



Mechanical Specifications for Externally Threaded Fasteners with Grade Markings

Specification	Material	Size Range (Inches)	Min. Proof Strength (psi)	Min. Tensile Strength (psi)	Core Hardness Rockwell		Min. Yield Strength (psi)	Grade Identification Marking
					Min.	Max.		
SAE J429-Grade 1	Low or Medium Carbon Steel	1/4 - 1-1/2	33,000	60,000	B70	B100	36,000	
SAE J429-Grade 2		1/4 - 3/4 7/8 - 1-1/2	55,000 33,000	74,000 60,000	B80 B70	B100 B100	57,000 36,000	
ASTM A307-Grade A	Low or Medium Carbon Steel	1/4-4		60,000	B69	B100		
ASTM A307-Grade B	Low or Medium Carbon Steel	1/4-4		60,000(min) 100,000(max)	B69	B95		
SAE J429-Grade 5 ASTM A449-Type 1	Medium Carbon Steel: Quenched and Tempered	1/4-1	85,000	120,000	C25	C34	92,000	
ASTM A449-Type 1 See Note 2		1-1/8 - 1-1/2 1-3/4 - 3	74,000 55,000	105,000 90,000	C19	C30	81,000 58,000	
ASTM A325-Type 1	Medium Carbon Steel: Quenched & Tempered	1/2-1 1-1/8 - 1-1/2	85,000 74,000	120,000 105,000	C25 C19	C34 C30	92,000 81,000	See Note 5
ASTM A354 Grade BC	Medium Carbon Alloy Steel: Quenched & Tempered	1/4 - 2-1/2 over 2-1/2 - 4	105,000 95,000	125,000 115,000	C26 C22	C36 C33	109,000 99,000	
ASTM A354 Grade BD	Medium Carbon Alloy Steel: Quenched & Tempered	1/4 - 2-1/2 over 2-1/2 - 4	120,000 105,000	150,000 140,000	C33 C31	C39 C39	130,000 115,000	See Note 4
SAE J429 Grade 8	Medium Carbon Alloy Steel: Quenched & Tempered	1/4 - 1-1/2	120,000	150,000	C33	C39	130,000	
SAE J429-Grade 8.2	Low Carbon Boron Steel: Quenched & Tempered	1/4 - 1	120,000	150,000	C33	C39	130,000	
ASTM A490-Type 1	Medium Carbon Alloy Steel: Quenched & Tempered	1/2 - 1-1/2	120,000	150,000(min) 170,000(max)	C33	C38	130,000	
ASTM A574 Socket Head Cap Screw	Low Alloy Steel: Quenched & Tempered	#0 - 1/2 over 1/2 - 2	140,000 135,000	180,000 170,000	C39 C37	C45 C45		

Note 1: No minimum hardness is required on bolts and studs 3 times the diameter and longer.

Note 2: Bolts less than 3 times the diameter in length and studs less than 4 times diameter in length shall have hardness values not less than minimum and not more than maximum.

Note 3: Bolts 3 times the diameter in length and over are not required to meet minimum hardness requirements.

Note 4: ASTM A354-Grade BD shall be marked with the grade symbol "BD" and, in addition may be marked with six radial lines.

Note 5: Radial line markings 120 degrees apart are optional.

ASTM A36 Material Specification

Specification	Material	Tensile Strength (psi)	Minimum Yield Strength (psi)
ASTM A36	Carbon Structural Steel	58,000 (min.) - 80,000 (max.)	36,000

Most designers and end users focus on the strength and other characteristics of the bolt or stud. Once having selected the bolt, they must choose the appropriate nut. There are two simple rules when it comes to selecting the nut:

Rule #1; choose a nut specification compatible with the bolt specification. The bolt specification will usually dictate which nut specification is applicable (ASTM A193 bolts require ASTM A194 nuts).

Rule #2; choose a nut whose minimum proof strength is greater than or equal to the minimum ultimate tensile strength of the bolt. This ensures us that the bolt will break in tension prior to the female and/or male threads stripping.

A broken bolt is an obvious failure. It's loose. However, when the threads strip prior to the bolt breaking, we may not notice the failure until after the fastener is put into service.

SAE J429 Bolt and Nut Compatibility

Bolt Grade	Recommended Nut Grade (1)	Suitable Substitution (2)
SAE J-429 Grade 2	Low Carbon Regular or Heavy Hex Nut	SAE J995 Grade 5 or Grade 8 Hex Nut
SAE J-429 Grade 5	SAE J995 Grade 5 Hex Nut	SAE J995 Grade 8 Hex Nut
SAE J-429 Grade 8	SAE J995 Grade 8 Hex Nut	

(1) "Recommended" denotes a commercially available nut having the most suitable mechanical properties that will make it possible to obtain the desired bolt load.

