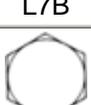
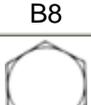


# ASTM, SAE AND ISO GRADE MARKINGS AND MECHANICAL PROPERTIES FOR STEEL FASTENERS

Identification Grade Mark	Specification	Fastener Description	Material	Nominal Size Range (in.)	Mechanical Properties		
					Proof Load (psi)	Yield Strength Min (psi)	Tensile Strength Min (psi)
 No Grade Mark	SAE J429 Grade 1	Bolts, Screws, Studs	Low or Medium Carbon Steel	1/4 thru 1-1/2	33,000	36,000	60,000
	ASTM A307 Grades A&B		Low Carbon Steel	1/4 thru 4	--	--	
	SAE J429 Grade 2		Low or Medium Carbon Steel	1/4 thru 3/4 Over 3/4 to 1-1/2	55,000 33,000	57,000 36,000	74,000 60,000
 No Grade Mark	SAE J429 Grade 4	Studs	Medium Carbon Cold Drawn Steel	1/4 thru 1-1/2	--	100,000	115,000
 B5	ASTM A193 Grade B5		AISI 501	1/4 Thru 4	--	80,000	100,000
 B6	ASTM A193 Grade B6		AISI 410			85,000	110,000
 B7	ASTM A193 Grade B7		AISI 4140, 4142, OR 4105	1/4 thru 2-1/2 Over 2-1/2 thru 4	-- --	105,000 95,000 75,000	125,000 115,000 100,000
 B16	ASTM A193 Grade B16		CrMoVa Alloy Steel	Over 4 thru 7		105,000 95,000 85,000	125,000 115,000 100,000
 B8	ASTM A193 Grade B8		AISI 304	1/4 and larger	--	30,000	75,000
 B8C	ASTM A193 Grade B8C		AISI 347				
 B8M	ASTM A193 Grade B8M		AISI 316				

 B8T	ASTM A193 Grade B8T	Bolts, Screws, Studs for High- Temperature Service	AISI 321	1/4 and larger	--	30,000	75,000			
 B8	ASTM A193 Grade B8		AISI 304 Strain Hardened	1/4 thr 3/4 Over 3/4 thru 1 Over 1 thru 1-1/4 Over 1-1/4 thru 1-1/2	-- -- -- --	100,000	125,000			
 B8C	ASTM A193 Grade B8C		AISI 347 Strain Hardened			80,000	115,000			
 B8M	ASTM A193 Grade B8M		AISI 316 Strain Hardened			65,000	105,000			
 B8T	ASTM A193 Grade B8T		AISI 321 Strain Hardened			50,000	100,000			
 L7	ASTM A320 Grade L7		AISI 4140, 4142 or 4145			100,000	125,000			
 L7A	ASTM A320 Grade L7A	AISI 4037	1/4 thru 2- 1/2	--	105,000			125,000		
 L7B	ASTM A320 Grade L7B	AISI 4137								
 L7C	ASTM A320 Grade LC7	AISI 8740								
 L43	ASTM A320 Grade L43	AISI 4340				1/4 thru 4	--		105,000	125,000
 B8	ASTM A320 Grade B8	Bolts, Screws, Studs for Low- Temperature Service				AISI 304	1/4 and larger		--	30,000
 B8C	ASTM A320 Grade B8C		AISI 347							
 B8T	ASTM A320 Grade B8T		AISI 321							
 B8F	ASTM A320 Grade B8F		AISI 303 or 303Se							

 B8M	ASTM A320 Grade B8M		AISI 316				
 B8	ASTM A320 Grade B8		AISI 304				
 B8C	ASTM A320 Grade B8C		AISI 347	1/4 thru 3/4			
 B8F	ASTM A320 Grade B8F		AISI 303 or 303Se	Over 3/4 thru 1	--	100,000	100,000
 B8M	ASTM A320 Grade B8M		AISI 316	Over 1 thru 1-1/4	--	80,000	80,000
 B8T	ASTM A320 Grade B8T		AISI 321	Over 1-1/4 thru 1-1/2	--	65,000	65,000
	SAE J429 Grade 5	Bolts, Screws, Studs	Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
	ASTM A449			Over 1 to 1-1/2	74,000	81,000	105,000
	SAE J429 Grade 5.1	Sems	Low or Medium Carbon Steel, Quenched and Tempered	No. 6 thru 3/8	85,000	--	120,000
	SAE J429 Grade 5.2	Bolts, Screws, Studs	Low Carbon Martensitic Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
 A325	ASTM A325 Type 1	High Strength Structural Bolts	Medium Carbon Steel, Quenched and Tempered	1/2 thru 1	85,000	92,000	120,000
 A325	ASTM A325 Type 2		Low Carbon Martensitic Steel, Quenched and Tempered	1/2 thru 1	85,000	92,000	120,000
 <u>A325</u>	ASTM A325 Type 3		Atmospheric Corrosion Resisting Steel, Quenched and Tempered	1/2 thru 1	85,000	92,000	120,000
	ASTM A354 Grade BB	Bolts, Studs	Alloy Steel, Quenched and	1/4 thru 2- 1/2	80,000 75,000	83,000 78,000	105,000 100,000

