



# RANFLEX METALS

An ISO 9001-2008 Certified Company  
Manufacturers and Stockholders of Stainless Steel Fasteners

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## PROPERTIES OF STUDS NUTS & BOLTS

### High Temperature High Tension Alloy Bolt Material Chemical & Mechanical Requirements

#### ASTM A193 B7 (Cr- Mo AISI 4140, 4142, 4145)

This material is considered as the most suitable for bolts to be used at temperature below 450 ° C, with a minimum effect on its Structural strength during application at a high temperature.

The material has the following chemical properties and physical Characteristics.

C	Mn	P	S	Si	Cr	Mo
0.37-0.49	0.65-1.10	0.035 Max	0.04 Max	0.15-0.35	0.75-1.20	0.15-0.25
Dia	Minimum Tempering Temperature ( ° F )	Tensile Strength min, ksi ( MPa)	Yield Strength. min, 0.2% offset, Ksi ( MPa)	Elongation in 4D min %	Reduction of Area min %	Hardness max
2 1/2" and under	1,100 (593 ° C)	125(860)	105(720)	16	50	321HB or 35 HRC
over 2 1/2" to 4"	1,100 (593 ° C)	115(795)	95(655)	16	50	302HB or 35 HRC
over 4" to 7"	1,100 (593 ° C)	100(690)	75(515)	18	50	277HB or 29 HRC

#### ASTM A1193 B7M (Cr- Mo AISI 4140,4142,4145 )

C	Mn	P	S	Si	Cr	Mo
0.37-0.49	0.65-1.10	0.035 Max	0.04 Max	0.15-0.35	0.75-1.20	0.15-0.25
Dia	Minimum Tempering Temperature ° F (° C)	Tensile Strength min, ksi MPa	Yield Strength. min, 0.2% offset, Ksi	Elongation in 2" min %	Reduction of Area min %	Hardness max
2 1/2" and under	1150 (620 ° C)	100(690)	80(550)	18	50	235HB, 99HRB



**ASTM A193 B16 (Cr- Mo -V)**

This material is considered as the most suitable for bolts to be used at temperature below 450 °. C, even at a high temperature range, the material has superior physical characteristics compared to ASTM A193 B7 previously mentioned. The chemical properties and physical characteristics are as follows

C	Mn	P	S	Si	Cr	Mo	Al	V
0.36-0.47	0.45-0.70	0.035 Max	0.04 Max	0.15-0.35	0.80-1.15	0.50-0.65	0.015Ma	0.25-0
Dia	Minimum Temperature ° F (°C)	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 4D min %	Reduction of Area min %	Hardness max		
2 1/2" and under	1200(650)	125(860)	105(725)	18	50	321HB or 35 HRC		
over 2 1/2" to 4"	1200(650)	110(760)	95(655)	17	45	302HB or 33 HRC		
over 4" to 7"	1200(650)	100(690)	85(586)	16	45	227HB or 29 HRC		

**ASTM A193 B5 (5% Cr AISI 501)**

C	Mn	P	S	Si	Cr	Mo
0.10 max	1.00 max	0.040 max	0.030 Max	1.0 Max	4.00 - 6.00	0.40 -0.65
Dia	Minimum Tempering Temperature ° F (°C)	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
up to 4" incl	1.100 (593 )	100(690)	80(550)	16	50	-

**ASTM A193 B8 (AISI 304) B8A Chemical Requirements**

C	Mn	P	S	Si	Cr	Ni
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	18.00 - 20.00	8.00 -10.50

**ASTM A193 B8C (AISI 347) B8CA**

C	Mn	P	S	Si	Cr	Ni	Columbium + Tantalum
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00 - 19.00	9.00 -13.00	10 x Carbon content, min



**ASTM A193 B8N (AISI 304N) B8NA**

C	Mn	P	S	Si	Cr	Ni	Nitrogen
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	18.00 - 20.00	8.00 - 10.50	0.10 - 0.16

**ASTM A193 B8MN (AISI 316N) B8MNA**

C	Mn	P	S	Si	Cr	Ni	Mo	Nitrogen
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	16.00 - 18.00	10.00 - 14.00	2.00 - 3.00	0.10 - 0.16

**ASTM A193 B8P (AISI 305) B8PA**

C	Mn	P	S	Si	Cr	Ni
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00 - 19.00	10.50 - 13.00