(2) "Suitable" denotes SAE J995 nuts having mechanical properties that will also make it possible to obtain the desired bolt load.



Grade Identification Markings for Nuts

Specification	Material	Nominal Size (Inches)	Proof Load Stress (psi)		Min.	Max.	Grade Identification Marking
			Plain	Zinc Coated			
ASTM A563 - Grade 0	Carbon Steel	1/4 - 1-1/2	69,000*	52,000*	B55	C32	
ASTM A563 - Grade A	Carbon Steel	1/4 - 1-1/2	90,000*	68,000*	B68	C32	
ASTM A563 - Grade A Heavy Hex	Carbon Steel	1/4 - 4	100,000*	75,000*	B68	C32	
ASTM A563 - Grade C Heavy Hex	Carbon Steel, May Be Quenched & Tempered	1/4 - 4	144,000	144,000	B78	C38	
ASTM A563 - Grade DH Heavy Hex	Carbon Steel, Quenched and Tempered	1/4 - 4	175,000	150,000	C24	C38	
ASTM A194 - Grade 2H Heavy Hex	Medium Carbon Steel	1/4 - 1-1/2	175,000	150,000***	C24	C38	
		over 1-1/2				C38	
ASTM A194 - Grade 8 Heavy Hex	AISI 304	1/4 - 1-1/2	80,000		B60	B105	

SAE J995 Grade Identification for Nuts

Specification	Material	Nominal Size (Inches)	Proof Load Stress (psi)	Min.	Max.	Grade Identification Marking	
						Previous	Revised
SAE J995 - Grade 5	Medium Carbon Steel, Quenched & Tempered	1/4 - 1 over 1 - 1-1/2	120,000*		C32		
			109,000**				
			105,000*		C32		
			94,000**				
SAE J995 - Grade 8	Medium Carbon Alloy Steel, Quenched & Tempered	1/4 - 5/8 over 5/8-1 over 1 - 1-1/2	150,000*	C24	C32		
				C26	C34		
				C26	C36		

* UNC and 8 UN

** UNF 12 UN and Finer

*** When a zinc coated A194 2Hnut is supplied, the zinc coating, overtapping, lubrication and rotation capacity testing shall be in accordance with ASTM A563 and the proof stress reduced accordingly. Nuts coated with zinc shall have an asterisk (*) marked after the grade symbol. Nuts coated cadmium shall have a plus sign (+) marked after the grade symbol.

**** These graded identification markings show the latest revision. Both markings will be acceptable for a transition period.

ASTM Bolt and ASTM A563 Nut Capatibility (ASTM A194 Compatibility Shown for A325 & A490 Bolts)

Grade of Bolt (A)	Surface Finish (B)	Nominal Size (In.)	ASTM A563 Grade and ANSI Style Nut	
			Recommended (C)	Suitable Substitution (D)
				Heavy Hex
ASTM A307 Grade A	Plain & Zinc Coated	1/4 to 1-1/2	Grade A Hex Nut	A, C, DH
		over 1-1/2 to 2	Grade A Heavy Hex Nut	C, DH
		over 2 to 4	Grade A Heavy Hex Nut	C, DH
ASTM A307 Grade B	Plain & Zinc Coated	1/4 to 1-1/2	Grade A Heavy Hex Nut	C, DH
		over 1-1/2 to 2	Grade A Heavy Hex Nut	C, DH
		over 2 to 4	Grade A Heavy Hex Nut	C, DH
ASTM A449 Types 1 & 2	Plain	1/4 to 1-1/2	Grade B Hex Nut	C, DH
		over 1-1/2 to 3	Grade A Heavy Hex Nut	C, DH
	Zinc Coated	1/4 to 1-1/2	Grade DH Heavy Hex Nut	C, DH
ASTM A325	Plain	1/2 to 1-1/2	Grade DH Heavy Hex Nut	
			Grade C Heavy Hex Nut	DH
ASTM A354 Grade BC	Zinc Coated	1/2 to 1-1/2	ASTM A194 2H, Plain	
		1/4 to 1-1/2	Grade DH Heavy Hex Nut	DH
	Plain	1/4 to 1-1/2	Grade C Heavy Hex Nut	DH
		over 1-1/2 to 4	Grade C Heavy Hex Nut	DH
ASTM A354 Grade BD	Zinc Coated	1/4 to 1-1/2	Grade DH Heavy Hex Nut	
		over 1-1/2 to 4	Grade DH Heavy Hex Nut	
		1/4 to 1-1/2	Grade DH Heavy Hex Nut	DH
ASTM A490	Plain	1/2 to 1-1/2	Grade DH Heavy Hex Nut	
			Grade DH Heavy Hex Nut	DH
ASTM A193 Grade B7			ASTM A194	
ASTM A193 Grade B8			Grade 2H Heavy Hex Nut	
ASTM A193 Grade B8M			ASTM A194	
			Grade 8	
			ASTM A194	
			Grade 8M	