BB							
 BC	ASTM A354 Grade BC		Tempered	2-3/4 thru 4	105,000 95,000	109,000 99,000	125,000 115,000
	SAE J429 Grade 7	Bolts, Screws,	Medium Carbon Alloy Steel, Quenched and Tempered <sup>4</sup>	1/4 thru 1- 1/2	105,000	115,000	133,000
	SAE J429 Grade 8	Bolts, Screws, Studs	Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1- 1/2	120,000	130,000	150,000
	ASTM A354 Grade BD		Alloy Steel, Quenched and Tempered <sup>4</sup>				
 No Grade Mark	SAE J429 Grade 8.1	Studs	Medium Carbon Alloy or SAE 1041 Modified Elevated Temperature Drawn Steel	1/4 thru 1- 1/2	120,000	130,000	150,000
 A490	ASTM A490	High Strength Structural Bolts	Alloy Steel, Quenched and Tempered	1/2 thru 1- 1/2	120,000	130,000	150,000 min 170,000 max
 No Grade Mark	ISO R898 Class 4.6	Bolts, Screws, Studs	Medium Carbon Steel, Quenched and Tempered	All Sizes thru 1-1/2	33,000	36,000	60,000
 No Grade Mark	ISO R898 Class 5.8				55,000	57,000	74,000
8.8  or  88	ISO R898 Class 8.8		85,000		92,000	120,000	
10.9  or  109	ISO R898 Class 10.9		120,000		130,000	150,000	

# FASTENER IDENTIFICATION MARKING

Grade Identification Marking	Specification	Material	Nominal Size In.	Proof Load Stress ksi	Hardness Rockwell		See Note
					Min	Max	
 No Mark	ASTM A563 - Grade 0	Carbon Steel	1/4 thru 1-1/2	69	B55	C32	3,4
	ASTM A563 - Grade A	Carbon Steel	1/4 thru 1-1/2	90	B68	C32	3,4
	ASTM A563 - Grade B	Carbon Steel	1/4 thru 1	120	B69	C32	3,4
over 1 thru 1-1/2			105				
	ASTM A563 - Grade C	Carbon Steel May be Quenched and Tempered	1/4 thru 4	144	B78	C38	5
	ASTM A563 - Grade C3	Atmospheric Corrosion Resistant Steel May be Quenched and Tempered	1/4 thru 4	144	B78	C38	5,9
	ASTM A563 - Grade D	Carbon Steel May be Quenched and Tempered	1/4 thru 4	150	B84	C38	6
	ASTM A563 - Grade DH	Carbon Steel Quenched and Tempered	1/4 thru 4	175	C24	C38	6
	ASTM A563 - Grade DH3	Atmospheric Corrosion Resistant Steel, Quenched and Tempered	1/4 thru 4	175	C24	C38	5,9
	ASTM A194 - Grade 1	Carbon Steel	1/4 thru 4	130	B70	--	7
	ASTM A194 - Grade 2	Medium Carbon Steel	1/4 thru 4	150	159	352	7,8
	ASTM A194 - Grade 2H	Medium Carbon Steel, Quenched and Tempered	1/4 thru 4	175	C24	C38	7
	ASTM A194 - Grade 2HM	Medium Carbon Steel, Quenched and Tempered	1/4 thru 4	150	159	237	7,8
	ASTM A194 - Grade 4	Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 4	175	C24	C38	7
	ASTM A194 - Grade 7	Medium Carbon Alloy Steel, Quenched	1/4 thru 4	175	C24	C38	7

		and Tempered					
	ASTM A194 - Grade 7M	Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 4	150	159	237	7
See Note 1,2	10						