**ASTM A193 B8T (AISI 321) B8TA**

C	Mn	P	S	Si	Cr	Ni	Titanium
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00 - 19.00	9.00 - 12.00	5 x Carbon content, min

**ASTM A193 B8R B8RA**

C	Mn	P	S	Si	Cr	Ni	Mo	Nitrogen	Columbium Tantalum	V
0.06 Max	4.00 - 6.00	0.040 Max	0.030 Max	1.00 Max	20.50 - 23.50	11.50 - 13.50	1.50 - 3.00	0.20 - 0.40	0.10 - 0.30	0.10 - 0.30

**ASTM A193 B8S B8SA**

C	Mn	P	S	Si	Cr	Ni	Nitrogen
0.10 Max	7.00 - 9.00	0.040 Max	0.030 Max	3.50 - 4.50	16.00 - 18.00	8.00 - 9.00	0.08 - 0.18

**ASTM A193 B8LN, B8LNA**

C	Mn	P	S	Si	Cr	Ni	Mo	Nitrogen
0.030 Max	2.00	0.045 Max	0.030 Max	1.00	18.00 - 20.00	8.00 - 10.50	-	0.10 - 0.16

**B8MLN, B8MLNA**

C	Mn	P	S	Si	Cr	Ni	Mo	Nitrogen
0.030 Max	2.00	0.045 Max	0.030 Max	1.00	16.00 - 18.00	10.00 - 14.00	2.00 - 3.00	0.10 - 0.16



**CLASS I: B8, B8C, B8M, B8P, B8T, B8LN, B8MLN Mechanical Requirements**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treat	75(515)	30(205)	30	50	223 HB or 96HR (3/4" in & smaller, 241HB or 100 HRB)

**CLASS IA: B8A, B8CA, B8MA, B8PA, B8TA, B8LNA, B8MLNA, B8NA, B8MN4**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treated in the finished conditions	75(515)	30(205)	30	50	192 HB or 90HRB

**CLASS IB: B8N, B8MN**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treat	80(550)	35(240)	30	40	223 HB or 96HR (3/4" in & smaller, 241 or 100 HRB)

**CLASS IC: B8R**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treat	100(690)	55(380)	35	55	271 HB or 28 HRC

**CLASS IC: B8RA**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treated in the finished conditions	100(690)	55(380)	35	55	271 HB or 28 HRC



**CLASS IC: B8S**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treated	95(655)	50(345)	35	55	271 HB or 28 HRC

**CLASS IC: B8SA**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
All diameters	Carbide Solution Treated in the finished condition	95(655)	50(345)	35	55	271 HB or 28 HRC

**CLASS 2: B8, B8C, B8P, B8T, B8N**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ks (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
3/4" & under	Carbide Solution Treated and Strain Hardened	125(860)	100(690)	12	35	321 HB or 35 HRC
over 3/4" & 1" in		115(795)	80(550)	15	35	
over 1" & 1 1/4" in		105(725)	65(450)	20	35	
1 1/4" to 1 1/2" in		100(690)	50(345)	28	45	

**CLASS 2: B8MN / B8M**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
3/4" & under	Carbide Solution Treated and Strain Hardened	110(760)	95(655)	15	45	321 HB or 35 HRC
over 3/4" & 1" in		100(690)	80(550)	20	45	
over 1" & 1 1/4" in		95(655)	65(450)	25	45	
1 1/4" to 1 1/2" in		95(655)	75(515)	25	40	



**CLASS 2B: B8M2**

Dia	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness°max
2" & under	Carbide Solution Treated and strain Hardened	95(655)	75(515)	25	40	321 HB or 35 HRC
over 2" & 2 1/2" in		90(620)	65(450)	30	40	
over 2 1/2" to 3" in		80(550)	55(380)	30	40	

**Low-Temperature Alloy Steel Bolt Material** Chemical & Mechanical Requirements

**ASTM A320-L7 (Cr- Mo AISI 4140,4142,4145 )**

This material is considered as the most suitable for bolts to be used at temperature 0-(-)100 ° C, The chemical properties and physical characteristics are as follows:

