

ALLOWANCE

The prescribed difference between the design size (maximum material) and the basic size.

BASIC PROFILE

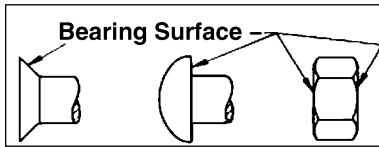
The cyclical outline, in an axial plane, of the permanently established boundary between the provinces of the external and internal threads. All deviations are with respect to this boundary.

BASIC SIZE

That size from which the limits of size are derived by the application of allowances and tolerances.

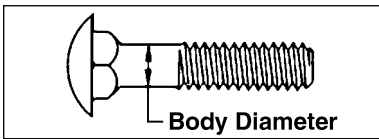
BEARING SURFACE

The bearing surface is the supporting or locating surface of a fastener with respect to the part which it fastens (mates). The loading of a fastener is usually through the bearing surface.



BODY DIAMETER

The body diameter is the diameter of the body of a threaded fastener.

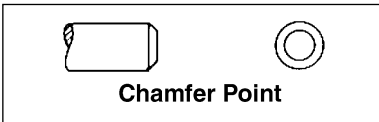


CHAMFER

The conical surface at the starting end of a thread.

CHAMFER POINT

A chamfer point is a truncated cone point, the end of which is approximately flat and perpendicular to the fastener axis. These points on threaded fasteners generally have point included angles of 45 to 90 degrees and a point diameter equal to or slightly less than the minor diameter of the thread. This point is intended to facilitate entry of fasteners into holes at assembly.



CLASS OF THREAD

An alphanumeric designation to indicate the standard grade of tolerance and allowance specified for a thread.

Class 1A and 1B

Classes 1A and 1B are very loosely toleranced, therefore, this class produces the loosest fit; that is, the greatest amount of play in assembly. An allowance is applied to the external thread in class 1A and 1B. This class is ideally suited where quick and easy assembly is of prime design concern.

Class 1A and 1B is standard for only coarse and fine threads with sizes of 1/4 inch and larger. Very few fasteners produced in Canada and the United States have this class of fit.

Class 2A and 2B

Class 2A and 2B is the most common thread class specified for inch series fasteners. Class 2A for external threads has an allowance while class 2B for internal threads does not. Class 2A and 2B threads offer excellent value of fit when considering manufacturing conveniences and economy, against fastener performance. This class offers a good grade of

commercial products such as machine screws, bolts, nuts, and studs for most interchangeable equipment parts and structural applications. It is estimated that over 90 percent of inch fastener series in Canada and the United States have class 2A and 2B threads.

Class 3A and 3B

Class 3A and 3B threads have no specific allowance and are manufactured to restrictive tolerances. These classes of threads are intended for exceptionally high-grade commercial products such as socket cap screws, set screws, aerospace bolts and nuts, and connecting rod bolts where close or snug fit for precision is essential, as well as in applications where safety is a critical design feature.

CLEARANCE FIT

The maximum material condition clearance between mating assembled parts.

COLD WORKING

Cold working is the plastic deformation of metals at temperatures below that which will cause recrystallization. This cold working is accompanied by an increase in strength and hardness, called work hardening, and a decrease in ductility. The cold working effects of forming bolt and screw heads, of extruding bolt shanks, and of roll threading increase strength values, often considerably.

CONE POINT

A cone point is a sharp conical point designed to perform perforating or aligning functions at assembly.



COUNTERSINK

Flare or bevel at the hole end.

ELEMENT

Elements of a thread are flank angle, root, crest, pitch, lead angle, surface finish, major, minor, and pitch diameters.

EXTERNAL THREAD

A screw thread formed on the outside of a cylindrical surface.

FASTENER

A fastener is a mechanical devise for holding two or more bodies in definite positions with respect to each other.

FULL OR NOMINAL DIAMETER BODY

A full or nominal diameter body is a body the diameter of which is generally within the dimensional limits of the major diameter of the thread. Sometimes referred to as "full size body".

GIMLET POINT

A gimlet point is a threaded cone point usually having a point angle of 45 to 50 degrees. It is used on thread forming screws such as Type "AB" tapping screws, wood screws, lag screws, etc.

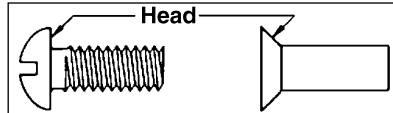


GRADES OF FASTENERS

In the SAE system, grades are designated by numbers from 1 through 8. These numbers have no quantitative relationship to strength properties, except that increasing numbers represent increasing tensile strengths. Decimals after whole numbers indicate the same basic properties, with variations in either material or processing treatment. The ASTM grades are designated by their document number. Some of the ASTM standards describe two or more types or grades with the difference being either a variation of material – for example, ASTM A325 Types 1, 2 and 3 – or modified properties of the same material – ASTM A307 Grades A and B.

HEAD

The head of a fastener is the enlarged shape preformed on one end of a headed fastener to provide a bearing surface.

**HIGH STRENGTH FASTENER**

A high strength fastener is a fastener having high tensile and shear strengths attained through combinations of materials, work-hardening and heat treatment.

HEAT TREATMENT

The strength and ductility of metals can be significantly altered by various types of heating operations. Heat treatment refers to any of a number of operations involving the heating of the parts in appropriate furnaces, gas fired or electric, often with controlled atmosphere, and the subsequent cooling at controlled rates. In the manufacture of fasteners the strength and ductility of the parts can in this way be adjusted, within limits, to fit the particular application.

INCOMPLETE THREAD

Threads having crests or roots not fully formed. Incomplete threads occur at the end of pointed externally threaded products, at countersinks in the faces of threaded holes or nuts, and at thread runouts where the threaded section blends into the unthreaded shank.

THREAD

A thread is a portion of a screw thread encompassed by one pitch. On a single-start thread it is equal to one turn. See threads per inch and turns per inch.

MAJOR CYLINDER

An imaginary cylinder that would bound the crests of an external straight thread or the roots of an internal straight thread.

MAJOR DIAMETER

On an internal thread, the diameter at the root and on an external thread the major diameter is the diameter at the thread crest.

MINOR DIAMETER

On an internal thread, the diameter at the crests and on an external thread, the diameter at the root.

NOMINAL SIZE

The designation which is used for the purpose of general identification. The basic major diameter of a threaded fastener is often referred to as "nominal size".

PHYSICAL PROPERTIES

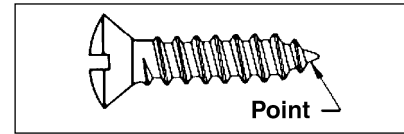
Physical properties are the properties defining the basic characteristics of the material or fastener.

PITCH

The pitch of a thread having uniform spacing is the distance, measured parallel to its axis, between corresponding points on adjacent thread forms in the same axial plane and on the same side of the axis. Pitch is equal to the lead divided by the number of thread starts.

POINT

The point of a fastener is the configuration of the end of the shank of a headed fastener or of each end of a headless fastener.

**PROOF LOAD**

Proof load represents the maximum useable load limit of the fastener for many design-service applications. Proof load is commonly defined as the tension applied load which the fastener must support without evidence of any deformation. Often, proof load and yield strength are interpreted as being the same.

Note: Proof load is a force measurement. The units are pounds or newton. Yield strength is a stress measurement. The units are PSI or MPa. The stress at the proof load is 90-93% of the yield strength.

REFERENCE DIMENSION

A dimension usually without tolerance, used for information purposes only. It does not govern production or inspection operations. A reference dimension is derived from other values shown on the drawing or on related drawings.

RIGHT-HAND THREAD

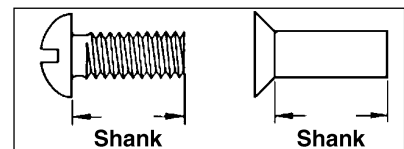
A thread is right-hand if, when viewed end-on, it winds in a clockwise and receding direction. A thread is considered to be right-hand unless specifically indicated.

ROOT

That surface of the thread that joins the flanks of adjacent thread forms and is immediately adjacent to the cylinder from which the thread projects.

SHANK

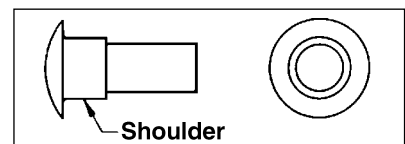
The shank is that portion of a headed fastener which lies between the head and the extreme point.

**SHEAR STRENGTH**

Shear is transverse rupture. It is caused by a pushing or pulling force at 90° from the axis of a part. Thus, a rivet used as a pulley axle will shear if the load on the pulley exceeds the shear value of the rivet. Shear strengths generally are 60% of the specified minimum tensile strength.

SHOULDER

A shoulder is an enlarged portion of the body of a threaded fastener or shank of an unthreaded fastener.



TENSILE STRENGTH

Tensile strength, or ultimate strength, is that property of a material which determines how much load it can withstand without breaking. It is calculated by determining the tensile stress corresponding to the maximum load observed in a tension test. Cold working raises the tensile strength of most metals and alloys. Heat treatment can often be used to increase or reduce the tensile strength.

THREADED FASTENER

A threaded fastener is a fastener – a portion of which has some form of screw thread.

THREAD PITCH

The distance measured parallel to the thread axis between corresponding points on adjacent threads. Pitch is equal to the lead divided by the number of thread starts. Unified threads are designated in threads per inch and their thread pitch is reciprocal of the number of threads per inch (TPI). Metric threads are designated by their actual pitch.

THREAD SERIES

Thread series are groups of diameter-pitch combinations distinguished from each other by the number of threads per inch applied to a series of specific diameters. There are two general series classifications: standard and special.

Coarse Thread Series Applications

The coarse thread series (UNC/UNRC) is generally used for the bulk production of screws, bolts, and nuts. It is commonly used in relatively low strength materials such as cast iron, aluminum, magnesium, brass, bronze, and plastic because the coarse series threads provide more resistance to internal thread stripping than the fine or extra-fine series. Coarse series threads are advantageous where rapid assembly or disassembly is required, or if corrosion or damage from nicks due to handling or use is likely.

Fine Thread Series Applications.

The fine thread series (UNF/UNRF) is commonly used for bolts and nuts in high strength applications. This series has less thread depth and a larger minor diameter than coarse series threads. Consequently, thinner walls are permitted for internal threads and more strength is available to external threads than for coarse series threads of the same nominal size.

8-Thread Series.

The 8-thread series (8UN) is a uniform-pitch series for large diameters or as a compromise between coarse and fine thread series. Although originally intended for high-pressure-joint bolts and nuts, it is now widely used as a substitute for the coarse thread series for diameters larger than 1 in.

12-Thread Series

The 12-thread series (12UN) is a uniform-pitch series for large diameters requiring threads of medium-fine pitch. Although originally intended for boiler practice, it is now used as a continuation of the fine thread series for diameters larger than 1-1/2 in.

THREADS PER INCH

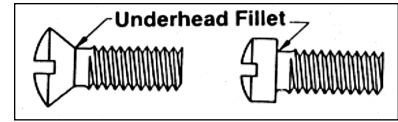
The number of thread pitches per inch. It is the reciprocal of the axial pitch value in inches.

TOLERANCE

The total amount of variation permitted for the size of a dimension. It is the difference between the maximum limit of size and the minimum limit of size.

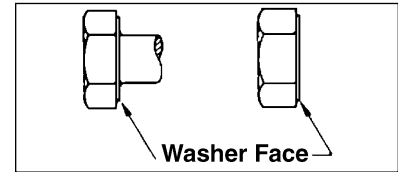
UNDERHEAD FILLET

An underhead fillet is the fillet at the junction of the head and shank of a headed fastener.



WASHER FACE

A washer face is a circular boss on the bearing surface of a bolt or nut.



YIELD STRENGTH

Yield strength is defined as the tension applied stress at which the fastener experiences a specified amount of permanent deformation. The fastener material simply has been stressed beyond its elastic limit and has entered its plastic zone. Yield strengths of machined test specimens are easily determined because of their uniform cross-sectional area throughout the stressed length. It has been noted that the yield strength characteristics of test specimens do not always parallel those of the full size fastener from which they are taken. This is because the beneficial effects of cold working may be completely lost when the test piece is machined from the parent product. It is difficult to test full size fasteners for yield strength because of the different strain rates in areas such as: the fully threaded portion; the thread runoff; and the unthreaded shank which comprises the stressed length. Because of this, the "proof load" system was introduced as an approved technique for testing a fastener's deformation characteristics.



STEEL FASTENERS

CARBON STEEL FASTENERS

Approximately 90 percent of all fasteners are manufactured from carbon steel. Steel has excellent workability, a broad range of strength properties, and the raw material is quite inexpensive. There are over 100 different standard strength grades for steel fasteners, each with its own set of properties and designations.

In general, carbon steel fastener strength grades can be placed into three broad groupings involving low carbon, medium carbon, and alloy steel. The most widely referenced strength grade for carbon steel external threaded fasteners is detailed in the SAE J429 standard. The system is comprised of bolt grades made from low carbon steel through to alloy steels.

The common grades of the SAE system are repeated and expanded upon in separate ASTM standards, notably A307, A449, A325 and A490.

LOW CARBON STEELS

Low carbon steels, as used for fasteners, are defined as those with insufficient carbon content to permit a predictable response to a strengthening heat treatment process. The most commonly used analysis are AISI 1006, 1008, 1016, 1018, 1021 and 1022. These steels have good workability, they can be case hardened, and are weldable.

Note: (Piping Bolt) *The low carbon steel fastener ASTM A307 is a special bolt used in piping and flange work. It has properties similar to other low carbon steel bolts except that it has the added requirement of a specified maximum tensile strength. The reason for this is to ensure that the bolt will fracture, before breaking a cast iron flange on a pump or valve, if the bolt is inadvertently over-tightened.*

MEDIUM CARBON STEELS

Medium carbon steels are heat treatable, which means that through metallurgical treatments the tensile strength of the fastener after processing can be significantly higher than that of its original raw material. Popular analysis are AISI 1030, 1035, 1038 and 1541. On a strength-to-cost basis, medium carbon heat treated steel fasteners provide more load carrying capability per unit of cost than any other known metal. Their yield-to-tensile ratio is the lowest of all heat treated steels which gives them superior ductility. In fact, they are frequently referred to as "forgiving" which means they have a punching bag ability to absorb punishment and service abuse.