**NOTES:**

1. In addition to the indicated grade marking, all grades, except A563 grades O, A and B, must be marked for manufacturer identification.
2. The markings shown for all grades of A194 nuts are for cold formed and hot forged nuts. When nuts are machined from bar stock the nut must be additionally marked with the letter 'B'.
3. Nuts are not required to be marked unless specified by the purchaser. When marked, the identification marking shall be the grade letter O, A or B.
4. Properties shown are those of nonplated or noncoated coarse thread hex nuts.
5. Properties shown are those of coarse thread heavy hex nuts.
6. Properties shown are those of coarse thread heavy hex nuts.
7. Properties shown are those of coarse 8-pitch thread heavy hex nuts.
8. Hardnesses are Brinell Hardness Numbers.
9. The nut manufacturer, at his option, may add other markings to indicate the use of atmospheric corrosion resistant steel.
10. Specifications --  
 ASTM A563 -- Carbon and Alloy Steel Nuts.  
 ASTM A194/A194M -- Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.

## Proper Drill Bit Size for Drilling Pilot Holes & Shank Holes

SCREW GAGE NUMBER	SHANK HOLE HARD & SOFT WOOD	PILOT HOLE SOFT WOOD	PILOT HOLE HARD WOOD
0	1/16"	1/64"	1/32"
1	5/64"	1/32"	1/32"
2	3/32"	1/32"	3/64"
3	7/64"	3/64"	1/16"
4	7/64"	3/64"	1/16"
5	1/8"	1/16"	5/64"
6	9/64"	1/16"	5/64"
7	5/32"	1/16"	3/32"
8	11/64"	5/64"	3/32"
9	3/16"	5/64"	7/64"
10	3/16"	3/32"	7/64"
11	13/64"	3/32"	1/8"
12	7/32"	7/64"	1/8"
14	1/4"	7/64"	9/64"
16	17/64"	9/64"	5/32"

<b>18</b>	<b>19/64"</b>	<b>9/64</b>	<b>3/16"</b>
<b>20</b>	<b>21/64"</b>	<b>11/64"</b>	<b>13/64"</b>

# HEAT-TREATED ALLOY STUDS, BOLTS AND THREADED BARS

## Chemical Composition

Elements	A354 Grades BC, BD		A193 Grade B7	
	**See Note Below		Chromium-Molybdenum	
	Range percent	Check variation over percent	Range percent	Check variation over or under percent
Carbon...	--	--	*0.38-0.48	0.02
Manganese...	--	--	0.750-1.00	0.04
Phosphorus, max...	0.04	0.005	0.04	0.005 over
Sulphur, max...	0.04	0.005	0.04	0.005 over
Silicon...	--	--	0.20-0.35	0.02
Chromium...	--	--	0.80-1.10	0.05
Molybdenum...	--	--	0.15-0.25	0.02

Elements	A193 Grade B16 Chromium-Molybdenum-Vanadium	
	Range percent	Check variation over or under percent
Carbon...	0.36-0.44	0.02
Manganese...	0.45-0.70	0.03
Phosphorus, max...	0.04	0.005 over
Sulphur, max...	0.04	0.005 over
Silicon...	0.20-0.35	0.02
Chromium...	0.80-1.15	0.05
Molybdenum...	0.50-0.65	0.03
Vanadium...	0.25-0.35	0.03

Elements	A320 Grade L7	A320 Grade L43
	Chromium-Molybdenum (AISI 4140, 4142, 4145)	Nickel-Chromium-Molybdenum (AISI 4340)

	Range percent	Check variation over percent	Range percent	Check variation over or under percent
Carbon...	*0.38-0.48	0.02	0.38-0.148	0.02
Manganese...	0.75-1.00	0.04	0.60-0.85	0.03
Phosphorus, max...	0.04	0.005 over	0.04	0.005 over
Sulphur, max...	0.04	0.005 over	0.04	0.005 over
Silicon...	0.20-0.35	0.02	0.20-0.35	0.02
Nickel...	--	--	1.65-2.00	0.05
Chromium...	0.80-1.10	0.05	0.70-1.90	0.03
Molybdenum...	0.15-0.25	0.02	0.20-0.30	0.02

\*For bar sizes over 3-1/2 in. to 4 in., inclusive, the carbon content may be 0.50 pct. max.