C	Mn	P	S	Si	Cr	Mo	Impact Energy Absorption Requirements	
0.38-0.48	0.75-1.00	0.035 Max	0.04 Max	0.15-0.35	0.80-1.10	0.15-0.25	Minimum Impact Value	Minimum Impact Value
Dia	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max		Required for Average of Each set of three specimens ft lbf [J]	Permitted for Specimen only of a set ft lbf [J]
2 1/2" and under	125 ( 860 )	105 ( 725 )	16	50	277-321HB for reference		20[27]	15[20]



**ASTM A 320 L7M**

Dia.	Heat Treatment	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Reduction of Area min %	Hardness max
2 1/2" and under	Quenched and tempered at 1,150 ° F (620 ° C) min	100(690)	80(550)	18	50	235HB or 99HRB

**ASTM A320 B8 (18Cr-8Ni AISI 304)**

This material is considered as the most suitable for bolts and nuts to be used at temperatures (-)100-(-)200 ° C The chemical properties are as follows:

C	Mn	P	S	Si	Cr	Ni	
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	18.00-20.00	8.00-10.50	

**ASTM A320 B8M**

C	Mn	P	S	Si	Cr	Ni	Mo
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	16.00-18.00	10.00-14.00	2.00-3.00

**ASTM A320 B8C**

C	Mn	P	S	Si	Cr	Ni	Columbium + Tantalum
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00-19.00	9.00-13.00	10 * Carbon content, min

**ASTM A320 B8T**

C	Mn	P	S	Si	Cr	Ni	Titanium
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00-19.00	9.00-12.00	5 * Carbon content, min



## Super High Temperature Resistant Bolt Material Chemical & Mechanical Requirements

This material is considered as suitable for bolts to be used as temperature below 1,200 ° F (650 ° C) and the material has superior resistance to oxidation and shrinkage to those high temperature resistant bolt material mentioned so far. The chemical properties and physical characteristics are as follows:

### ASTM A453 Gr. 660

C	Mn	P	S	Si	Cr
0.08 Max	2.00 Max	0.040 Max	0.030 Max	1.00 Max	24.00-27.00
Cr	Mo	Ti	Al	V	Boron
13.50-16.00	1.00-1.50	1.90-2.35	0.35 Max	0.10-0.50	0.0010 - 0.010
CLASS	Tensile Strength min, ks (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 4x Dia. min, %	Reduction of Area min, %	Brinell Hardness Number
A,B and C	130(895)	85(585)	15	18	248-341 (min 99HRB, max 37HRC)

### ASTM A453 Gr. 651

C	Mn	P	S	Si	Cr
0.28 - 0.35	0.75 -1.50	max 0.040	max 0.030	0.30 - 0.80	8.00-11.00
Cr	Mo	Ti	W	Cb	Cu
18.00-21.00	1.00-1.75	0.10 - 0.35	1.00 - 1.75	0.25 - 0.60	max 0.50
CLASS	Tensile Strength min, ks (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 4x Dia min, %	Reduction of Area min, %	Brinell Hardness Number
A ( 3" and under)	100(690)	70(485)	18	35	217-277 (min 95HRB, max 28HRC)
A (over 3")		60(415)			
B ( 3" and under)	95(655)	60(415)	18	35	217-277 (min 95HRB, max 28HRC)
B (over 3")		50(345)			





**ASTM B408 (800,800H)**

Ni	Cr	Fe	Mu	C	Cu	Si	S	Al	Ti
30.0 - 35.0	19.0 - 23.0	*39.5 min	1.5 Max	0.10 Max	0.75 Max	1.0 Max	0.015 Max	0.15 - 0.60	0.15 - 0.60

\* = Iron shall be determined arithmetically by difference

CLASS	CONDITION	Tensile Strength min, ksi (MPa)	Yield Strength. min, Ksi (MPa)	Elongation in % min
800	(all sizes) Hot finished rods and bars	80(550)	35(240)	25
	(all sizes) Cold drawn and (annealed) Hot finished rods and bars	75(520)	30(205)	30
800H	(all sizes) Cold drawn and (annealed) Hot finished rods and bars	65(450)	25(170)	30

**HASTALLOY C/ASME SB336,UNS N10002**

Class	Ni	Co	Cr	Mo	W	Fe	Si	Mn	C
C	Balance	< 2.5	16	16	4	5	< 1.00	< 1.00	< 0.08

**Monel K-500**

Ni	C	Mn	Fe	S	Si	Cu	Al	Ti
63 - 70	0.25 Max	1.50 Max	2.00 Max	0.01 Max	0.5 Max	balance	2.3 - 3.15	0.35 - 0.85

