0 0 0 0 0 0 0 0 0 1 2
Brine		L		20°	0	0
Chlorhydric acid	HCl	L L L L	0.2% 0.5% 1% 2%	20° 50° 20° 50° 20° 50° 20° 50°	1 2 1 3 2 3 3 3	0 1 0 2 1 2 3 3
Mustard		L		20°	0	0
Silver nitrate	$AgNO_3$		10% charge	20° and boiling 250°	0 0	0 0
Fresh water		L		20° boiling	0 2	0 –
Butyric acid	C_3H_7COOH		100%	20°	0	0
Solution of sugar				boiling	0	0
Soda	Na_2CO_3		charge	20° and boiling 320°	0 2	0 2
Stearic acid	$CH_3(CH_2)_{16}$ COOH			20° and 80° 130°	0 0	0 0
Sulphite gases, exhaust gases from boiling of cellulose			up to 8 bar	160°	0	–
Sulphite lye (fresh pulping liquor or spent liquor)				20° 80° 140°	0 2 3	0 0 0
Superphosphate			+3% H_2SO_2	20°	0	0
Sauerkraut water		L			2	1
Sulphur	S		melted boiling	130° 445°	0 2	0 2
Sulphur anhydride	SO2			20°-100° 100°-500°	0 2	0 0
Sulphur monochloride	S_2Cl_2	L	100%	20° boiling	0 0	0 0
Sulphuric acid	H_2SO_4		0.1% 1% 5% 10% 20% 40% 60% 80% 98%	100° 20° boiling 20° 70° boiling 20° 70° boiling 20° 70° boiling 20° 70° boiling 20° 70° boiling 20° 70° boiling 20° 70° boiling	– 1 1 1 1 2 2 2 3 1 2 3 1 2 3 3 3 1 3 3 0 2 2	0 0 1 1 1 2 1 2 2 1 2 3 1 2 3 3 3 1 2 3 0 2 2

Attacker	Chemical formula	Hole corrosion trend	Concentration	Temperature °C	Steel group	
					A2	A4
Sulphuric acid	H_2SO_4		steaming 11% free SO_3 steaming 60% free SO_3 15%+1% $CuSO_4$ 15%+1% iron sulphate 15%+peroxide	20° 100° 20° 80° boiling boiling 50°	0 1 0 0 0 0 0	0 0 0 0 0 0 0
Sulphurous acid	H_2SO_3		3-6% at 4 bar at 5-8 bar at 10-20 bar	20° 135° 160° 180°-200°	1 1 2 2	0 1 1 1
Hydrogen sulphide	H_2S		dry damp	20° 100° above 200° 20°	0 0 3 0	0 0 3 0
Tannin (Tannic acid)	$C_{76}H_{52}O_{46}$		10%	20° and boiling	0	0
Mercapto acetic acid	$HS{\cdot}CH_2{\cdot}COOH$			20° and boiling	–	0 1
Tar, pure				20° and hot	0	0
Toluole	$C_6H_5{\cdot}CH_3$			20° and boiling	0	0
Trichlorethylene	$CHCl{\cdot}CCl_2$	L L		20° boiling	0 1	0 0
Trichloroacetic acid	$CCl_3{\cdot}COOH$		all concentrations	20°	3	3
Trisodium phosphate	$Na_3PO_4{\cdot}12H_2O$		cold saturated	20° and boiling	0	0
Turpentine				20° and hot	0	0
Soap				20°	0	0
Urine		L		20°	0	0
Vaseline				20° and varm	0	0
Water, distilled	H_2O			20° and boiling	0	0
Water steam with SO_2 with CO_2				400°	0 1 0	0 0 0
Wine (white or red wine)				20° hot	0 0	0 0
Tartaric acid	$COOH(CHOH)_2$ COOH		10% 50%	20° 20°	0 0	0 0
Hydroperoxide, pure technical stabilised	H_2O_2		30% 85%	20° and varm 70°	0 –	0 0
Zinc	Zn		melted	500°	3	3
Zinc chloride, damp	$ZnCl_2$	L	20%	20° 90°	0 0	0 0
White vitriol, damp	$ZnSO_4{+}7H_2O$		varm saturated	boiling	0	0
Malic acid	$(COOH)_2$ CH_2CH OH		up to 50%	20°	0	0
Apple wine				20°	0	0
Vinegar				20°	0	0
Acetic acid	CH_3COOH		10% 50%	20° 20°	0 0	0 0
Acetic acid Hydroperoxide	$CH_3COOH{+}$ H_2O_2		10 and 50%	20° 50° 90°	0 0 0	0 0
Beer				20°	0	0

Description of materials for rubber types

Nitrile rubber (NBR)
High oil constancy (petrol, mineral oils).
Poor weather constancy and should not be used for details that are exposed to weather and wind.
Work temperature: -10°C to +50°C.

EPDM rubber
Very high ozone- and weather constancy.
Good cold constancy. Certain degree of constancy against oxidising acids and chemicals, animal or vegetable oils.
No constancy against mineral oils.
Work temperature: -40°C to +100°C.

Flourine rubber Viton (FPM)
High heat- and weather constancy.
Very good constancy against oils, acids and oxidising chemicals.
Expand in esters, ethers and ketones.
Work temperature: -40°C to +260°C.

Keeping and storing of rubber articles

Ozone accelerates the ageing process of rubber. O-rings and other sealing materials should therefore if possible be kept in a sealed package, not near fluorescent tubes or machines that generate ozone. Furthermore they should be protected against rapid ventilation. With regards to the rubbers ageing, sealing materials should be kept in dark, dust-free and dry store areas, where preferably the temperature does not exceed +15°C. Sealing materials may consequently not be stored close to radiators/electric heaters.

Seals should not be tied together with steel wire or similar materials, as the frail surface could easily be damaged.

Seals should be kept in their original package up until assembly. Seals should be kept in open condition. This means that when packing in cardboard the space should be large enough so that the seal does not deform by folding or similar.

Maximum storing time for rubber articles is 36 months (3 years).