\*\* Any alloy steel capable of meeting the tensile requirements of Specification A354 may be used.

### Tensile Requirements

Grade	Diameter, in.	Min tempering temp F	Tensile strength min psi	Yield point min psi	Elongation in 2 in. min pct	Reduction of area min pct
<b>A354 Grade BC</b>	{2-1/2 and under {Over 2-1/2 to 4 incl.	850	125,000	109,000	16	50
<b>A354 Grade BD</b>	1-1/2 and under	850	115,000	99,000	16	45
<b>A193 Grade B7</b> Chromium-Molybdenum	{2-1/2 and under {Over 2-1/2 to 4 incl. {Over 4 to 7 incl.	850	150,000	125,000	14	35
<b>A193 Grade B16</b> Chromium-Molybdenum-Vanadium	{2-1/2 and under {Over 2-1/2 to 4 incl. {Over 4 to 7 incl.	1100 1100 1100	125,000 115,000 100,000	105,000 95,000 75,000	16 16 18	50 50 50
<b>A320 Grade L7</b> Chromium-Molybdenum	2-1/2 and under	--	125,000	105,000	16	50
<b>A320 Grade L43</b> Nickel-Chromium-Molybdenum	4 and under	--	125,000	105,000	16	50

Commonly used are the following grades of heat-treated alloy steel for high-pressure or extreme temperature service in diameters of 1/2 in. to 2 in., inclusive. Other grades and other diameters are available on special order.

**ASTM A354, Grades BC and BD** - heat-treated alloy steels for applications at normal atmospheric temperatures where high strength is required.

**ASTM A193, Grade B7** - a heat-treated chromium-molybdenum steel widely used for medium high-temperature service.

**ASTM A193, Grade B16** - a heat-treated chromium-molybdenum-vanadium steel for high-pressure, high-temperature service.

**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 15 ft-lb at this temperature. Sizes 2-1/2 in. and under.

**ASTM A320, Grade L43** - The same properties offered by Grade L7 in sizes up to 2-1/2 are obtainable up to 4 in. in Grade L43.

## Mechanical Requirements for Stainless Steel & Non-Ferrous Fasteners

Grade(1)	General Description of Material	Bolts, Screws and Studs					Nuts		
		Full Size Bolts, Screws, Studs		Machine Test Specimens of Bolts, Screws, Studs			Hardness Rockwell	Proof Load Stress	Hardness Rockwell
		Yield (2) Strength	Tensile Strength	Yield (2) Strength	Tensile Strength	Elongation(3)			
		Min psi	Min psi	Min psi	Min psi	% Min.	Min	psi	Min
303A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B75	75,000	B75
304-A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B75	75,000	B75
304	Austenitic Stainless Steel- Cold Worked	50,000	90,000	45,000	85,000	20	B85	90,000	B85
304-SH	Austenitic Stainless Steel- Strain Hardened	See Note 6	See Note 6	See Note 6	See Note 6	15	C25	See Note 6	C20
305-A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B70	75,000	B70
305	Austenitic Stainless Steel-	50,000	90,000	45,000	85,000	20	B85	90,000	B85

	Cold Worked								
305-SH	Austenitic Stainless Steel- Strain Hardened	See Note 6	See Note 6	See Note 6	See Note 6	15	C25	See Note 6	C20
316-A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B70	75,000	B70
316	Austenitic Stainless Steel- Cold Worked	50,000	90,000	45,000	85,000	20	B85	90,000	B85
316-SH	Austenitic Stainless Steel- Strain Hardened	See Note 6	See Note 6	See Note 6	See Note 6	15	C25	See Note 6	C20
XM7-A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B70	75,000	B70
XM7	Austenitic Stainless Steel- Cold Worked	50,000	90,000	45,000	85,000	20	B85	90,000	B85
384-A	Austenitic Stainless Steel- Sol. Annealed	30,000	75,000	30,000	75,000	20	B70	75,000	B70
384	Austenitic Stainless Steel- Cold Worked	50,000	90,000	45,000	85,000	20	B85	90,000	B85
410-H	Martensitic Stainless Steel- Hardened and Tempered	95,000	125,000	95,000	125,000	20	C22	125,000	C22
410-HT	Martensitic Stainless Steel- Hardened and Tempered	135,000	180,000	135,000	180,000	12	C36	180,000	C36
416-H	Martensitic Stainless Steel- Hardened and Tempered	95,000	125,000	95,000	125,000	20	C22	125,000	C22
416-HT	Martensitic Stainless Steel- Hardened and Tempered	135,000	180,000	135,000	180,000	12	C36	180,000	C36