ALLOY STEELS

Carbon steel is classed as an alloy steel when the maximum of the range of content specified for manganese is greater than 1.65 percent, or for silicon 0.60 percent, or for copper 0.60 percent, or when the chromium content is less than 4.0 percent (if greater it approaches being a stainless steel), or when the steel contains a specified minimum content of aluminum, boron, cobalt, columbium, molybdenum, nickel, titanium, vanadium, zirconium, or any other element added to achieve a specific effect.

ALLOY STEEL STUD BOLTING MATERIALS

The following grades of heat treated alloy steel studs are commonly used for high-pressure or extreme service in diameters of 1/4 in. to 4 in., inclusive. Other grades and other diameters are available on special order.

ASTM A193, Grade B7

A heat treated chromium-molybdenum steel widely used for medium high temperature service. (Liquid quench -50° to 900°F, Air quench -40° to 900°F)

ASTM A193, Grade B7M

Similar to B7 studs except that the minimum yield and tensile strength requirements are reduced and the hardness controlled to 235 Brinell maximum. Designed for use in corrosive environments. (-50° to 900°F.)

ASTM A193, Grade B16

A heat treated chromium-molybdenum, vanadium steel for high pressure, high temperature service. (-50° to 1100°F.)

ASTM A320, Grade L7

This grade is intended for low temperature service down to minus 150°F and has a minimum Charpy impact value of 20 ft. lbs. at this temperature. (-150° to 1100°F.)

ASTM A320, Grade L7M

Similar to L7 studs except that the minimum yield and tensile strength requirements are reduced and the hardness controlled to 235 Brinell maximum. This stud is designed for use in low temperature corrosive environments. (-150° to 1100°F.)

ASTM A193, Grade B8

These Chromium-Nickel (AISI 304) austenitic steel studs are used in corrosive environments. (-325° to 1500°F.)

ASTM A193, Grade B8M

These Chromium-Nickel Molybdenum (AISI 316) austenitic steel studs are used in corrosive environments. (-325° to 1500°F.)

CARBON AND ALLOY STEEL NUTS

ASTM A194, Latest Revision, Grade 2H

Suitable for use in high temperatures and high pressure conditions.

ASTM A194, Grade 2HM

Similar to 2H nuts except this grade is designed for use in corrosive environments.

ASTM A194, Latest Revision, Grade 4

Heat treated molybdenum steel nuts suitable for severe temperature and pressure conditions.

ASTM A194, Latest Revision, Grade L7

New stamping as per ASTM is 7L. Heat treated chrome-molybdenum steel nuts suitable for extreme temperature and pressure conditions. Suitable for sub-zero service conditions and have minimum Charpy impact values of ASTM spec. A320. Grade 7 down to -150°F.

ASTM A194, Grade L7M

New stamping as per ASTM is 7ML. Similar to grade L7 nuts except this grade is designed for use in corrosive environments.

ASTM A194, Grade 8/8M

Stainless steel nuts designed for use in corrosive environments.

WHY IS STAINLESS STAINLESS?

Stainless steels achieve "stainless" characteristics by virtue of their ability to form a tight adherent film of iron-chromium oxide which strongly resists attack by the atmosphere and a wide variety of industrial gases and chemicals. This effect, plus the superior high temperature strength characteristics exhibited by many of these alloys, accounts for their wide use at ordinary and elevated temperatures with a wide choice of mechanical properties and several distinct levels of corrosion resistance.

These steels may be subdivided into the following groups:

1. Martensitic stainless steels are iron-chromium alloys which are hardenable by heat treatment. Representative of this group are Types 410, 420, 431 and 440C.
2. Ferritic stainless steels are iron-chromium alloys which cannot be hardened significantly by heat treatment. Representative of this group are Types 405 and 430.
3. Austenitic stainless steels are iron-chromium-nickel and iron-chromium-manganese-nickel alloys which are hardenable by cold working. Representative of this group are Types 201, 304, and 316.
4. Precipitation hardening stainless steels are iron-chromium-nickel alloys with additional elements which are hardenable by solution treating and aging.

Alloys in the first two groups are magnetic in all conditions; those in the third group are slightly magnetic in the cold worked condition, but non-magnetic in the annealed condition in which they are most often used. Alloys in the fourth group are magnetic in the precipitation hardened condition.

NOTE: The Fastener Industry is now involved in the process of changing the head markings on stainless steel bolts to correspond to the ASTM specification. Please refer to the chart at the bottom of the page.

QUOTE

There are few, if any, jobs in which ability alone is sufficient. Needed, also, are loyalty, sincerity, enthusiasm and team play.

WILLIAM B. GIVEN, JR.

MATERIALS AVAILABLE

18.8 Stainless Steel

This is the most popular type of stainless used in the production of fasteners. Its composition is approximately 18% Chromium and 8% Nickel, thus the name 18.8. Several grades of stainless are included in this classification including 302, 303, 304 and 305. These all have good strength and corrosion resistance.

316 Stainless Steel

This is more corrosion resistant than 18.8, but also more expensive. It is composed of approximately 18% Chromium and 12% Nickel with the addition of 2% to 4% Molybdenum. It also maintains its strength at higher temperatures than 18.8.

410 Stainless Steel

It has approximately 12% Chromium with no Nickel. It is not very corrosion resistant and is magnetic, but it can be heat treated to become harder.

Alloy 20

This alloy has approximately 20% Chromium and 34% Nickel plus 3% to 4% Molybdenum. It is very corrosion resistant and is especially popular when in contact with sulfuric acid.

Brass

This metal is approximately 65% Copper and 35% Zinc. It offers a good combination of strength, corrosion resistance and workability.

Nickel Copper 400

This alloy is approximately 70% Nickel and 30% Copper. It has excellent strength and corrosion resistance and is used in salt water marine and other chemical environments.

Titanium

This has a very high strength to weight ratio, as well as good corrosion resistance.

Inconel

Registered Trade Mark of Inco Ltd. Composed of approximately 77% Nickel and 15% Chromium. It offers superior strength and good corrosion at high temperatures.

Silicon Bronze

It is composed of approximately 96% Copper, 3% Silicon and 1% Manganese. It is more corrosion resistant and tougher than brass. It is widely used in the electrical industry.

EXAMPLES OF HEAD MARKING CHANGES

**18.8 STAINLESS STEEL
HEX HEAD CAP SCREWS
UNC – Unified National Coarse Thread**

Present Head Markings
All Diameters

New Head Markings
1/4" - 5/8" Dia. 3/4 - 1" Dia.

**316 STAINLESS STEEL
HEX HEAD CAP SCREWS
UNC – Unified National Coarse Thread**


Present Head Markings
All Diameters



New Head Markings
1/4" - 5/8" Dia. 3/4 - 1" Dia.

Chromium	Nickel	Max. Carbon	Max. Mangan.	Max. Phosph.	Max. Sulphur	Molybd.	Max. Silicon	Copper	Other Elements	Tensile	Yield	Approx. Hardness
300 SERIES AUSTENITIC STAINLESS: Accounts for 86%-90% of stainless fasteners; best corrosion resistance of stainless alloys; non-magnetic before cold working; low heat conductivity; good strength at higher temperatures; not hardenable by heat treatment. Tensile and yield will increase sharply in austenitic fasteners made by cold forming but may decrease in fasteners made by machining. Consequently, the range for tensile and yield is broad and depends largely on how fasteners are made. Grades commonly used for cold forming such as 302HQ, 304, and 316 may have much higher strength than other grades.												
18-8 Most common designation for non-magnetic stainless fasteners; encompasses 30 to 40 various mixtures of 301, 302, 303, 304, 305 and XM7.												
17-20% Usually 17-19%	8-13% Usually 8-10.5%	.08% Usually .03-05%	2%	.2% Usually .045%	.03-15% Usually .03%		1%	0-4% Usually 2%-3%		80,000-150,000 usual range. After cold work: 100,000-125,000 typical for 1/4-5/8 dia.; 100,000 typical for 3/4-1" dia.; 80,000-90,000 typical over 1" dia.	40,000 min. After cold work: 80,000-90,000 typical 1/4-5/8 dia.; 45,000-70,000 typical 3/4 and over dia.	B85-95
304 Most popular stainless for hex head cap screws; also frequently used for flat washers.												
18-20%	8-10.5%	.08%	2%	.45%	.03%		1%			85,000-150,000 range. After cold work: 125,000 typical for 1/4-5/8 dia.; 100,000 typical for 3/4-1" dia.; 90,000 typical above 1" dia.	40,000 min. After cold work: 90,000 typical for 1/4-5/8 dia.; 50,000-70,000 typical for 3/4 and over dia.	B85-95
304L Low carbon increases corrosion resistance and welding capacity.												
18-20%	8-12%	.03%	2%	.045%	.03%		1%			Slightly lower than 304 due to lower carbon content		
305 High nickel content lowers work hardening during severe cold forming and keeps parts non-magnetic.												
17-19%	10.5-13%	.12%	2%	.045%	.03%		1%			90,000-125,000 Typical: 100,000	40,000 min. Typical: 50,000-70,000	
316 Addition of molybdenum increases corrosion resistance to chloride and sulfides.												
16-18%	10-14%	.08%	2%	.045%	.03%	2-3%	1%			85,000-140,000 usual range. After cold work: 120,000 typical for 1/4-5/8 dia.; 95,000 typical for 3/4-1" dia.; 80,000 typical above 1" dia.	40,000 min. After cold work: 80,000-90,000 typical for 1/4-5/8 dia.; 50,000-70,000 typical for 3/4 and over dia.	B85-95
309 Higher chromium and nickel give better corrosion resistance at high temperatures (1900 deg. F.)												
22-24%	12-15%	.2%	2%	.045%	.03%		1%		100,000-120,000	60,000-80,000	B85-95	
400 SERIES MARTENSITIC STAINLESS: About 5% of stainless fasteners; magnetic; no nickel and high carbon content mean the lowest corrosion resistance among the different types of stainless. Tensile and yield will increase sharply in martensitic stainless by heat treating.												
400 Mixture Martensitic Often a mixture of different 400 materials, usually with carbon content towards high end of max. giving greater strength but lowering corrosion resistance.												
11.5-14%		.30% Usually .15-.30%	1.25% Usually 1%	.06% Usually .04%	.15% Usually .03%		1%			180,000-250,000 if heat treated	150,000-200,000 if heat treated	C34-C45
410 Higher carbon content gives strength; most popular of the grades with 12% chrome; used in highly stressed conditions.												
11.5-13.5%		.15%	1%	.04%	.03%		1%			180,000 heat treated	150,000 heat treated	C34
416 Higher sulfur content helps machinability but lowers corrosion resistance.												
12-14%		.15%	1.25%	.06%	.15%		1%			180,000 heat treated	150,000 heat treated	C34
420 Higher carbon gives greater strength but lowers corrosion resistance.												
12-14%		.30% Nom. 15% Min.	1%	.04%	.03%		1%			250,000 heat treated	200,000 heat treated	C45
PRECIPITATION HARDENED STAINLESS, MONEL, AND ALUMINUM												
630 Infrequently used; high corrosion resistance; strength and ductility in high and low temperatures due to solution annealing and hardening.												
15.5-17.5%	3.5%	.07%	1%	.04%	.03%	1%		3-5%	Columbian and Tantalum - 15.4 5%	135,000	105,000	C28
Monel 400 Most commonly used nickel-copper alloy for cold forming; excellent corrosion resistance in heat and salt water.												
	63-70%	.3%	2%		.5%				2.5%-Iron, .5%-Alum., .15% Sulf., remainder Copper	80,000-125,000	400,000-70,000	B70
Aluminum 2024 Most popular of aluminum alloys; needs heat treatment for strength.												
.1%			.3-.9%		.5%			3.8-4.9%	.25% Zinc. 1.2-1.8% Magnesium, remainder Alum.	60,000 heat treated	50,000 heat treated	B60 heat treated

Chromium	Nickel	Max. Carbon	Max. Mangan.	Max. Phosph.	Max. Sulphur	Molybd.	Max. Silicon	Copper	Other Elements	Tensile	Yield	Approx. Hardness
BRASS and BRONZE												
Brass Alloy 270 Good cold forming due to high copper content; also used for milled from bar nuts.												
								65%	35% Zinc	70,000	45,000	B65
Brass Alloy 360 Good machinability due to added lead; good for screw machine parts.												
								61.5%	3% Lead remainder Zinc	50,000	30,000	B55
Commercial Brass Easier to cold form as copper content increases; as copper content decreases, the metal becomes stronger and harder.												
								60-65%	35-40% Zinc. .05-.15 Lead	55,000	35,000	B60
Bronze Alloy 651 Generally used for hex head cap screws.												
			.07%				2.0%	96.0% min.	.05% Lead max. 1.5% Zinc max.	70,000-80,000	35,000-45,000	B70-B75
Bronze Alloy 655 Used for hot forged fasteners.												
	.06%		1.5%				3.8%	94.8% min.	.05% Lead max. 1.5% Zinc max.	70,000-80,000	35,000-45,000	B70-B75
Commercial Bronze Addition of lead helps machinability.												
							2-4%	94-96%	.05-.8% Lead, .05-1.5% Zinc.	70,000-80,000	35,000-45,000	B70-B75
Phosphorus Bronze Tin increases strength; phosphorus helps against stress corrosion; excellent cold forming properties.												
				.3%				95%	5% Tin	60,000	35,000	B60
Naval Bronze Addition of tin gives better corrosion resistance against salt water.												
								59-62%	.5-1% Tin, 2% Lead remainder Zinc	70,000	30,000	B65

TORQUE GUIDE CHART - STAINLESS STEEL

		18-8 SERIES STAINLESS		
Proof Load	Yield Strength	Tensile Strength		
None	30,000	75,000		

				316 STAINLESS		
Diameter	Proof Load	Yield Strength	Tensile Strength			
1/4"-3/4"	None	100,000	125,000			
3/4" - 1"	None	80,000	115,000			
1 - 1-1/4"	None	65,000	105,000			
1-1/4" - 1-1/2"	None	50,000	100,000			

Size	Clamp Load (lbs.)	Assembly Torque Dry (ft. lbs.)	Min. Lub (ft. lbs.)	Tensile (lbs.)
1/4 - 20	1350	68 in.	51 in.	2780
1/4 - 28	1500	77 in.	58 in.	3020
5/16 - 18	2200	12 ft.	9 ft.	4400
5/16 - 24	2400	13	10	4700
3/8 - 16	3200	20	15	6500
3/8 - 24	3700	23	17	9000
1/2 - 13	5900	50	37	11900
1/2 - 20	6700	56	42	12800
5/8 - 11	9500	100	75	18800
5/8 - 18	10800	113	84	20400
3/4 - 10	14100	177	132	27600
3/4 - 16	15700	197	148	29600
7/8 - 9	11700	171	128	37900
1 - 8	15300	256	192	49700
1-1/8 - 7	19300	363	272	62700
1-1/4 - 7	24500	512	384	78800
1-3/8 - 6	29200	671	503	94400
1-1/2 - 6	35600	891	668	114000

Size	Clamp Load (lbs.)	Assembly Torque Dry (ft. lbs.)	Min. Lub (ft. lbs.)	Tensile (lbs.)
1/4 - 20	2100	9	7	4600
1/4 - 28	2400	10	7	5000
5/16 - 18	3400	18	13	7400
5/16 - 24	3800	20	15	7900
3/8 - 16	5100	32	24	10900
3/8 - 24	5700	36	27	15000
1/2 - 13	9350	78	58	19800
1/2 - 20	10550	88	66	21400
5/8 - 11	14950	156	117	31400
5/8 - 18	16850	176	132	34000
3/4 - 10	20300	276	121	42300
3/4 - 16	22670	308	191	45400
7/8 - 9	16850	246	213	58100
1 - 8	22900	368	290	69500
1-1/8 - 7	25400	386	411	87800
1-1/4 - 7	32200	548	480	110300
1-3/8 - 6	38400	629	629	125900
1-1/2 - 6	46700	835	835	152000

TECHNICAL

CORROSION GUIDE

This guide details the effects of various corrosive environments on popularly used fastener materials.