Note: the above chart should not be considered all inclusive for the fasteners listed. The nuts listed are those that are readily available.

(A) "Bolt" includes all externally threaded types of fasteners.

(B) Zinc coated nuts are nuts intended for use with externally threaded fasteners which are hot-dip zinc-coated, mechanically zinc-coated or have a plating or coating of sufficient thickness to require overtapping the nut to provide assembly.

(C) "Recommended" denotes a commercially available nut having the most suitable mechanical properties and dimensional configuration, or style, that will make it possible to obtain the desired bolt load.

(D) "Suitable" denotes nuts having mechanical properties that will make it possible to obtain the desired bolt load, but may require consideration of dimensional configuration, style, suitability and availability.



Fastener Materials Selection Based on the Galvanic Reaction of Metals

Fastener Metal ↓ Base Metal →	Zinc & Galvanized Steel	Aluminum & Aluminum Alloys	Steel & Cast Iron	Brasses Copper Bronzes & Monel	Martensitic Stainless Type 410	Austenitic Stainless Type 302/304, 303, 305
Zinc & Galvanized Steel	1	2	2	3	3	3
Aluminum & Aluminum Alloys	1	1	2	3	Never Recommended	2
Steel & Cast Iron	1,4	1	1	3	3	2
Tempe (lead-tin) Plated Steel Sheets	1,4,5	1,5	1,5	3	3	2
Brasses, Copper Bronzes & Monel	1,4,5	1,5	1,5	1	1	2
Ferritic Stainless Steel (type 430)	1,4,5	1,5	1,5	1	1	1
Austenitic Stainless Steel (type 302/304)	1,4,5	1,5	1,5	1,5	1	1

Key:

1. The corrosion of the base metal is not increased by the fastener.
2. The corrosion of the base metal is marginally increased by the fastener.
3. The corrosion of the base metal may be considerably increased by the fastener material.
4. The plating on the fastener is rapidly consumed, leaving the bare fastener metal.
5. The corrosion of the fastener is increased by the base metal.

NOTE: Surface treatment and environment can significantly alter activity.

Mechanical Properties of Common Stainless Steel Fasteners in Accordance with ASTM F593

Stainless Alloy Group	Condition	Nominal Diameter (Inches)	Tensile Strength (psi)	Core Hardness Rockwell		Minimum Yield Strength (psi)	Grade Identification Marking
				Min.	Max.		
Group 1 303, 304, 304L, 305 384, XM1, XM7, 303Se	CW 1	1/4 - 5/8	100,000 - 150,000	B95	C32	65,000	
	CW 2	3/4 - 1-1/2	85,000 - 140,000	B80	C32	45,000	
Group 2 316, and 316L	CW 1	1/4 - 5/8	100,000 - 150,000	B95	C32	65,000	
	CW 2	3/4 - 1-1/2	85,000 - 140,000	B80	C32	45,000	

CW: Headed and rolled from annealed or solution-annealed stock.

Alloy-Steel and Stainless Steel for use in High Temperature Service

Specification	Material	Nominal Diameter (Inches)	Minimum Tensile Strength (psi)	Rockwell Hardness (Maximum)	Minimum Yield Strength (psi)	Grade Identification Marking
ASTM A193 Grade B7	Chromium-Molybdenum (AISI 4140, 4142, 4145, 4140H, 4142H, 4145H)	Up to 2-1/2 Over 2-1/2 - 4 Over 4 - 7	125,000 115,000 100,000	C35 C33 C29	105,000 95,000 75,000	
ASTM A193 Grade B8 Class 1	AISI 304	1/4 and Larger	75,000	B96	30,000	
ASTM A193 Grade B8M Class 1	AISI 316	1/4 and Larger	75,000	B96	30,000	