430	Ferritic Stainless Steel	40,000	70,000	40,000	70,000	20	B75	70,000	B75
464-HF	Naval Brass	15,000	52,000	14,000	50,000	25	B56	52,000	B56
464	Naval Brass	27,000	60,000	25,000	57,000	25	B65	60,000	B65
462	Naval Brass	27,000	52,000	24,000	50,000	20	B65	52,000	B65
642	Aluminum Bronze	35,000	72,000	35,000	72,000	15	B75	72,000	B75
630	Aluminum Bronze	50,000	105,000	50,000	105,000	10	B90	105,000	B90
614	Aluminum Bronze	40,000	75,000	40,000	75,000	30	B70	75,000	B70
510	Phosphor Bronze	35,000	60,000	35,000	60,000	15	B60	60,000	B60
675	Manganese Bronze	22,000	55,000	22,000	55,000	20	B60	55,000	B60
655-HF	Silicon Bronze	20,000	52,000	18,500	50,000	20	B60	52,000	B60
655	Silicon Bronze	38,000	70,000	36,000	68,000	15	B75	70,000	B75
651	Silicon Bronze	45,000	75,000	42,500	72,000	8	B75	75,000	B75
661	Silicon Bronze	38,000	70,000	38,000	70,000	15	B75	70,000	B75
NICU-A-HF	Nickel-Copper Alloy A	25,000	70,000	25,000	70,000	20	B70	70,000	B70
NICU-A	Nickel-Copper Alloy A	40,000	80,000	40,000	80,000	20	B80	80,000	B80
NICU-B	Nickel-Copper Alloy B	40,000	80,000	40,000	80,000	20	B80	80,000	B80
NICU-K(7)	Nickel-Copper Aluminum Alloy	90,000	130,000	90,000	130,000	20	C24	130,000	C24
2024-T4	Aluminum Alloy	40,000	55,000	40,000	55,000	14	B70	55,000	B70
6061-T6	Aluminum Alloy	35,000	42,000	35,000	42,000	12	B50	42,000	B50

**Note 6.** Austenitic stainless steel, strain hardened bolts, screws, studs, and nuts shall have the following strength per properties.

Product Size	Bolts, Screws, Studs				Nuts
	Tested Full Size		Machine Test Specimens,		Proof Load Stress
	Yield Strength	Tensile Strength	Yield Strength	Tensile Strength	
in.	min psi	min psi	min psi	min psi	psi
to 5/8 in.	100,000	125,000	90,000	115,000	125,000
over 5/8 to 1 in.	70,000	105,000	65,000	100,000	105,000
over 1 to 1-1/2 in.	50,000	90,000	45,000	85,000	90,000

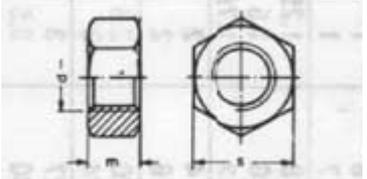
# METRIC

## SOCKETS, BOLTS, SCREWS, NUTS

### DIMENSIONS OF MOST COMMON HEADS

(ALL MEASUREMENTS IN mm)