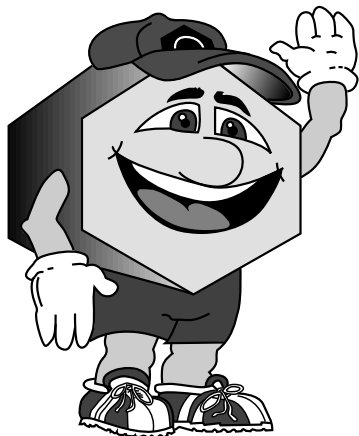
Corrosive Medium	Stainless Steel			Brass and Naval Bronze	Silicon Bronze	Copper	Copper (Monel)	Aluminum	Nylon
	18-8, 302	303, 304	410, 416						
	305	316	430						
Acetate Solvents, Crude	Excel	Excel	Good	Fair	Good	Good	Good	Excel	Good
Acetate Solvents, Pure	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Acetate Acid, Crude	Good	Excel	Poor ²	Fair ¹	Good	Good	Good	Good	Poor
Acetate Acid (Pure)	Good	Excel	Poor ²	Fair ¹	Good	Good	Good	Excel	Poor
Acetic Acid Vapors	Good	Excel	Poor	Poor	Good	Good	Fair	Good	Poor
Acetic Anhydride	Good	Excel	Poor	Poor	Good	Good	Good	Excel	Poor
Acetone	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Acetylene	Excel	Excel	Excel	3	Poor	Poor	Good	Excel	
Alcohols	Excel	Excel	Excel	Good	Excel	Excel	Excel	Good	Good
Aluminum Sulfate	Fair	Good	Poor	Fair ¹	Good	Good	Good	Fair	Poor
Alums	Fair	Good	Poor	Fair ¹	Good	Good	Good	Excel	Fair
Ammonia Gas ⁴	Excel	Excel	Excel	Poor ⁵⁶	6	6	6	Excel	Good ³⁶
Ammonium Chloride	Fair	Excel	Fair	Fair ¹	Good	Good	Excel	Poor	Fair
Ammonium Hydroxide	Excel	Excel	Excel	Poor	Poor	Poor	Fair Good	Good ³⁶	
Ammonium Nitrate	Excel	Excel	Excel	Poor	Fair	Fair	Fair	Excel	Fair
Ammonium Phosphate (Ammoniacal)	Excel	Excel	Excel	Poor	Poor	Poor	Good	Poor	Good
Ammonium Phosphate (Neutral)	Excel	Excel	Good	Fair	Fair	Fair	Good	Fair	Excel
Ammonium Phosphate (Acid)	Good	Excel	Fair	Fair ¹	Fair	Fair	Good	Fair	Fair
Ammonium Sulfate	Excel	Excel	Good	Fair ¹	Fair	Fair	Good	Good ³⁵	Fair
Asphalt	Excel	Excel	Good	Good	Excel	Excel	Excel	Excel	Excel
Beer	Excel	Excel	7	Good	Good	Good	Excel	Excel	Excel
Beet Sugar Liquors	Excel	Excel	Good	Good	Excel	Excel	Excel	Excel	Good
Benzene or Benzol ⁸	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Benzine ⁸	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Borax	Excel	Excel	Excel	Good	Good	Good	Excel	Good	Good
Boric Acid	Good	Excel	Fair	Fair ¹	Good	Good	Excel	Excel	Good
Butane, Butylene, Butadiene ⁹	Excel ¹⁰	Excel ¹⁰	Excel ¹⁰	Excel ³⁴	Excel ³⁴	Excel ³⁴	Excel	Excel	Excel
Calcium Bisulfite	Good	Excel	Poor	Poor	Good	Good	Poor	Poor	Good
Calcium Hypochlorite	Fair	Good	Poor	Fair	Fair	Fair	Fair	Poor	Fair
Cane Sugar Liquors	Excel	Excel	Good	Good	Excel	Excel	Excel	Excel	Good
Carbon Dioxide (Dry)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Carbon Dioxide (Wet and Aqueous)	Excel	Excel	Excel ¹¹	Fair ¹¹	Good ¹¹	Good ¹¹	Good ¹¹	Excel	Excel
Carbon Disulfide	Excel	Excel	Good	Fair	Poor	Poor	Fair	Excel	Excel
Carbon Tetrachloride ¹²	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Chlorine (Dry)	Good	Good	Good	Good	Good	Good	Excel	Poor	Poor
Chlorine (Wet)	Poor	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Poor
Chromic Acid	Good	Excel	Fair	Poor	Poor	Poor	Fair	Poor	Poor
Citric Acid	Good	Excel	Fair	Fair ¹	Good	Good	Good	Good	Good
Coke Oven Gas	Excel	Excel	Excel	Fair	Fair	Fair	Good	Good	Fair
Copper Sulfate	Excel	Excel	Excel	Poor	Fair	Fair	Fair	Poor	Fair
Core Oils	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Cottonseed Oil	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Creosote	Excel	Excel	Excel	Fair	Good	Good	Excel	Good	
Ethers	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Ethylene Glycol	Excel	Excel	Excel	Good	Excel	Excel	Excel	Good	Good
Ferric Chloride	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Ferric Sulfate	Excel	Excel	Excel	Poor	Fair	Fair	Fair	Good	Poor
Formaldehyde	Excel	Excel	Excel	Good	Good	Good	Excel	Good	Good
Formic Acid	Good	Excel	Poor	Fair ¹	Good	Good	Good	Poor	Poor
Freon	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Furfural	Excel	Excel	Excel	Good	Good	Good	Excel	Excel	Excel
Gasoline (Sour)	Excel	Excel	Fair	Fair	Poor	Poor	Poor	Poor	Excel
Gasoline (Refined)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Gelatin	Excel	Excel	Fair ¹³	Fair ¹³	Excel ¹³	Excel ¹³	Excel	Excel	Excel
Glucose	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Glue	Excel	Excel	Excel	Fair	Excel	Excel	Excel	Fair	Excel
Glycerine or Glycerol	Excel	Excel	Excel	Good	Excel	Excel	Excel	Excel	Good

Corrosive Medium	Stainless Steel			Brass and Naval Bronze	Silicon Bronze	Copper	Copper (Monel)	Aluminum	Nylon
	18-8, 302	303, 304	410, 416						
	305	316	430						
Hydrochloric Acid	Poor	Poor	Poor	Poor	Fair ¹⁴	Fair ¹⁴	Fair ¹⁴	Poor	Poor
Hydrocyanic Acid (Hydrogen Cyanide)	Excel	Excel	Fair	Poor	Poor	Poor	Good	Excel	Excel
Hydrofluoric Acid	Poor	Poor	Poor	Poor	Fair	Fair	Excel	Poor	Poor
Hydrogen Fluoride	Good	Good	Fair	Fair	Good	Good	Excel	Poor	Poor
Hydrogen ⁹	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Hydrogen Peroxide	Excel	Excel	Excel	Poor	Fair	Fair	Good	Good	Fair
Hydrogen Sulfide (Dry)	Excel	Excel	Good	Fair ⁶	Poor ⁶	Poor ⁶	Fair ⁶	Excel	Good ³⁷
Hydrogen Sulfide (Wet and Aqueous)	Good	Excel	Fair ¹⁵	Fair	Poor	Poor	Fair	Excel	Good ³⁷
Lacquers and Lacquer Solvents	Excel	Excel	Excel	Fair	Excel	Excel	Excel	Excel	Excel
Lime-Sulfur	Excel	Excel	Good	Poor	Fair	Fair	Good	Poor	Good
Magnesium Chloride	Good	Excel	Fair	Fair	Good	Good	Excel	Poor	Excel
Magnesium Hydroxide	Excel	Excel	Excel	Good	Excel	Excel	Excel	Fair	Good
Magnesium Sulfate	Excel	Excel	Excel	Good	Excel	Excel	Excel	Good	Excel
Mercuric Chloride	Poor	Fair ¹⁶	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Mercury	Excel	Excel	Excel	Poor	Poor	Poor	Good	Poor	Excel
Milk	Excel	Excel	Good	Fair	Fair	Fair	Fair	Excel	Excel
Molasses	Excel	Excel	Good	Good	Excel	Excel	Excel	Excel	Excel
Natural Gas	Excel	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Nickel Chloride ¹⁷	Fair	Good	Poor	Poor	Fair	Fair	Good	Poor	Poor
Nickel Sulfate ¹⁷	Good	Excel	Fair	Fair	Good	Good	Excel	Poor	Poor
Nitric Acid	Good	Good	Good ¹⁸	Poor	Poor	Poor	Poor	Fair	Poor
Oleic Acid	Good ²⁰	Excel	Good ²⁰	Fair ¹⁹	Good ²⁴	Good ²⁴	Excel	Excel	Excel
Oxalic Acid	Good	Excel	Fair	Fair	Fair	Fair	Excel	Poor	Poor
Oxygen ⁹	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good
Palmitic Acid	Good ²⁰	Excel	Good ²⁰	Fair ¹⁹	Good ²⁴	Good ²⁴	Excel	Excel	Excel
Petroleum Oils (Sour)	Excel	Excel	Fair	Fair	Poor	Poor	Poor	Poor	Excel
Petroleum Oils (Refined)	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Phosphoric Acid 25%	Fair ²³	Excel	Poor	Poor	Good ²¹	Good ²¹	Good ²²	Poor	Poor
Phosphoric Acid 25%, 50%	Poor	Good	Poor	Poor	Good ²¹	Good ²¹	Good ²²	Poor	Poor
Phosphoric Acid 50%, 85%	Poor	Good	Poor	Poor	Good ²¹	Good ²¹	Good ²²	Excel	Excel
Picric Acid	Excel	Excel	Good	Poor	Poor	Poor	Poor	Fair	Poor
Potassium Chloride	Good	Excel	Fair	Fair	Good	Good	Excel	Poor	Excel
Potassium Hydroxide	Excel	Excel	Excel	Poor	Fair	Fair	Excel	Poor	Good ³⁸
Potassium Sulfate	Excel	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Propane ⁹	Excel ¹⁰	Excel ¹⁰	Excel ¹⁰	Excel	Excel	Excel	Excel	Excel	Excel
Rosin (Dark)	Excel	Excel	Excel	Good	Good	Good	Excel	Excel	Excel
Rosin (Light)	Excel	Excel	Excel	Poor	Poor	Poor	Good	Good	Excel
Shellac	Excel	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Soda Ash (Sodium Carbonate)	Excel	Excel	Excel	Good	Good	Excel	Excel	Poor	Excel
Sodium Bicarbonate	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good	Excel
Sodium Bisulfate	Poor	Excel	Poor	Fair ¹	Good	Good	Excel	Fair	Fair
Sodium Chloride	Good	Excel	Fair	Fair	Good	Good	Excel	Good	Excel
Sodium Cyanide	Excel	Excel	Excel	Poor	Poor	Poor	Good	Poor	Good
Sodium Hydroxide	Excel	Excel	Excel	Poor	Fair	Fair	Excel	Poor	Good ³⁸
Sodium Hypochlorite	Fair	Excel	Poor	Excel	Fair	Fair	Fair	Poor	Fair
Sodium Metaphosphate	Excel	Excel	Good	Fair	Good	Good	Excel	Fair	Excel
Sodium Nitrate	Excel	Excel	Excel	Fair	Good	Good	Excel	Excel	Excel
Sodium Perborate	Excel	Excel	Excel	Fair	Good	Good	Excel	Fair	
Sodium Peroxide	Excel	Excel	Excel	Fair	Good	Good	Excel	Fair	Fair
Sodium Phosphate (Alkaline)	Excel	Excel	Excel	Fair	Good	Good	Excel	Poor	Good
Sodium Phosphate (Neutral)	Excel	Excel	Excel	Good	Excel	Excel	Excel	Poor	Excel
Sodium Phosphate (Acid)	Good	Excel	Poor	Fair ¹	Good	Good	Excel	Poor	Fair
Sodium Silicate	Excel	Excel	Excel	Fair	Good	Good	Excel	Good	Good
Sodium Sulfate	Excel	Excel	Excel	Good	Excel	Excel	Excel	Excel	Excel
Sodium Sulfide	Excel	Excel	Excel	Poor	Poor	Poor	Good	Poor	Good
Sodium Thiosulfate (Hypo)	Excel	Excel	Excel	Poor	Poor	Poor	Good	Excel	Good ³⁹
Sludge Acid	Poor	Fair	Poor	Poor	Good	Good	Good	Poor	
Stearic Acid	Good ²⁰	Excel	Good ²⁰	Fair ¹⁹	Good ²⁴	Good ²⁴	Excel	Excel	Excel
Sulfur	Excel	Excel	Excel	Fair	Fair	Fair	Fair	Excel	Good
Sulfur Chloride	Fair	Good	Poor	Poor	Poor	Poor	Good	Poor	Poor
Sulfur Dioxide (Dry) ⁹	Excel	Excel	Excel	Fair	Excel	Excel	Excel	Good	Good
Sulfur Dioxide (Wet)	Good	Excel	Poor	Poor	Good	Good	Poor	Fair	Fair