**Monel 400**

Ni	C	Mn	Fe	S	Si	Cu
63 - 70	0.30 Max	2.0 Max	2.5 Max	0.024 Max	0.050 Max	balance



## Nut Material Chemical & Mechanical Requirements

### ASTM A194 Gr.2H

This is the material for bolts made from ASTM A-193 B7, considered to be used with suitable heat treatment. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Brinell Hardness	Rockwell Hardness
0.40 Min	1.00 Max	0.040 Max	0.050 Max	0.40 Max	To 11/2" incl 248 to 352	24 to 38 HRC
					Over 11/2", 212 to 352	38 HRC Max

### ASTM A194 Gr.2HM

C	Mn	P	S	Si	Brinell Hardness	Rockwell Hardness
0.40 Min	1.00 Max	0.040 Max	0.050 Max	0.40 Max	159 to 237	22 HRC Max

### ASTM A194 Gr.4

This material is considered as the most suitable for nuts, when they are used with bolts made from ASTM A-193 B16 and A-320 L7. Even at high temperature range. Then material has superior physical characteristics to those ASTM A-194 2H previously mentioned. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Mo	Brinell Hardness	Rockwell Hardness
0.40 - 0.50	0.70 - 0.90	0.035 Max	0.04 Max	0.15 - 0.35	0.20 - 0.30	248 to 352	24 to 38 HRC

### ASTM A194 Gr. 8 (AISI 304)

This is nut material for bolts made from ASTM A-193 B8, considered to be used with suitable heat treatment. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Cr	Ni	Brinell Hardness	Rockwell Hardness
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	18.00 - 20.00	8.00 - 10.50	126 to 300	60 to 105 HRB

### ASTM A194 Gr. 8M (AISI 316)

This is nut material for bolts made from ASTM A-193 B8M and A-320 B8M, considered to be used with suitable heat treatment. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Cr	Ni	Mo	Brinell Hardness	Rockwell Hardness
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	16.00 - 18.00	10.00 - 14.00	2.00 - 3.00	126 to 300	60 to 105 HRB

**ASTM A194 Gr. 8C (AISI 347)**

This is nut material for bolts made from ASTM A-193 B8C, A-320 B8C and A-320 B8T, considered to be used with suitable heat treatment. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Cr	Ni	Cb + Ta	Brinell Hardness	Rockwell Hardness
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00 - 19.00	9.00 - 13.00	10 * C% min	126 to 300	60 to 105 HRB

**ASTM A194 Gr. 8T (AISI 321)**

This is nut material for bolts made from ASTM A-193 B8T and A-320 B8T, considered to be used with suitable heat treatment. The chemical properties and physical characteristics are as follows :

C	Mn	P	S	Si	Cr	Ni	Ti	Brinell Hardness	Rockwell Hardness
0.08 Max	2.00 Max	0.045 Max	0.030 Max	1.00 Max	17.00 - 19.00	9.00 - 12.00	5 C% min	126 to 300	60 to 105 HRB

**ASTM A307**

This material is suitable in structural application where nominal strength along with weldability is required.

Grade	P	S	Tensile Strength min, ksi (MPa)	Yield Strength. min, 0.2% offset, Ksi (MPa)	Elongation in 2" min %	Hardness max
A	0.06 Max	0.15 Max	60 (415)	-	18	121 - 241 BHN
B	0.04 Max	0.05 Max	60 - 100 (415 - 690)	-	18	121 - 212 BHN
C	-	-	58 - 80 (400 - 550)	36(50)	23	Not Required

**ASTM A563**

This specification of material is used for manufacturing nuts for bolts/studs made from ASTM A307

Grade	C	Mn (Max)	P (Max)	S (Max)
O,A,B,C	0.58 Max	-	0.13	-
D	0.58 Max	0.27	0.048	0.058
DH	0.18-0.58	0.57	0.048	0.058



Grade	Hardness Required
O	103 to 302 BHN
A	116 to 302 BHN
B	90 to 121 BHN
C	143 to 352 BHN
D	159 to 352 BHN
DH	248 to 352 BHN

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