DIN	DIA		ILLUSTRATION	M1.6	M2	M2.5	M3	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30	M36	
912	DIA	$d_2$		3	3.8	4.5	5.5	7	8.5	10	13	16	18	24	30	36	45	54	
	HEIGHT	K		1.6	2	2.5	3	4	5	6	8	10	12	16	20	24	30	36	
	HEX KEY SIZE DIN 911	S		1.5	1.5	2	2.5	3	4	5	6	8	10	14	17	19	22	27	
6912	DIA	$d_2$		<b>DIN 6912 IS LOW HEAD DIN 6911 IS A HEX KEY WITH GUIDE</b>				7	8.5	10	13	16	18	24	30	36	45	54	
	HEIGHT	K						2.8	3.5	4	5	6.5	7.5	10	12	14	17.5	21.5	
	HEX KEY SIZE DIN 6911	S						3	4	5	6	8	10	14	17	19	22	27	
7984	DIA	$d_2$		<b>SIMILAR TO DIN 6912 BUT HEX SOCKET IS WITHOUT GUIDE</b>				5.5	7	8.5	10	13	16	18	24	30	36		
	HEIGHT	K						2	2.8	3.5	4	5	6	7	9	11	13		
	HEX KEY SIZE DIN 911	S						2	2.5	3	4	5	7	8	12	14	17		
7991	DIA	$d_2$					6	8	10	12	16	20	24	30	36	39			
	HEIGHT	K					1.7	2.3	2.8	3.3	4.4	5.5	6.5	7.5	8.5	14			
	HEX KEY SIZE DIN 911	S					2	2.5	3	4	5	6	8	10	12	14			
931 933 960 961	ACROSS FLATS (WRENCH SIZE)	S					5.5	7	8	10	13	17	19	24	30	36	46	55	
	HEIGHT	K					2	2.8	3.5	4	5.5	7	8	10	13	15	19	23	
84	DIA	$d_2$		3	3.8	4.5	5.5	7	8.5	10	13	16							
	HEIGHT	K		1	1.3	1.6	2	2.6	3.3	3.9	5	6							
7985	DIA	$d_2$					6	8	10	12	16	20							
	HEIGHT	K					2.4	3.1	3.8	4.6	6	7.5							
934	ACROSS FLATS (WRENCH SIZE)	S		3.2	4	5	5.5	7	8	10	13	17	19	24	30	36	46	55	

HEIGHT	m		1.3	1.6	2	2.4	3.2	4	5	6.5	8	10	13	16	19	24	29

## MECHANICAL PROPERTIES OF FASTENERS

CLASS	New Designation	4.6	4.8	5.6	5.8	6.6	6.8	6.9	8.8	10.9	12.9	14.9
	Formerly	4D	4S	5D	5S	6D	6S	6G	8G	10K	12K	--
U.S. GRADE		1	2	2	2	3	3	3	5	8	--	--
Brinell	min.	110	140	170		225		280	330	390		
	max.	170	215	245		300		365	425	--		
Rockwell	HRB	min.	63	78	88		--	--	--	--		
		max.	88	97	102		--	--	--	--		
	HRC	min.	--	--	18		27	34	40			
		max.	--	--	31		38	44	49			
Yield Point psi		45,000	56,000	76,000	76,000	91,000	128,000	153,000	180,000			
Tensile Strength psi	min.	56,000	70,000	85,000	85,338	113,784	142,230	170,000	200,000			
	max.	78,000	100,000	113,000	99,561	128,000	170,676	200,000	230,000			

## MECHANICAL PROPERTIES OF NUTS

NOMINAL DIAMETER mm	PITCH mm	NOMINAL STRESS AREA mm <sup>2</sup>	PROPERTY CLASSES OF NUTS						
			4	5	6	8	10	12	14
			PROOF LOAD kfg						
M6	1	20.1	800	1,000	1,200	1,600	2,000	2,400	2,800
M7	1	28.9	1,150	1,450	1,730	2,300	2,900	3,470	4,000
M8	1.25	36.6	1,450	1,830	2,200	2,900	3,650	4,300	5,100
M10	1.5	58	2,300	2,900	3,500	4,600	5,800	6,950	8,100
M12	1.75	84.3	3,350	4,210	5,050	6,700	8,400	10,000	11,800
M14	2	115	4,600	5,750	6,900	9,200	11,500	13,800	16,100
M16	2	157	6,300	7,850	9,400	12,600	15,700	18,800	22,000
M20	2.5	245	9,800	12,200	14,700	19,600	24,500	29,400	34,300
M24	3	353	14,100	17,600	21,200	28,200	35,300	42,300	49,400
M27	3	459	18,400	23,000	27,600	36,700	45,900	55,000	64,300
M30	3.5	561	22,400	28,000	33,600	44,800	56,100	67,300	78,500
M33	3.5	694	27,800	34,700	41,600	55,500	69,400	83,300	97,000
M36	4	817	32,700	40,800	49,000	65,300	81,700	98,000	114,400
M8	1	39.2	1,570	1,960	2,350	3,100	3,900	4,700	5,500
M10	1.25	61.2	2,400	3,060	3,700	4,900	6,100	7,350	8,550
M12	1.25	92.1	3,700	4,600	5,500	7,400	9,200	11,000	12,900
M16	1.5	167	6,700	8,350	10,000	13,400	16,700	20,000	23,400
M20	1.5	272	10,900	13,600	16,300	21,800	27,200	32,600	38,000