Corrosive Medium	Stainless Steel			Brass and Naval Bronze		Copper		Aluminum	Nylon
	18-8, 302		410, 416	Silicon Bronze	Copper	Copper (Monel)			
	303, 304	316							
Sulfuric Acid 10%	Poor	Good ²⁵	Poor	Poor	Good ²⁵	Good	Good ²⁵	Poor	Poor
Sulfuric Acid 10%, 75%	Poor	Poor	Poor	Poor	Fair	Fair	Good	Poor	Poor
Sulfuric Acid 75%, 95%	Fair ²⁷	Good ²⁷	Fair ²⁷	Poor	Fair ²⁶	Fair ²⁶	Fair ²⁶	Poor	Poor
Sulfuric Acid 95%	Good	Good	Good	Poor	Fair	Poor	Poor	Fair	Poor
Sulfurous Acid	Fair	Good	Poor	Poor	Good	Good	Poor	Poor	Fair
Tar	Excel	Excel	Good	Good	Excel	Excel	Excel	Excel	Excel
Tartaric Acid	Good	Excel	Fair	Fair ¹	Good	Good	Good	Good	Fair
Toluene or Toluol ⁸	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Trichloroethylene ¹²	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Good
Turpentine	Excel	Excel	Good ²⁸	Fair ²⁸	Excel	Excel	Excel	Excel	Excel
Varnish ²⁹	Excel	Excel	Excel	Good	Good	Good	Excel	Excel	Excel
Vegetable Oils ²⁹	Excel	Excel	Excel	Good	Good	Good	Excel	Excel	Excel
Vinegar ²⁵	Good	Excel	Fair	Poor	Good	Good	Good	Excel	Fair
Water (Acid Mine Water)	31	31	31	Poor	30	30	30	Fair	Good
Water (Fresh)	Excel	Excel	Excel	Fair ²	Good	Good	Excel	Excel	Excel
Water (Salt)	Good ³³	Fair ³³	Fair ³²	Good	Good	Excel	Good	Excel	
Whiskey	Excel	Excel	Fair	Good	Good	Good	Good	Fair	Excel
Wines	Excel	Excel	Fair	Good	Good	Good	Good	Fair	Excel
Xylene or Xylol ⁸	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
Zinc Chloride	Poor	Good	Poor	Poor	Good	Good	Excel	Poor	Good
Zinc Sulfate	Good	Excel	Fair	Fair	Good	Good	Excel	Good	Good ³⁹

Notes:

- Subject to dezincification and/or stress corrosion; especially at elevated temperatures and with concentrated solutions.
- May be useful with cold dilute acid.
- Alloys containing up to 60 percent copper acceptable; high copper alloys not acceptable.
- Temperature assumed to be below that at which gas cracks and liberates nascent nitrogen.
- Subject to stress corrosion with low concentrations.
- Apparently resistant to dry gas at ordinary temperatures; attacked rapidly by moist gas and by hot gas.
- Not recommended for use with beverage grade.
- Chemicals used for treating in manufacture assumed to be absent.
- Temperature assumed to be no higher than that normally encountered in compression, storage, and distribution.
- Useful at elevated temperatures.
- Not recommended for use with carbonated beverages.
- Water assumed to be absent.
- Not recommended for use with edible grades.
- Only with dilute or unaerated solutions.
- Subject to stress corrosion by moist gas; and to severe general corrosion by saturated aqueous solution.
- Subject to stress corrosion.
- None of these materials recommended for use with nickel plating solutions.
- Higher chromium alloys (over 18 percent) preferred.
- Not recommended for temperature over 212°F (100°C).
- Alloys with less than 18 percent Cr. not recommended for temperatures over 212°F (100°C). Others not recommended for temperatures over 392°F (200°C).
- Up to 140°F (60°C).
- Up to 194°F (90°C).
- At room temperature.
- Not recommended for temperatures over 392°F (200°C).
- Non-ferrous alloys preferred when unaerated and at temperatures above normal. Stainless Steel best when aerated and at normal to moderate temperatures.
- With cold acid only.
- In the absence of exposure to moist air.
- Crude produce may contain acids which corrode these materials.
- Some of these ratings may not apply when handling light colored products at elevated temperatures of 392°F (200°C).
- Good with water containing no oxidizing salts; fair with water containing oxidizing salts.
- Excellent with water containing oxidizing salts; not good with water containing no oxidizing salts.
- Subject to dezincification with hot and/or aerated waters.
- Subject to pitting attack.
- Copper may act as a catalyst for undesirable reactions.
- Free sulphuric acid absent.
- Good at concentrations under 10 percent and below 100°F (38°C).
- Suitable for limited service at concentrations under 50 percent and below 100°F (38°C).
- Good only at concentrations under 10 percent and below 100°F (38°C).
- Good only at concentrations under 20 percent and below 100°F (38°C).



QUOTE

Anyone can hold the helm when the sea is calm.
PUBLILIUS SYRUS

IDENTIFICATION MARKINGS

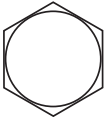






It is a mandatory requirement in SAE and ASTM standards that fasteners of the medium carbon and alloy steel strength grades be marked for grade identification. The only exceptions are slotted and recessed head screws and very small size fasteners – generally, smaller than 1/4" where head size doesn't permit marking. Additionally, and of major importance, these same standards require **all** carbon steel externally threaded fasteners be further marked to identify the manufacturer.

Identification markings are the purchaser's best guarantee of product quality. By indicating the strength properties the







fastener should have and the producing company, markings provide traceability and accountability. With the ever present threat of a liability action in case of a service failure, traceability is ample incentive to any reputable producer to exercise all of the care necessary to manufacture fully conforming parts.

Carbon steel bolts and screws without markings should be viewed with a high degree of suspicion. The only prudent assumption is that the fastener has the lowest strength properties permitted in any steel grade, and if not manufacturer marked, then it was produced either by a non-North American company or by one using questionable practices.

Grade Identification Markings for Popular Grades of Carbon Steel Externally Threaded Fasteners

Grade Identification Marking	Specification	Nominal Size (in.)	Proof Load Stress ksi	Tensile Strength Min. ksi	Hardness Rockwell		See Note
					Min.	Max	
Material: Low or Medium Carbon Steel							
 NO MARK	SAE J429 – Grade 1	1/4 thru 1-1/2	33	60	B70	B100	
	SAE J429 – Grade 2	1/4 thru 3/4	55	74	B80	B100	
	over 3/4 thru 1-1/2	33	60	B70	B100		
	ASTM A307 – Grade A	1/4 thru 4	–	60	B69	B100	
	ASTM A307 – Grade B	1/4 thru 4	–	60 min	B69	B95	
				–	100 max		
Material: Medium Carbon Steel, Quenched and Tempered							
	SAE J429 – Grade 5	1/4 thru 1	85	120	C25	C34	
	ASTM A449 – Type	over 1 thru 1-1/2	74	105	C19	C30	
	ASTM A449 – Type 1	over 1-1/2 thru 3	55	90	183	235	3
Material: Low or Medium Carbon Steel, Quenched and Tempered							
	SAE J429 – Grade 5.1	No. 6 thru 1/2	85	120	C25	C40	4
Material: Low Carbon Martensite Steel, Quenched and Tempered							
	SAE J429 – Grade 5.2	1/4 thru 1	85	120	C26	C36	
	ASTM A449 – Type 2	1/4 thru 1	85	120	C25	C34	
Material: Medium Carbon Steel, Quenched and Tempered							
	ASTM A325 – Type 1	1/2 thru 1	85	120	C24	C35	5
		over 1 to 1-1/2	74	105	C19	C31	
Material: Low Carbon Martensite Steel, Quenched and Tempered							
	ASTM A325 – Type 2	1/2 thru 1	85	120	C24	C35	
		over 1 to 1-1/2	74	105	C19	C31	
Material: Atmospheric Corrosion Resistant Steel, Quenched and Tempered							
	ASTM A325 – Type 3	1/2 thru 1	85	120	C24	C35	6
		over 1 to 1-1/2	74	105	C19	C31	

GRADE IDENTIFICATION MARKINGS FOR POPULAR GRADES OF CARBON STEEL EXTERNALLY THREADED FASTENERS

Grade Identification Marking	Specification	Nominal Size (in.)	Proof Load Stress ksi	Tensile Strength Min. ksi	Hardness Rockwell Min.	Hardness Rockwell Max	See Note
Material: Medium Carbon Alloy Steel, Quenched and Tempered							
	ASTM A354 – Grade BC	1/4 thru 2-1/2	105	125	C26	C36	
		Over 2-1/2 thru 4	95	115	C22	C33	
Material: Medium Carbon Alloy Steel, Quenched and Tempered							
	SAE J429 – Grade 8	1/4 thru 1-1/2	120	150	C33	C39	
	ASTM A354 – Grade BD	1/4 thru 2-1/2	120	150	C33	C39	7
		over 2-1/2 thru 4	105	140	C31	C39	7
Material: Low Carbon Martensite Steel, Quenched and Tempered							
	SAE J429 – Grade 8.2	1/4 thru 1	120	150	C33	C39	
Material: Medium Carbon Alloy Steel, Quenched and Tempered							
	ASTM A490 – Type 1	1/2 thru 1-1/2	120	150 min 170 max	C33	C38	
Material: Low Carbon Martensite Steel, Quenched and Tempered							
	ASTM A490 – Type 2	1/2 thru 1	120	150 min 170 max	C33	C38	
Material: Atmospheric Corrosion Resistant Steel, Quenched and Tempered							
	ASTM A490 – Type 3	1/2 thru 1-1/2	120	150 min 170 max	C33	C38	5

NOTES:

1. In addition to the indicated grade marking, all grades included in this Table must be marked for manufacturer identification.
2. While hex heads are shown, grade markings apply equally to products with other head configurations.
3. Hardnesses are Brinell Hardness Numbers.
4. Grade 5.1 is a popular grade for sems.
5. A325 Type 1 bolts may also be marked with 3 radial lines 120° apart in addition to the A325 marking.
6. The bolt manufacturer, at his option, may add other markings to indicate the use of atmospheric corrosion resistant steel.
7. A354 Grade BD products, in sizes 1-1/2" and smaller, are identified as shown and, at the manufacturer's option, may have the letters BD added. Larger sizes are marked only BD.

QUOTE


Forget yourself in your work. If your employer sees that you are more concerned about your own interests than about his, that you are fussy about getting credit of every little or big thing you do, then you are apt to be passed by when a responsible job has to be filled...Don't worry about how big an increase in your salary you can contrive to get. Don't let your mind dwell on money at all, if you can help it. Throw yourself, body, soul, and spirit, into whatever you are doing...The truth is that in every organization, no matter how large or how small, someone is taking notice of any employee who shows special ability.

HARRY B. THAYER

BOLTS

Identification • Strength • Clamp • Torque • Materials




GRADE 2



Diameter	Proof Load	Yield Strength	Tensile Strength
1/4"-3/4"	55,000	57,000	74,000
3/4" - 1-1/2"	33,000	36,000	60,000

Low or Medium Carbon Steel

A325 GRADE 5






H5CZ

Diameter	Proof Load	Yield Strength	Tensile Strength
1/4"-1"	85,000	92,000	120,000
3/4" - 1-1/2"	74,000	81,000	105,000

Medium Carbon Steel, Quenched and Tempered

GRADE 8



Proof Load	Yield Strength	Tensile Strength
120,000	130,000	150,000

Carbon Alloy Steel, Quenched and Tempered

Size	Clamp Load (lbs.)	Assembly Torque Dry (in lbs.)	Assembly Torque Lub (in lbs.)	Min. Tensile (lbs.)
1/4 - 20	1320	66	50	2700
1/4 - 28	1500	76	56	2900
5/16 - 18	2160	11	11	4400
5/16 - 24	2400	12	12	4700
3/8 - 16	3200	20	15	6400
3/8 - 24	3620	23	17	8800
1/2 - 13	5850	50	35	11500
1/2 - 20	6600	55	40	12500
5/8 - 11	9350	100	75	18500
5/8 - 18	10550	110	85	20000
3/4 - 10	13800	175	130	27000
3/4 - 16	15400	200	150	29000
7/8 - 9	11450	170	125	30000
1 - 8	15000	250	190	39500
1-1/8 - 7	18900	350	270	50000
1-1/4 - 7	24000	500	380	63000
1-3/8 - 6	28600	670	490	75500
1-1/2 - 6	34800	870	650	91000

Size	Clamp Load (lbs.)	Assembly Torque Dry (in lbs.)	Assembly Torque Lub (ft. lbs.)	Min. Tensile (lbs.)
1/4 - 20	2000	8	75	4450
1/4 - 28	2300	10	86	4840
5/16 - 18	3350	17	13	7190
5/16 - 24	3700	19	14	7670
3/8 - 16	4950	30	23	10530
3/8 - 24	5600	35	25	14400
1/2 - 13	9000	75	55	19000
1/2 - 20	10500	90	65	20500
5/8 - 11	14400	150	110	30100
5/8 - 18	16370	180	130	32600
3/4 - 10	21300	260	200	44200
3/4 - 16	23800	300	220	47400
7/8 - 9	29450	320	320	53100
1 - 8	38600	640	480	69500
1-1/8 - 7	42300	800	600	87800
1-1/4 - 7	53800	1120	840	110300
1-3/8 - 6	64100	1460	1100	132200
1-1/2 - 6	78000	1910	1460	159600

Size	Clamp Load (lbs.)	Assembly Torque Dry (ft. lbs.)	Assembly Torque Lub (ft. lbs.)	Min. Tensile (lbs.)
1/4 - 20	2850	12	9	6600
1/4 - 28	3250	14	10	7200
5/16 - 18	4700	25	18	10700
5/16 - 24	5200	25	20	11500
3/8 - 16	7000	45	35	15800
3/8 - 24	7900	50	35	21600
1/2 - 13	12750	110	80	28600
1/2 - 20	14370	120	90	30800
5/8 - 11	20350	220	170	45200
5/8 - 18	23000	240	180	49000
3/4 - 10	30100	380	280	66300
3/4 - 16	33500	420	320	71100
7/8 - 9	41600	600	460	91000
1 - 8	54500	900	680	119200
1-1/8 - 7	68900	1280	960	150500
1-1/4 - 7	87200	1820	1360	189200
1-3/8 - 6	104000	2380	1780	226700
1-1/2 - 6	126500	3160	2360	273600

Yield Strength is the load at which the fastener exhibits a specified elongation at a specific load.

Tensile Strength is the minimum total load that will fail the fastener.

Clamp Load – 75% x Proof x Stress Area. Also called the fastener preload or initial load. The “Clamp” Load is the true maximum load of any fastener.

Proof Load is the load which the fastener must withstand without a permanent set.

Torque Dry assumes a coefficient of friction of 0.20.

Torque Lubricated assumes a coefficient of friction of 0.15.

Minimum Tensile - minimum load at which the fastener will fail. Minimum safe working load is 4:1.

A325 is the designation for “structural” Grade 5 bolt which has larger head dimensions.

QUOTE

“I can’t do it” never yet accomplished anything; “I will try” has performed wonders.
GEORGE P. BURNHAM

THREADED ROD DATA

Rod Diameter (inch)	Stressed Cross Section (sq. inch)	Steel Strength (lbs)					
		ASTM A 307 Rod (Grade 2)			Stainless Steel (Grade 304 or 316)		
		Yield Strength	Tensile Strength	Shear Strength	Yield Strength	Tensile Strength	Shear Strength
1/4	0.0318	1,145	1,908	1,259	954	2,385	1,590
3/8	0.0775	2,790	4,650	3,069	2,325	5,813	3,875
1/2	0.1419	5,108	8,514	5,619	4,257	10,653	7,095
5/8	0.226	8,136	13,560	8,950	6,780	16,950	11,330
3/4	0.334	12,024	20,040	13,226	10,020	25,050	16,700
7/8	0.462	16,632	27,720	18,295	13,860	34,650	23,100
1	0.606	21,816	36,360	23,998	18,180	45,450	30,300
1-1/4	0.969	34,884	58,140	38,372	29,070	72,675	48,450
1-1/2	1.045	37,620	62,700	41,382	31,350	78,375	52,250

METRIC THREADS

Metric threads evolved similarly to the inch thread series. The current ISO metric screw thread system includes a coarse series, fine series and a number of constant pitch thread series.

The ISO metric coarse thread series is uniquely positioned, in terms of its thread pitches. It is located approximately half way between Unified coarse and Unified fine. For a given diameter, metric coarse threads are finer than Unified coarse but coarser than Unified fine. The metric coarse thread has certain technical advantages over either of the two Unified inch thread series.

ISO metric fine thread series has much finer thread pitches than those of the Unified fine series. Use of the metric fine series for commercial metric fastener applications is not recommended.

Metric External Fastener Strength Grades

The metric fastener strength grades are called "property classes." This term originated in ISO standards and were continued into ASTM and SAE specifications. The ISO "property class" system for externally threaded metric fasteners is specified in ISO 898/1.

Property class designations, as found on the head of a metric bolt, are numerals indicating the following information:

- The numeral or numerals preceding the first decimal point approximate 1/100th of the specified minimum tensile strength in megapascals (MPa).

Metric Grades

- The numeral following the first decimal point approximates 1/10th of the ratio (expressed as a percentage), between the minimum yield strength and the minimum tensile strength. The yield strength is always a percentage of the tensile strength. Yield strength is where thread deformation begins, and this value is always less than the bolt's tensile strength.

Metric Strength Grade System Examples

A class 4.6 steel metric bolt has a specified minimum tensile strength of 400 MPa (4 x 100) and a specified minimum yield strength of 240 MPa (0.6 x 400). The numbers 4 and .6 make up the designation, with the .6 being the ratio of 240 MPa minimum yield strength to 400 MPa minimum tensile strength.

Not all metric designations give exact tensile and yield values as earlier discussed. Each gives reasonable approximates.

Note: It is a mandatory regulation in SAE and ASTM standards that inch series fasteners of the medium-carbon and alloy steel strength grades and metric fasteners of all property classes be marked for grade identification. The only exceptions are slotted and recessed head screws and bolts smaller than 5mm. Also of major importance is that these same standards require that all steel fasteners be marked to identify the manufacturer.

METRIC/IMPERIAL COMPARATIVE CHART FOR DIAMETERS

1 inch = 25.4 mm

1 mm = 0.04"

Metric Diameter	Decimal (in.)	Nearest Diameter (in.)	Decimal (in.)
M2	(0.079)	#2	(0.086)
M2.5	(0.098)	#3	(0.999)
M3	(0.118)	#5	(0.125)
M3.5	(0.138)	#6	(0.138)
M4	(0.157)	#8	(0.164)
M5	(0.197)	3/16	(0.187)
M6	(0.236)	1/4	(0.250)
M8	(0.315)	5/16	(0.312)
M10	(0.394)	3/8	(0.375)
M12	(0.472)	7/16	(0.437)
		1/2	(0.500)
M14	(0.551)	9/16	(0.562)
M16	(0.630)	5/8	(0.625)
M20	(0.787)	3/4	(0.750)
M24	(0.945)	1	(1.000)
M30	(1.181)	1-1/8	(1.125)
M36	(1.417)	1-1/4	(1.250)
		1-3/8	(1.375)
M42	(1.653)	1-1/2	(1.500)
M48	(1.890)	1-3/4	(1.750)
		2	(2.000)
M56	(2.205)	2-1/4	(2.250)
M64	(2.520)	2-1/2	(2.500)
M72	(2.835)	2-3/4	(2.750)
M80	(3.150)	3	(3.000)
M90	(3.543)	3-1/2	(3.500)
M100	(3.937)	4	(4.000)

METRIC/IMPERIAL COMPARATIVE CHART FOR LENGTHS

Metric Length	Decimal (in.)	Nearest Length (in.)	Decimal (in.)
10mm	(0.394)	3/8	(0.375)
12mm	(0.472)	1/2	(0.500)
16mm	(0.630)	5/8	(0.625)
20mm	(0.787)	3/4	(0.750)
25mm	(0.984)	1	(1.000)
30mm	(1.181)	1-1/4	(1.250)
35mm	(1.387)	1-3/8	(1.375)
40mm	(1.575)	1-1/2	(1.500)
45mm	(1.772)	1-3/4	(1.750)
50mm	(1.968)	2	(2.000)
55mm	(2.165)	2-1/4	(2.250)
60mm	(2.362)	2-3/8	(3.375)
65mm	(2.559)	2-1/2	(2.500)
70mm	(2.756)	2-3/4	(2.750)
75mm	(2.953)	3	(3.000)
80mm	(3.150)	3-1/4	(3.250)
90mm	(3.543)	3-1/2	(3.500)
100mm	(3.937)	4	(4.000)
120mm	(4.724)	4-3/4	(4.750)
130mm	(5.118)	5	(5.000)
140mm	(5.512)	5-1/2	(5.500)
150mm	(5.905)	6	(6.000)
160mm	(6.299)	6-1/4	(6.250)
170mm	(6.693)	6-1/2	(6.500)
180mm	(7.087)	7	(7.000)
190mm	(7.480)	7-1/2	(7.500)
200mm	(7.874)	8	(8.000)

QUOTE

The three great essentials to achieve anything worth while are, first, hard work; second, stick-to-itiveness; third, common sense.

THOMAS EDISON

IMPERIAL/DECIMAL/METRIC CHART FOR SMALL DIAMETERS

Gauge or Diameter	Decimal (Inches)	Millimeters
No. 0000	0.021	.53
No. 000	0.034	.86
No. 00	0.047	1.19
No. 0	0.060	1.524
No. 1	0.073	1.854
No. 2	0.086	2.184
No. 3	0.099	2.515
No. 4	0.112	2.845
No. 5	0.125	3.175
No. 6	0.138	3.505
No. 8	0.164	4.166
No. 10	0.190	4.826
No. 12	0.216	5.484

QUOTE

It is the direct man who strikes sledgehammer blows, who penetrates the very marrow of a subject at every stroke and gets the meat out of a proposition, who does things.

ORISON S. MARDEN

FASTENER CONVERSION CHART

INCH TO METRIC		
Inch Equivalent	UNC	Metric Size-Pitch ISO and IFI Recommended
1 - 64	1 - 72	M2 x 0.4
3 - 48	3 - 56	M2.5 x 0.45
4 - 40	4 - 48	M3 x .05
6 - 32	6 - 40	M3.5 x 0.6
8 - 32	8 - 36	M4 x .07
10 - 24	10 - 32	M5 x .08
1/4 - 20	1/4 - 28	M6 x 1
5/16 - 18	5/16 - 24	M8 x 1.25
3/8 - 16	3/8 - 24	M10 x 1.5
7/16 - 14	7/16 - 20	M12 x 1.75
1/2 - 13	1/2 - 20	M14 x 2
5/8 - 11	5/8 - 18	M18 x 2
3/4 - 10	3/4 - 16	M20 x 2.5
1 - 8	1 - 12	M24 x 3
1-1/4 - 7	1-1/8 - 12	M30 x 3.5
1-1/2 - 6	1-1/4 - 12	M36 x 4









APPROXIMATE EQUIVALENCY CHART METRIC/IMPERIAL

ROUGHLY EQUIVALENT US BOLT MATERIALS			
Metric Bolt Class	Metric Nut Class Normally Used	SAE J429 Grades	ASTM Grades
4.6	4 or 5	1	A307, Grade A
4.f8	4 or 5	2	
5.8	5	2	
8.8	8	5	A325, A449
9.9	9	5+	A193, B7 and B16
10.9	10 or 12	8	A490; A354, Grade 8D
12.9	10 or 12		A540; B21 through B24

COMMON DIN NUMBERS FOR METRIC FASTENERS

DIN	Hex Capscrews
931	Coarse Thread Pitch Partially Threaded (Specify grade)
933	Coarse Thread Pitch Fully Threaded (Specify grade)
930	Fine Thread Pitch Partially Threaded (Specify grade)
961	Fine Thread Pitch Fully Threaded (Specify grade)
DIN	Nuts
934	Hex Nuts (Specify pitch and class)
985	Nylon Insert Locknuts (Specify pitch and class)
980V	All Metal Locknuts (Specify pitch and class)
DIN	Washers
125	Flatwashers
127	Lockwashers
DIN	Socket Products
912	Socket Head Capscrews (Normally GR 12.9 and coarse thread)
7991	Flat Head Socket Capscrews (Normally GR 12.9 and coarse thread)
916	Socket Setscrews (Normally GR 12.9 and coarse thread)
DIN	Machine Screws
7985	Pan head Phillips Drive Zinc Plated
965	Flat head Phillips Drive Zinc Plated
DIN	Threaded Rod
975	All Threaded Rod (Normally 1 meter lengths, specify grade and pitch)

STRENGTHS

<p>METRIC (ISO 898)</p>  <p>No Marking</p> <p>Grade: 4.8 (4.6, 5.8) Tensile: 429 MPa (60,900 psi)</p>	=	<p>INCH (SAE J429)</p>  <p>No Marking</p> <p>Grade: 2 Tensile: 60,000 psi</p>
<p>METRIC (ISO 898)</p>  <p>10.9</p> <p>Grade: 10.9 Tensile: 1040 MPa (150,800 psi)</p>	=	<p>INCH (SAE J429)</p>  <p>8</p> <p>Grade: 8 Tensile: 150,000 psi</p>
<p>METRIC (ISO 898)</p>  <p>8.8</p> <p>Grade 8.8 Tensile: 830 MPa (120,350 psi)</p>	=	<p>INCH (SAE J429)</p>  <p>5</p> <p>Grade: 5 Tensile: 120,000 psi</p>
<p>METRIC (ISO 898)</p>  <p>12.9</p> <p>Grade: 12.9 Tensile: 1220 MPa (176,900 psi)</p> <p>* Generally not marked</p>	=	<p>INCH (SAE J429)</p>  <p>No Marking</p> <p>Grade: ASTM A574 Tensile: 170,000 psi</p>

*Note: Metric Hex Socket Cap Screws are available in lower strength grades (8.8, 10.9) and marked accordingly.

QUOTE

The great achievements have always been individualistic. Indeed, any original achievement implies separation from the majority. Though society may honour achievement, it can never produce it.

GEORGE CHARLES ROCHE

TECHNICAL

TORQUE FIGURES FOR METRIC COARSE THREAD BOLTS AND SCREWS

Torque figures for bolts and screws with metric thread and head dimension, as in DIN 912, 931, 934 etc.

The figures MA in this table include:

- a) coefficient of friction microns total + 0.14
- b) 90% of minimum elongation
- c) torque figures when assembling fasteners

The coefficient of friction of microns total = 0.14 applies for fasteners without coating (self-colour) when slightly lubricated. Additional lubrication of the thread will substantially alter the coefficient of friction, leading to uncontrollable pre-load situations! Pre-load situations will also be influenced by the fastening methods and tools used.

The following figures are guidelines only.

Figures in NM (Newton Meters).

Thread Diameter	Property Classes				
	4.6	5.6	8.8	10.9	12.9
M4	1.02	1.37	3.0	4.4	5
M5	2.00	2.70	5.9	8.7	10
M6	3.50	4.60	10	15	18
M8	8.40	11	25	36	43
M10	17	22	49	72	84
M12	29	39	85	125	145
M14	46	62	135	200	235
M16	71	95	210	310	365
M18	97	130	300	430	500
M20	138	184	425	610	710
M22	186	250	580	820	960
M24	235	315	730	1,050	1,220
M27	350	470	1,100	1,550	1,800
M30	475	635	1,450	2,100	2,450
M33	645	865	1,970	2,770	3,330
M36	830	1,111	2,530	3,560	4,280

QUOTE

The only thing to do with good advice is to pass it on; it is never of any use to oneself.

OSCAR WILDE

TORQUE FIGURES FOR METRIC FINE THREAD BOLTS AND SCREWS

Thread Diameter	Tightening Torque MA max (Nm)		
	8.8	10.9	12.9
M8 x 1.00	22	30	36
M10 x 1.25	42	59	71
M12 x 1.25	76	105	130
M14 x 1.50	120	165	200
M16 x 1.50	180	250	300
M18 x 1.50	260	365	435
M20 x 1.50	360	510	610
M22 x 1.50	480	680	810
M24 x 2.00	610	860	1050

Conversion Figures	
To get NCM from Nm	Nm x 100
To get inch pounds from Ncm	Ncm x 0.08851
To get foot pounds from Ncm	Ncm x 0.00737
To get foot pounds from NM	Nm x 0.7376

All information is strictly informative

QUOTE

We pay for the mistakes of our ancestors, and it seems only fair that they should leave us the money to pay with.