M24	2	384	15,400	19,200	23,000	30,700	38,400	46,000	53,800
-----	---	-----	--------	--------	--------	--------	--------	--------	--------

## TIGHTENING TORQUES IN KILOGRAM METERS

GRADE		NOMINAL DIAMETER - REGULAR PITCH														
		M4	M5	M6	M7	M8	M10	M12	M14	M16	M18	M20	M22	M24	M27	M30
8.8	kpm	0.29	0.57	1	1.6	2.5	5	8	13	20	26	36	51	65	98	134
	Pound-Feet	2	4	7	11	18	32	58	94	144	190	260	368	470	707	967
10.9	kpm	0.4	0.8	1.4	2.3	3.5	6	12	18	27	37	51	72	92	138	188
	Pound-Feet	2.9	6	10	16	25	47	83	133	196	269	366	520	664	996	1357
12.9	kpm	0.5	1	1.6	2.7	4	8	14	22	33	45	61	87	110	167	226
	Pound-Feet	3.6	7	11	20	29	58	100	159	235	323	440	628	794	1205	1630

## TAP AND DRILL SIZE CHART

THREAD SIZE	DRILL DIAMETER <i>Coarse Thread</i>	TAP DRILL SIZE
1-64	.0595	No. 53
2-56	.0700	No. 50
3-48	.0785	No. 47
4-40	.0890	No. 43
5-40	.1015	No. 38
6-32	.1065	No. 36
8-32	.1360	No. 29
10-24	.1495	No. 25
12-24	.1770	No. 16
1/4-20	.2010	No. 7
5/16-18	.2570	'F'
3/8-16	.3125	5/16
7/16-14	.3680	'U'
1/2-13	.4219	27/64
9/16-12	.4844	31/64
5/8-11	.5312	17/32
3/4-10	.6562	21/32
7/8-9	.7656	49/64
1"-8	.8750	7/8
<b><i>Fine Thread</i></b>		

0-80	.0469	3/64
1-72	.0595	No. 53
2-64	.0700	No. 50
3-56	.0820	No. 45
4-48	.0935	No. 42
5-44	.1040	No. 37
6-40	.1130	No. 33
8-36	.1360	No. 29
10-32	.1590	No. 21
12-28	.1820	No. 14
1/4-28	.2130	No. 3
5/16-24	.2720	'I'
3/8-24	.3320	'Q'
7/16-20	.3906	25/64
1/2-20	.4531	29/64
9/16-18	.5156	33/64
5/8-18	.5781	37/64
3/4-16	.6875	11/16
7/8-14	.8125	13/16
1"-14	.9375	59/64

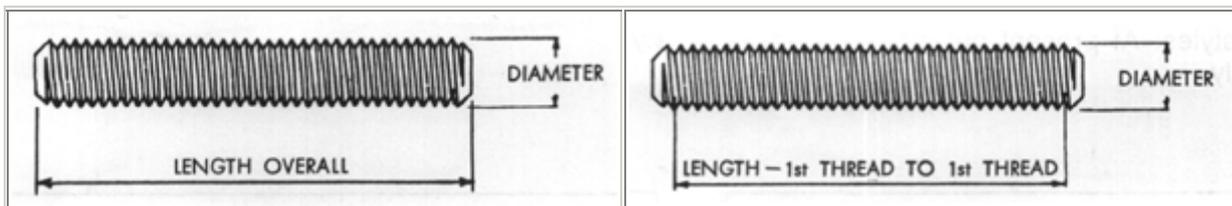
## Thread Terminology

	<p><b>A. FULL DIAMETER SHANK:</b> Equal to major diameter of thread. Produced by cut thread or by roll thread on extruded blank. Characteristic of machine bolts and cap screws.</p>	<p><b>ROLLED THREAD:</b> Threads are cold formed by squeezing the blank between reciprocating serrated dies. This acts to increase the major diameter of the thread over and above the diameter of unthreaded shank (if any), unless an extruded blank is used.</p>
	<p><b>B. UNDERSIZED SHANK:</b> Equal approximately to pitch diameter of thread. Produced by roll threading a non-extruded blank. Characteristic of machine screws.</p>	<p>Classes of thread are distinguished from each other by the amounts of tolerance and allowance specified. External threads or bolts are designated with the suffix "A"; internal or nut threads with "B".</p>
	<p><b>C. PITCH:</b> The distance from a point on</p>	<p><b>CLASSES 1A and 1B:</b> For work of rough commercial</p>