DONALD MARQUIS



CONVERSION CHART

Table with 4 columns of conversion data: Fractions in., Decimals in., mm, Fractions in., Decimals in., mm, Fractions in., Decimals in., mm, Fractions in., Decimals in., mm. Rows contain various fractional and decimal values and their metric equivalents in millimeters.

TECHNICAL

METRIC TABLES

LINEAR	One METRE (m) = 10 decimetre (dm) = 100 centimetre (cm) = 1000 millimetres (mm)	1000 metres = One kilometre (km)
SQUARE	One SQUARE METRE (m ²) = 100 sq. decimetres (dm ²) = 10000 sq. centimetres (cm ²) = 1,000,000 sq. millimetres (mm ²)	
CUBIC	One CUBIC METRE (m ³) = 1000 cu. decimetre (dm ³) = 1,000,000 cu. centimetres (cm ³)	
CAPACITY	One LITRE (L) = 10 decilitres (dL) = 1000 millilitres (mL)	100 litres = One Hectolitre (hL)
WEIGHT	One KILOGRAM (kg) = 1000 grams (g)	100 kilos = One metric cent (q) 1000 kilos = One ton (t)
PRESSURE	One KILO PER SQUARE CENTIMETRE (kg/cm ²) = 1000 grams (g) per sq. centimetre	One kilo per sq. centimetre = One ATMOSPHERE (atm)
TEMPERATURE	CENTIGRADE degree (°C) = CELSIUS degree (°C)	

METRIC CONVERSION EQUIVALENTS

LINEAR

INCH to METRIC

- 1 inch = 25.400 millimetres
- 1 inch = 2.540 centimetres
- 1 foot = 304.800 millimetres
- 1 foot = 30.480 centimetres
- 1 foot = 0.3048 metres
- 1 yard = 91.4400 centimetres
- 1 yard = 0.9144 metres
- 1 mile = 1.609.35 metres
- 1 mile = 1.609 kilometres

METRIC to INCH

- 1 millimetre = .0393700 inches
- 1 centimetre = .393700 inches
- 1 metre = 39.3700 inches
- 1 metre = 3,2808 feet
- 1 metre = 1.0936 yards
- 1 kilometre = .62137 miles

AREA

SQ. INCH to METRIC

- 1 sq. inch = 645.16 sq. millimetres
- 1 sq. inch = 6.4516 sq. centimetres
- 1 sq. foot = 929.00 sq. centimetres
- 1 sq. foot = .0929 sq. metres
- 1 sq. yard = .836 sq. metres
- 1 sq. mile = 2.5889 sq. kilometres

METRIC to SQ. INCH

- 1 sq. millimetre = .00155 sq. inches
- 1 sq. centimetre = .1550 sq. inches
- 1 sq. metre = 10.7640 sq. feet
- 1 sq. metre = 1.196 sq. yard
- 1 sq. kilometre = .38614 sq. miles

CUBIC

CU. INCH to METRIC

- 1 cu. inch = 16.387 sq. centimetres
- 1 cu. foot = .02832 cu. metres
- 1 cu. yard = .765 cu. metres

METRIC to CU. INCH

- 1 cu. centimetre = .0610 cu. inches
- 1 cu. metre = 35.314 cu. feet
- 1 cu. metre = 1.308 cu. yards

CAPACITY

IMPERIAL to METRIC

- 1 fluid ounce = 28.413 millilitres
- 1 fluid ounce = 0.02841 litres
- 1 pint = 0.56826 litres
- 1 quart = 1.13652 litres
- 1 gallon = 4.546 litres

METRIC to IMPERIAL

- 1 millilitre = 0.035195 fluid oz.
- 1 centilitre = 0.35195 fluid oz.
- 1 decilitre = 3.5195 fluid oz.
- 1 litre = 0.88 quarts
- 1 hectolitre = 21.9969 gallons

WEIGHT

AVOIR DUPOIS to METRIC

- 1 grain = 64.7989 milligrams
- 1 ounce = 28.35 grams
- 1 pound = .4536 kilograms
- 1 short ton (2000 lbs.) = 907.200 kilograms
- 1 short ton (2000 lbs.) = 9.072 metric cents
- 1 short ton (2000 lbs.) = 9.072 ton

METRIC to AVOIR DUPOIS

- 1 gram = 15.432 grains
- 1 dekogram = .353 ounces
- 1 kilogram = 2.2046 pounds
- 1 metric cent = 220.46 pounds
- 1 ton = 2204.6 pounds
- 1 ton = 1.102 short tons

PRESSURE

POUNDS/INCHES to METRIC

- 1 pound per square inch = .0703 kilogram per square centimetre
- 1 pound per square inch = .0703 atmosphere (metric)

METRIC to POUNDS/INCHES

- 1 kilogram/sq. centimetre = 14.223 pounds/sq. inch
- 1 kilogram/sq. centimetre = 1 atmosphere

TEMPERATURE

FAHRENHEIT to CELSIUS

- 1 Fahrenheit degree (°F) = 1.8 x (°C) plus 32

CELSIUS to FAHRENHEIT

- 1 Centigrade (Celsius) degree (°) = .556 x (°F minus 32)

RECOMMENDED TAPPING DRILL SIZE

M (ISO METRIC COARSE)

Size mm	Pitch mm	Drill mm
M1	.25	.75
M1.1	.25	.85
M1.2	.25	.95
M1.4	.3	1.1
M1.6	.35	1.25
M1.8	.35	1.45
M2	.4	1.6
M2.2	.45	1.75
M2.5	.45	2.05
M3	.5	2.5
M3.5	.6	2.9
M4	.7	3.3
M4.5	.75	3.75
M5	.8	4.2
M6	1	5
M7	1	6
M8	1.25	6.75
M9	1.25	7.75
M10	1.5	8.5
M11	1.5	9.5
M12	1.75	10.2
M14	2	12
M16	2	14
M18	2.5	15.5
M20	2.5	17.5
M22	2.5	19.5
M24	3	21
M27	3	24
M30	3.5	26.5
M33	3.5	29.5
M36	4	32
M39	4	35
M42	4.5	37.5
M45	4.5	40.5
M48	5	43
M52	5	47
M56	5.5	50.5
M60	5.5	54.5
M64	6	58
M68	6	62
M72	6	66
M76	6	70

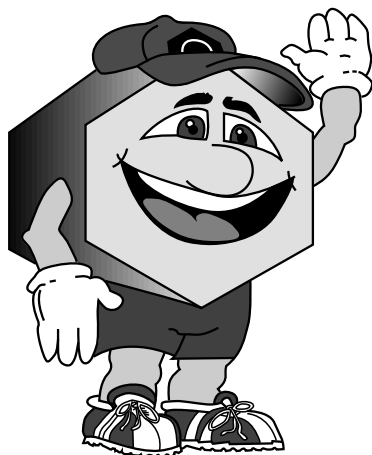
MF (ISO METRIC FINE)

Size mm	Pitch mm	Drill mm
M2	.25	1.75
M2.2	.25	1.95
M2.3	.25	2.05
M2.5	.35	2.15
M2.6	.35	2.25
M3	.35	2.65
M3.5	.35	3.15
M4	.35	3.65
M4	.5	3.5
M5	.35	4.65
M5	.5	4.5
M5	.75	4.25
M5.5	.5	5
M6	.5	5.5
M6	.75	5.25
M7	.75	6.25
M8	.5	7.5
M8	.75	7.25
M8	1	7
M9	.75	8.25
M9	.1	8
M10	.5	9.5
M10	.75	9.25
M10	1	9
M10	1.25	8.75
M11	.75	10.25
M11	1	10
M11	1.25	9.75
M12	.5	11.5
M12	.75	11.25
M12	1	11
M12	1.25	10.75
M12	1.5	10.5
M14	1	13
M14	1.25	12.75
M14	1.5	12.5
M15	.75	14.25
M15	1	14
M15	1.5	13.5
M16	.5	15.5
M16	.75	15.25
M16	1	15
M16	1.25	14.75
M16	1.5	14.5
M17	1	16
M17	1.5	15.5
M18	.75	17.25
M18	1.25	16.75
M18	1.5	16.5
M18	2	16
M19	1	18
M20	1	19
M20	1.5	18.5
M20	2	18
M22	1	21
M22	1.5	20.5
M22	2	20
M24	1	23

MF (ISO METRIC FINE)

Size mm	Pitch mm	Drill mm
M24	1.5	22.5
M24	2	22
M25	1	24
M25	1.5	23.5
M25	2	23
M27	1	26
M27	1.5	25.5
M27	2	25
M28	1	27
M28	1.5	26.5
M28	2	26
M30	1	29
M30	1.5	28.5
M30	2	28
M30	3	27
M32	1	31
M32	1.5	30.5
M32	2	30
M33	1.5	31.5
M33	2	31
M33	3	30
M35	1.5	33.5
M35	2	33
M35	3	32
M36	1	35
M36	1.5	34.4
M36	2	34
M36	3	33
M38	1	37
M38	1.5	36.5
M38	2	36
M39	1.5	37.5
M39	2	37
M39	3	36
M40	1	39
M40	1.5	38.5
M40	3	37
M42	1.5	40.5
M42	2	40
M42	3	39
M42	4	38
M45	1.5	43.5
M45	2	43
M45	3	42
M48	1.5	46.5
M48	2	46
M48	3	45
M48	4	44
M50	1.5	48.5
M50	2	48
M50	3	47
M52	1.5	50.5
M52	2	50
M52	3	49
M52	4	48
M56	2	54
M56	4	52

All information is strictly informative



QUOTE

I know of no more disagreeable situation than to be left feeling generally angry without anybody in particular to be angry at.

FRANK MOORE COLBY

TECHNICAL

TAP DRILL SIZES

Table with 2 columns: Thread, Drill. Lists various thread sizes (e.g., 0-80, 1-64, 1-72) and their corresponding drill sizes (e.g., 3/64, 53, 53).

DECIMAL EQUIVALENTS

Fractional • Wire • Metric • Letter Sizes

Table with 2 columns: Drill Size, Decimal. Lists fractional drill sizes (e.g., 0.10, 97, 96) and their decimal equivalents (e.g., .0039, .0059, .0063).

Table with 2 columns: Drill Size, Decimal. Lists fractional drill sizes (e.g., 1.35, 54, 1.40) and their decimal equivalents (e.g., .0531, .0550, .0551).

Table with 2 columns: Drill Size, Decimal. Lists fractional drill sizes (e.g., 3.70, 26, 25) and their decimal equivalents (e.g., .1457, .1470, .1495).

Table with 2 columns: Drill Size, Decimal. Lists letter and decimal drill sizes (e.g., G, 6.70, 17/64) and their decimal equivalents (e.g., .2610, .2638, .2656).

Table with 2 columns: Drill Size, Decimal. Lists letter and decimal drill sizes (e.g., 11.00, 7/16, 11.20) and their decimal equivalents (e.g., .4331, .4375, .4409).



ASTM STANDARDS

ASTM (The American Society for Testing and Materials), founded in 1898, is a scientific and technical organization formed for "the development of standards on characteristics and performance of materials, products, systems, and services; and the promotion of related knowledge." ASTM is the world's largest source of voluntary consensus standards.

STANDARDS AND SPECIFICATIONS

- | | |
|--|---|
| <p>A29/
A29M Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-finished</p> <p>A31 Steel Rivets and Bars for Rivets, Pressure Vessels</p> <p>A36 Structural Steel</p> <p>A90 Test method for Weight of Coating on Zinc-Coated (Galvanized) Iron and Steel Articles</p> <p>A31 Structural Steel for Ships</p> <p>A143 Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement</p> <p>A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware (see Page B-165)</p> <p>A183 Carbon Steel Track Bolts and Nuts</p> <p>A193/
A193M Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service</p> <p>A194/
A194M Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service</p> <p>A239 Test Method for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip)</p> <p>A242 High-Strength Low-Alloy Structural Steel</p> <p>A262 Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels</p> <p>A276 Stainless and Heat-Resisting Steel Bars and Shapes</p> <p>A307 Carbon Steel Externally Threaded Standard Fasteners</p> <p>A320/
A320M Alloy Steel Bolting Materials for Low-Temperature Service</p> <p>A325 High Strength Bolts for Structural Steel Joints</p> <p>A342 Test Methods for Permeability of Feebly Magnetic Materials</p> <p>A353/
A353M Pressure Vessel Plates, Alloy Steel, 9 Percent Nickel, Double-Normalized and Tempered</p> <p>A354 Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners</p> <p>A370 Methods and Definitions for Mechanical Testing of Steel Products</p> | <p>A380 Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems</p> <p>A385 Providing High-Quality Zinc Coatings (Hot-Dip)</p> <p>A394 Zinc-Coated Steel Transmission Tower Bolts</p> <p>A437/
A437M Alloy Steel Turbine-Type Bolting Material Specially Heat Treated for High-Temperature Service</p> <p>A449 Quenched and Tempered Steel Bolts and Studs</p> <p>A453/
A453M Bolting Materials, High-Temperature, 50 to 120 ksi Yield Strength, with Expansion Coefficients Comparable to Austenitic Steels</p> <p>A484/
A484M Stainless and Heat-Resisting Wrought Steel Products (Except Wire)</p> <p>A489 Carbon Steel Eyebolts</p> <p>A490 Heat-Treated Steel Structural Bolts, 150 ksi Tensile Strength</p> <p>A493F Stainless and Heat-Resisting Steel for Cold Heading and Cold Forging</p> <p>A502 Steel Structural Rivets</p> <p>A540/
A540M Alloy Steel Bolting Materials for Special Applications</p> <p>A555/
A555M Stainless and Heat-Resisting Steel Wire</p> <p>A563 Carbon and Alloy Steel Nuts</p> <p>A564 Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars, Wire, and Shapes</p> <p>A568 Steel, Carbon and High-Strength Low-Alloy Hot-Rolled and Cold-Rolled Sheets</p> <p>A574 Alloy Steel Socket-Head Cap Screws</p> <p>A582 Free-Machining Stainless and Heat-Resisting Steel Bars, Hot-Rolled or Cold-Finished</p> <p>A588/
A588M High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4 in. Thick</p> <p>A591 Steel Sheet, Cold-Rolled, Electrolytic Zinc-Coated</p> <p>A676 Hot-dipped Aluminum Coatings on Ferrous Articles</p> <p>A687 High-Strength Nonheaded Steel Bolts and Studs</p> <p>A706 Low-Alloy Steel Deformed Bars for Concrete Reinforcement</p> <p>A709 Structural Steel for Bridges</p> <p>A751 Methods, Practices, and Definitions for Chemical Analysis of Steel Products</p> <p>A788 Steel Forgings</p> <p>B6 Zinc (Slab Zinc)</p> <p>B16 Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines</p> |
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|------------------------------|--|-------------|--|
| B99 | Copper-Silicon Alloy Wire for General Purposes | B568 | Measurement of Coating Thickness by X-Ray Spectrometry |
| B117 | Method of Salt Spray (Fog) Testing | B571 | Test Methods for Adhesion of Metallic Coatings |
| B134 | Brass Wire | B602 | Attribute Sampling of Electrodeposited Metallic Coatings and Related Finishes |
| B151 | Copper-Nickel-zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar | B633 | Electrodeposited Coatings of Zinc on Iron and Steel |
| B154 | Method of Mercurous Nitrate Test for Copper and Copper Alloys | B695 | Coatings of Zinc Mechanically Deposited on Iron and Steel |
| B159 | Phosphor Bronze Wire | B696 | Coatings of Cadmium Mechanically Deposited on Iron and Steel |
| B183 | Preparation of Low Carbon Steel for Electroplating | B697 | Guidelines for Selection of Sampling Plans for Inspection of Electrodeposited Metallic Coatings and Related Finishes on Products |
| B193 | Test Method for Resistivity of Electrical Conductor Materials | F432 | Roof and Rock Bolts and Accessories |
| B201 | Test Chromate Coatings on Zinc and Cadmium Surfaces | F436 | Hardened Steel Washers |
| B211 | Aluminum Alloy Bars, Rods, and Wire | F467 | Nonferrous Nuts for General Use |
| B242/
B242M | Preparation of High-Carbon Steel for Electroplating | F468 | Nonferrous Bolts, Hex Cap Screws, and Studs for General Use |
| B244 | Measurement of Thickness of Anodic Coatings on Aluminum and Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments | F541 | Alloy Steel Eyebolts |
| B254 | Preparation of and Electroplating on Stainless Steel | F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| B320 | Preparation of Iron Castings for Electroplating | F594 | Stainless Steel Nuts |
| B322 | Cleaning Metals Prior to Electroplating | F606 | Conducting Tests to Determine the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets |
| B342 | Test Method for Electrical Conductivity by Use of Eddy Current | F788 | Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric |
| B374 | Definitions of Terms Relating to Electroplating | F812 | Surface Discontinuities of Nuts, Inch and Metric |
| B487 | Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section | F835 | Alloy Steel Socket Button and Flat Countersunk Head Cap Screws |
| B499 | Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals | F837 | Stainless Steel Socket Head Cap Screws |
| B504 | Measurement of Thickness of Metallic Coatings by the Coulometric Method | F844 | Washers, Plain (Flat), Unhardened for General Use |
| B565 | Shear Testing of Aluminum-Alloy Rivets and Cold-Heading Wire and Rods | F879 | Stainless Steel Socket Button and Flat Countersunk Head Cap Screws |
| B567 | Measurement of Coating Thickness by the Beta Backscatter Method | F880 | Stainless Steel Socket Set Screws |
| | | F901 | Aluminum Transmission Tower Bolts and Nuts |
| | | F912 | Alloy Steel Socket Set Screws |
| | | F959 | Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners |

QUOTE

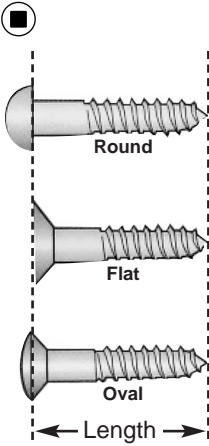
A bank is a place where they lend you an umbrella in fair weather and ask for it back again when it begins to rain.

ROBERT FROST

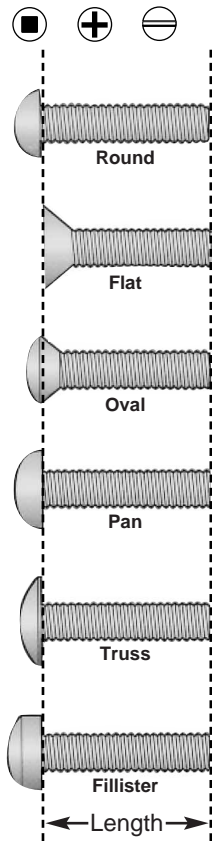


FASTENER MEASUREMENT CHART

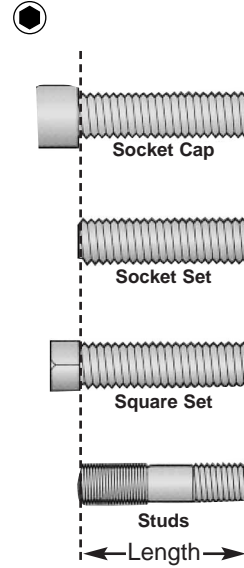
WOOD SCREWS



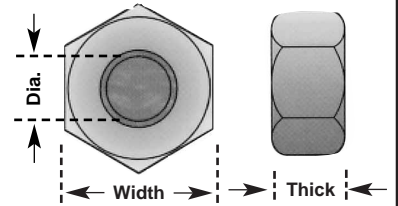
MACHINE SCREWS



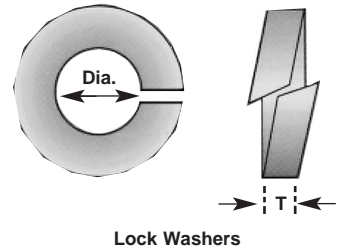
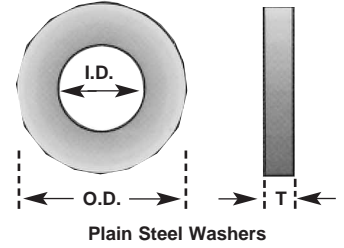
SET SCREWS and STUDS



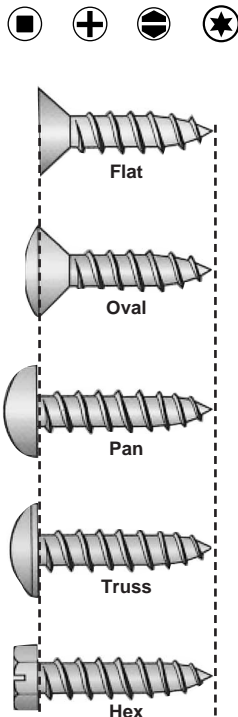
HEXAGON NUTS



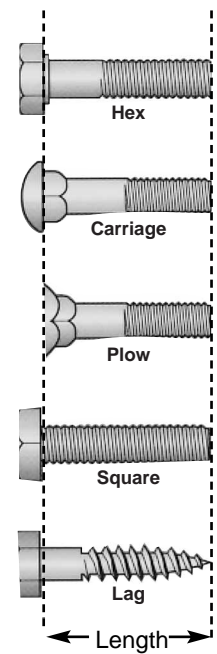
WASHERS



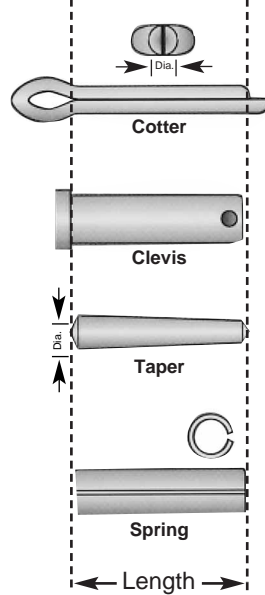
TAPPING SCREWS



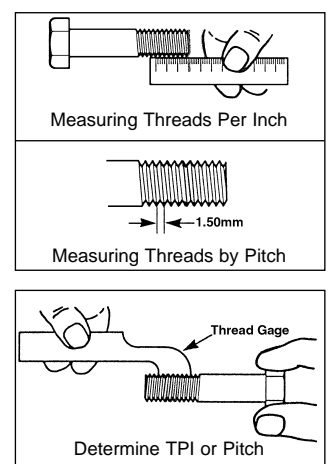
CAP SCREWS and BOLTS



STANDARD PINS



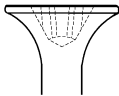
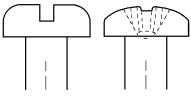
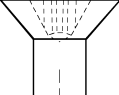
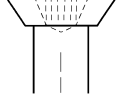
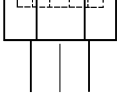
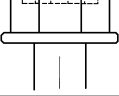
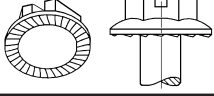
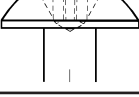
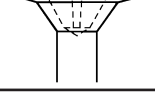
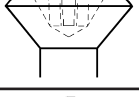
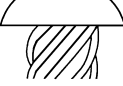
Measuring Threads




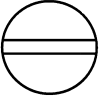
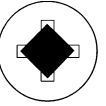

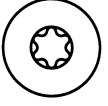
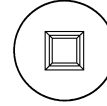
TECHNICAL

TECHNICAL

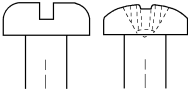
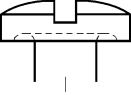
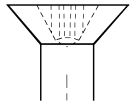
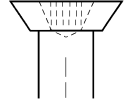
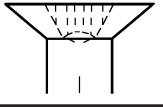
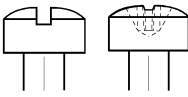
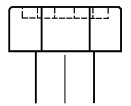
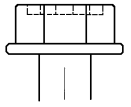
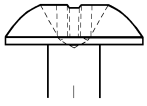
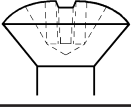
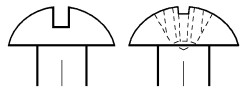
SELF-TAPPING SCREWS – HEAD STYLES

Schematic	Head Style	Description	Applications / Advantages
	Bugle	A countersunk head with a flat top surface and a concave underhead bearing surface.	Designed specifically for use in drywall. Distributes bearing stress over a wider area than flat heads.
	Pan	Slotted pan heads have a flat or gently rounded top surface, cylindrical sides and a flat bearing surface. Phillips, Torx, and square pan heads have a rounded top surface, cylindrical sides and a flat bearing surface.	For general applications. Can be substituted in most applications for round, truss or bearing heads.
	Flat 82°	A countersunk head with a flat top surface and a coneshaped bearing surface with a head angle of approximately 82°.	Used in applications where protrusion of the fastener above the mating surface is unacceptable. Use a protrusion gauge when measuring head height.
	Flat Undercut	Similar to an 82° flat head except that the head is undercut to 70% of its normal side height.	Standard for short lengths because it allows greater length of threads. Also avoids transition fillet and assembly interference.
	Indented Hex	Has an indented top surface, six flat sides, and a flat bearing surface.	Preferred in high volume assembly where pneumatic equipment is used to drive the screw. Can transmit significantly higher tightening torque levels than other head styles.
	Indented Hex Washer	Has an indented top surface, six flat sides with a flat washer which projects beyond the sides and provides a flat bearing surface. The washer and hex head are formed together as one piece	Increased bearing area reduces likelihood of crushing mating surfaces.
	Serrated Hex Washer	Same as an indented Hex Washer head but with serrations formed into the bearing surface on the same nominal size	Serration geometry is oriented to resist loosening. Also slows the screw at the point of engagement with the mating piece of sheet metal so as to minimize stripping.
	Truss	Has a low rounded top with a flat bearing surface greater in area than a round-head screw of the same nominal size	Weaker than pan or round heads but preferred in applications where minimal clearance exists above the head. Truss profile provides a trim, finished appearance.
	Wafer	A countersunk head with a flat top surface and a cone-shaped bearing surface. The wafer's 70° conical underhead area does not extend to the outer edge of the head, providing a bearing surface of 16° around the circumference of the underhead	Preferred head style for Type-CSD self-drilling screws. Provides the necessary bearing surface and flush fit in wood and softer materials. The head/shank fillet contoured to strengthen the underhead area.
	Oval	A countersunk head with a rounded top surface and a cone-shaped bearing surface of approximately 82°	Preferred over a flat head in conical applications, or when a more decorative finished look is desired. The countersunk surface nests into mating countersunk application sites.
	Round (U-drive)	Has a semi-elliptical top surface and a flat bearing surface	Standard head style for drive screws. Provides efficient non-torque fastening for high-speed assembly.

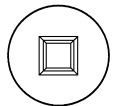

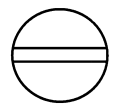
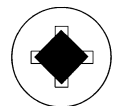
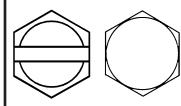
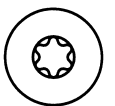
DRIVE TYPES

Schematic						
Drive Type	Phillips	Slotted	Phillips/Sq. Drive Combination	Hex / Slotted-hex	Torx	Square
Uses	Increases productivity with excellent torque transmission and resists cam-out.	Accepts standard blade screwdriver. Requires less downward pressure to drive parts than those with recessed openings.	Accepts Phillips and square drive screwdrivers. Used when fastener is expected to be backed out several times.	Accepts hex wrench. Slotted drive is added to make it easier to remove the fastener.	Positive-engaging, fast-locating method which transmits drive torque with less required downward pressure.	Provides good control in driving. Always use a driver bit of proper size in good condition.