	the screw thread to a corresponding point on the next thread measured parallel to the axis.	quality where loose fit for spin-on-assembly is desirable.
	<b>D. PITCH DIAMETER:</b> The simple, effective diameter of screw thread. Approximately half way between the major and minor diameters.	<b>CLASSES 2A and 2B:</b> The recognized standard for normal production of the great bulk of commercial bolts, nuts and screws.
	<b>E. MAJOR DIAMETER:</b> The largest diameter of a screw thread.	<b>CLASSES 3A and 3B:</b> Used where a closed fit between mating parts for high quality work is required.
	<b>F. MINOR DIAMETER:</b> The smallest diameter of a screw thread.	<b>CLASS 4:</b> A theoretical rather than practical class, now obsolete.
	<b>LEAD:</b> The distance a screw thread advances axially in one turn.	<b>CLASS 5:</b> For a wrench fit. Used principally for studs and their mating tapped holes. A force fit requiring the application of high torque for semi-permanent assembly.
	<b>CUT THREAD:</b> Threads are cut or chased; the unthreaded portion of shank will be equal to major diameter of thread.	

## TYPES OF STUDS

### Continuous Thread Studs



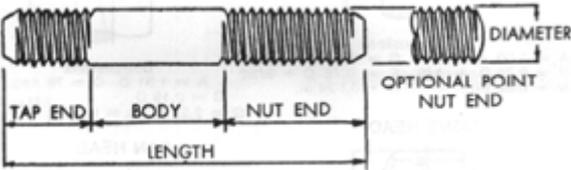
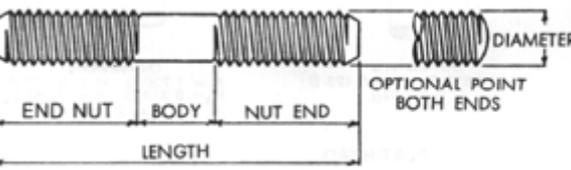
**Type 1**

**Type 2**

Continuous-thread studs are threaded from end to end and are often used for flange bolting with two nuts applied.

**Type 1** - General purpose. The length of this type is measured from end to end. Threads are UNRC-2A.

**Type 2** - Studs for temperature-pressure piping. These studs are made to the dimensional standard requirements of ANS B16.5 and have a length measurement requirement different from all other studs, i.e., the length is measured from first thread to first thread, exclusive points. Points are flat and chamfered. Threads are UNRC-2A for all sizes 1 in. and under and 8UNR-2A for all sizes over 1 in.

Tap-end Studs	Double-end Studs
	
<p>Tap-end studs have a short thread on one end, called the tap end which is threaded to a Class NC5 or Class UNRC-3A fit. This end is for screwing into a tapped hole. The other or nut end is threaded with a Class UNRC-2A fit. Length of the stud is measured overall. The tap end has a chamfered point, but the nut end may have either a chamfered or round point, at the manufacturer's option. Tap-end studs are available in four types, as follows:</p> <p><b>Type 1</b> - Unfinished, have a full diameter but no standard body tolerances.</p> <p><b>Type 2</b> - Finished, having either an undersize body with rolled threads or a full-size body with cut threads, at the manufacturer's option. The body portion will be finished to a maximum Class 2A pitch diameter or maximum basic major diameter of the nut-end thread.</p> <p><b>Type 3</b> - Finished, full-body, having tolerances equal to that on major diameter of Class 2A threads.</p> <p><b>Type 4</b> - Finished close-body, milled or ground to tolerances specified by the user.</p>	<p>Double-end studs have equal-length threads on each end to accommodate a nut and are threaded to a Class 2A fit. Length of stud is measured overall. Both ends have chamfered points, but round points may be furnished on either or both ends at the manufacturer's option. This style is furnished in the same four types listed for tap-end studs. Double-end studs are used for flange bolting or other applications where torching from both ends is necessary or desirable.</p> <p>Most steel grades not heat treated or quenched and tempered can be furnished on special order for production quantities. Only the Type 2 continuous thread studs made to specification ASTM A193 grade B7 are stocked in a full range of sizes.</p>

Tap end and double end studs are not available from stock. They available only on special order.