MACHINE SCREWS – HEAD STYLES

Schematic	Head Style	Description	Applications / Advantages
	Pan	Slotted pan heads have a flat or gently rounded top surface, cylindrical sides and a flat bearing surface. Phillips and torx pan heads have a rounded top, cylindrical sides and a flat bearing surface.	Has a general purpose bearing area. Can be substituted in most applications for round, truss or binding heads.
	Binding Undercut	Has a rounded top surface and slightly tapered sides. the bearing surface is flat with an annular undercut adjacent to the shank.	Preferred design for making a firm electrical connection.
	Flat 82°	A countersunk head with a flat top surface and a cone-shaped bearing surface with a head angle of approximately 82°.	Used in applications where protrusion of the fastener above the mating surface is unacceptable. Use a protrusion gauge when measuring head height.
	Flat Undercut	Similar to an 82° flat head except that the head is undercut to 70% of its normal side height.	Standard for short lengths because it allows greater length of threads. Also avoids transition fillet and assembly interference.
	Flat 100°	A countersunk head with a flat top surface and a cone-shaped bearing surface with a head angle of approximately 100°.	Preferred over an 82° flat head when fastening in soft materials – the 100° countersunk head distributes pressure over a larger surface area.
	Fillister	Has a rounded top surface, cylindrical sides, and a flat bearing surface. The greater side height is what distinguishes a fillister head from a pan head.	Preferred style for use in counterbored holes.
	Indented Hex	Has a top surface, six flat sides, and a flat bearing surface.	Preferred in high volume assembly where pneumatic equipment is used to drive the screw. Can transmit significantly higher tightening torque levels than other head styles.
	Indented Hex Washer	Has an indented top surface, six flat sides and a flat washer which projects beyond the sides and provides a flat bearing surface. The washer and hex head are formed together as one piece.	Offers greater protection to the mating surface than a standard indented hex head. Increases bearing area reduces likelihood of crushing mating surfaces.
	Truss	Has a low rounded top surface with a flat bearing surface greater in area than a round-head screw of the same nominal size.	Weaker than pan or round heads but preferred in applications where minimal clearance exists above the head. Truss profile provides a trim, finished assembly appearance.
	Oval	A countersunk head with a rounded top surface and a cone-shaped bearing surface of approximately 82°.	Preferred over a flat head in conical applications, or when a more decorative finished look is desired. The countersunk surface nests into mating countersunk application sites.
	Round	Has a semi-elliptical top surface and a flat bearing surface	Sometimes preferred over pan head for its smooth surface and appearance.

DRIVE TYPES

Schematic						
Drive Type	Square	Phillips	Slotted	Phillips/Sq. Drive Combination	Hex / Slotted-hex	Torx
Uses	Most recommended drive type. Provides good control in driving. Always use a driver bit of proper size in good condition.	Provides good control in driving. Always use a driver bit in good condition.	Accepts standard blade screwdrivers. Requires less downward pressure to drive slotted parts than it does those with cross-dressed openings.	Accepts Phillips and square drive screwdrivers. Often used when fastener is expected to be driven and backed-out several times.	Accepts hex wrench. Slotted drive is added to make it easier to remove the fastener.	Positive-engaging, fast-locating method of transmitting drive torque and optimizing worker efficiency.

TECHNICAL

BOLT THREADS AND THREAD LENGTHS

THREADS - MACHINE SCREW AND BOLT SIZES

Number of Threads per Inch - Unified Standard
Coarse Thread Series, Class 2A Fit, recommended for general bolt use.

Diameter of Bolt (In.)	UNC Coarse Thread Series	UNF Fine Thread Series	Diameter of Bolt (In.)	UNC Coarse Thread Series	UNF Fine Thread Series
No. 0	-	80	9/16	12	18
No. 1	64	72	5/8	11	18
No. 2	56	64	3/4	10	16
No. 3	48	56	7/8	9	14
No. 4	40	48	1	8	14 (12)*
No. 5	40	44	1-1/8	7	12
No. 6	32	40	1-1/4	7	12
No. 8	32	36	1-3/8	6	12
No. 10	24	32	1-1/2	6	12
No. 12	24	28	1-3/4	5	-
1/4	20	28	2	4-1/2	-
5/16	18	24	2-1/4	4-1/2	-
3/8	16	24	2-1/2	4	-
7/16	14	20	2-3/4	4	-
1/2	13	20	3	4	-

*Indicates number of threads per inch for Unified Fine (1"-12 thread is U.N.F. standard. However 1"-14 thread is popular demand and generally stocked in place of 1"-12.)

THREAD LENGTHS

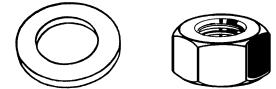
All Standard Except Lag Screws

Thread Length Formula:

For bolts 6" and shorter - twice the diameter plus 1/4". (2D + 1/4") Longer than 6" - twice the diameter plus 1/2". (2D + 1/2"). When bolts are short for formula thread length, thread will extend as close to head or shoulder as practical. In actual production, thread lengths may be longer than the formula thread lengths.

Diameter of Bolt (In.)	6" and Shorter (in.)	Longer Than 6" (in.)	Diameter of Bolt (In.)	6" and Shorter (in.)	Longer Than 6" (in.)
No. 10	5/8	7/8	1	2-1/4	2-1/2
1/4	3/4	1	1-1/8	2-1/2	2-3/4
5/16	7/8	1-1/8	1-1/4	2-3/4	3
3/8	1	1-1/4	1-3/8	3	3-1/4
7/16	1-1/8	1-3/8	1-1/2	3-1/4	3-1/2
1/2	1-1/4	1-1/2	1-5/8	3-1/2	3-3/4
5/8	1-1/2	1-3/4	1-3/4	3-3/4	4
3/4	1-3/4	2	1-7/8	4	4-1/4
7/8	2	2-1/4	2	4-1/4	4-1/2

WASHERS AND HEX NUTS



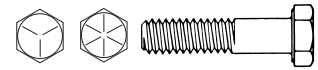
Length (in.)	HEX NUTS			USS WASHERS		SAE WASHERS		USS WASHERS Qty./100 lbs. (approx.)	SAE WASHERS Qty./100 lbs. (approx.)	LOCKWASHERS	
	Pkg.	Case	Bulk	Pkg.	Bulk (lbs.)	Pkg.	Bulk (lbs.)			Pkg.	Case
#6	100	2000	15000	100	50					100	7500
#8	100	2000	15000	100	50					100	7500
#10	100	2000	15000	100	50			29400		100	7500
1/4	100	2000	5500	100	40	100	40	16200	24400	100	7500
5/16	100	2000	3600	100	40	100	40	9600	21200	100	7500
3/8	100	1500	250	100	40	100	40	7460	15140	100	7500
7/16	50	800	1400	50	40	50	40	3800	11360	50	3750
1/2	50	800	1000	50	40	50	40	2740	5900	50	2500
9/16	25	300	650	25	40	25	40	2300	5740	25	1250
5/8	25	300	540	25	40	25	40	1290	3880	25	1250
3/4	20		325	20	40	20	40	1000	2360	20	1000
7/8	20		200	20	40	20	40	720	1720	20	780
1	20		135	20	40	20	40	580	1310	20	40
1-1/8	15		95	15	40			490		15	300
1-1/4	15		65	15	40			520		15	300
1-3/8	10		50	10	40			360		10	150
1-1/2	10		40	10	40			340		10	150
1-5/8			30	10	40			250			
1-3/4			23	10	40			230			
2			15	10	40			180			
2-1/4			10								
2-1/2			8								
2-3/4			6								
3			5								

QUOTE

When I am working on a problem, I never think about beauty. I think only about how to solve the problem. But when I have finished, if the solution is not beautiful, I know it is wrong.

BUCKMINSTER FULLER

BULK GRADE 5 AND 8 CAPSCREWS



TECHNICAL

Length (in.)	Diameter												
	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"	1-1/2"
1/2	3300	1950	1300										
5/8	3000	1800	1200										
3/4	2700	1650	1100	750	475								
1	2200	1400	900	650	400	350	250	150					
1-1/4	1800	1100	800	550	375	300	225	140					
1-1/2	1600	1000	675	500	300	300	200	125	85	55			
1-3/4	1400	850	600	450	275	250	175	120	80	55			
2	1200	800	550	400	250	225	175	100	75	50	40	30	
2-1/4	1000	700	450	350	225	200	150	100	70	50			
2-1/2	900	600	400	300	225	175	125	90	65	45	35	25	
2-3/4	750	550	400	300	200	150	125	85	60	40			
3	750	500	325	275	200	150	100	80	55	40	30	25	15
3-1/4	600	450	325	250	175	125	100	75	50	40			
3-1/2	550	450	300	225	150	125	100	70	50	35	30	20	15
3-3/4	500	400	250	225	150	125	100	65	45	35			
4	450	400	250	200	150	100	90	60	45	35	25	20	12
4-1/2	450	300	225	175	125	100	80	55	40	30	20	15	12
5	400	250	225	150	125	100	75	45	35	25	20	15	11
5-1/2	400	250	175	150	100	75	70	45	35	25	20	15	10
6	350	250	175	125	100	75	65	40	30	25	15	15	10
6-1/2			175		100		60	40	30	20	15	14	9
7			150		90		55	35	25	20	15	12	9
7-1/2			150		90		55	35	25	20	15	12	8
8			150		80		50	35	25	18	15	10	8
9			130	100	75		45	30	23	15	13	10	7
10			120	90	65		40	30	20	15	12	10	6
12			100	75	55		35	25	17	13	10	8	5

WOOD AND TAPPING SCREWS, FLAT AND ROUND HEAD



Length (in.)	Size										
	4			5			6		7		
	Pkg.	Case	Bulk	Pkg.	Case	Bulk	Pkg.	Case	Bulk	Pkg.	
1/4	100	3000	15000				100	3000	15000		
3/8	100	3000	15000	100	3000	15000	100	3000	15000		
1/2	100	30000	15000	100	3000	15000	100	3000	15000	100	
5/8	100	3000	15000	100	3000	15000	100	3000	15000		
3/4	100	3000	15000	100	3000	15000	100	3000	15000	100	
1	100	3000	15000	100	3000	15000	100	3000	15000	100	
1-1/4							100	1000	15000	100	
1-1/2							100	1000	15000	100	
2							100	1000	15000		

Length (in.)	Size											
	8			10			12			14		
	Pkg.	Case	Bulk	Pkg.	Case	Bulk	Pkg.	Case	Bulk	Pkg.	Case	Bulk
3/8	100	3000	15000	100	3000	12000						
1/2	100	3000	15000	100	3000	10000	50	2000	10000	50		
5/8	100	3000	15000	100	3000	10000	50	2000	6000	50		
3/4	100	3000	15000	100	3000	10000	50	2000	6000	50	500	5000
1	100	3000	10000	100	3000	8000	50	1000	6000	50	1000	4000
1-1/4	100	2000	7500	100	2000	5000	50	1000	4000	50	1000	3000
1-1/2	100	2000	5000	100	2000	4000	50	1000	3000	50	1000	2500
1-3/4	100	2000	4000	50	1000	3000	50	1000	2000	50	1000	2000
2	50	1500	3500	50	1000	2500	50	1000	2000	50	1000	2000
2-1/2	50	1000	2500	50	750	2000	50	500	1500	50	500	1500
3	50	500	2000	50	500	1500	25	500	1000	25	400	1000
3-1/2	25	500	1000	25	500	1000	25	500	800	25	400	800
4	25	500		25	400	800	25	400	500	25	300	500



WASHER GUIDE

Bolt Dia. (in.)	Dimensions Outside Dia. (in.)	Dimensions Hole Dia. (in.)	Thickness Gauge	Thickness Inches	*Approx. Number in 100 Lbs.	*Approx. Wt. 1000 Pcs. in Lbs.
PLATE WASHERS						
1/8	7/16	3/16	18	3/64	55,400	1.8
3/16	9/16	1/4	18	3/64	29,400	3.4
1/4	3/4	5/16	16	1/16	16,200	6.2
5/16	7/8	3/8	14	5/64	9,600	10.4
3/8	1	7/16	14	5/64	7,460	13.4
7/16	1-1/4	1/2	13	3/32	3,800	26.2
1/2	1-3/8	9/16	12	7/64	2,740	36.6
9/16	1-1/2	5/8	12	7/64	2,300	43.3
5/8	1-3/4	11/16	10	9/64	1,290	77.5
5/8	1-3/4	3/4	10	9/64	1,340	74.8
3/4	2	13/16	10	9/64	1,000	100.0
3/4	2	7/8	9	5/32	930	107.6
7/8	2-1/4	15/16	9	5/32	720	139.2
7/8	2-1/4	1	9	5/32	740	135.2
1 (S)	2-1/2	1-1/6	9	5/32	580	170.4
1 (L)	2-1/2	1-1/8	9	5/32	600	165.9
1-1/8 (S)	2-3/4	1-3/16	9	5/32	490	204.7
1-1/8 (L)	2-3/4	1-1/4	9	5/32	500	199.7
1-1/4 (S)	2-3/4	1-5/16	9	5/32	520	194.3
1-1/4 (L)	3	1-3/8	9	5/32	420	236.6
1-3/8	3-1/4	1-1/2	9	5/32	360	276.6
1-1/2 (S)	3-1/4	1-9/16	8	11/64	340	297.2
1-1/2 (L)	3-1/2	1-5/8	8	11/64	280	351.6
1-5/8	3-3/4	1-3/4	8	11/64	250	402.5
1-3/4 (S)	3-3/4	1-13/16	7	3/16	230	430.1
1-3/4 (L)	4	1-7/8	7	3/16	200	498.3
2 (S)	4-1/4	2-1/16	7	3/16	180	551.1
2 (L)	4-1/2	2-1/8	7	3/16	160	628.0
S.A.E. WASHERS						
3/16	1/2	7/32	16	1/16	37,000	2.7
1/4	5/8	9/32	16	1/16	24,400	4.1
5/16	11/16	11/32	16	1/16	21,200	4.7
3/8	13/16	13/32	16	1/16	15,140	6.6
7/16	59/64	15/32	16	1/16	11,360	8.8
1/2	1-1/16	17/32	13	3/32	5,900	16.9
9/16	1-3/16	19/32	13	3/32	4,740	21.1
5/8	1-5/16	21/32	13	3/32	3,880	25.8
3/4	1-1/2	13/16	11	1/8	2,360	42.3
7/8	1-3/4	15/16	11	1/8	1,720	58.1
1	2P	1-1/16	11	1/8	1,310	76.4
PLATE WASHERS HOT GALVANIZED						
1/4	3/4	5/16	16	1/16	15,700	
5/16	7/8	3/8	14	5/64	9,100	
3/8	1	7/16	14	5/64	6,500	
7/16	1-1/4	1/2	13	3/32	3,350	
1/2	1-3/8	9/16	12	7/64	2,400	
9/16	1-1/2	5/8	12	7/64	2,100	
5/8	1-3/4	11/16	10	9/64	1,200	
3/4	2	13/16	10	9/64	950	
7/8	2-1/4	15/16	9	5/32	660	
1(S)	2-1/2	1-1/16	9	5/32	530	
1-1/8 (L)	2-3/4	1-1/4	9	5/32	460	
1-1/4 (S)	2-3/4	1-5/16	9	5/32	480	

"S" SERIES STOCKED

*Quantity per pound may vary ±15% based on I.F.I. allowable thickness tolerances.

QUOTE

Any man worth his salt will stick up for what he believes right, but it takes a slightly bigger man to acknowledge instantly and without reservation that he is in error.

GENERAL PEYTON C. MARCH