



## BRODER METALS GROUP Alloy 286/660

Amongst our nickel alloy core grades and our high temperature steel bolting grades is Alloy 286, also known as 660.

Alloy 286 is a precipitation hardened austenitic iron based steel, suitable for applications requiring high strength, good corrosion resistance at temperatures up to 700 degree C, and a high degree of uniformity in developing full strength.

Broder Metals Group supply Alloy 286 air melt material to ASTM A453 GR 660 (High Temperature Bolting) and UNS S66286.

Our product conforms to the Alloy 660 grade D specification (with a guaranteed yield strength minimum of 105,000 PSI), but with stress rupture tests carried out to also conform to 660 grade A. These provide a tensile strength of 895 MPa (minimum), 0.2% offset yield strength of 725 MPa (minimum), elongation of 15% and reduction of area of 18%. Hardness is in the range 29-35 HRC.

Although best known for the above grades we also supply ASTM A453 GR 660 heat treated and tested to conform to grade B. This provides a tensile strength of 895 MPa (minimum), a lower 0.2 offset yield strength of 585 MPa (minimum), elongation of 15% and reduction of area of 18%. Hardness is in the range 24-37 HRC. Stress rupture tests are performed on the material as standard.

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Alloy 286 can be used in a wide range of high temperature applications –fasteners, turbines, critical frames in high stress / heat applications, castings and fasteners.

### Alloy 286 Chemical Analysis

	C	Mn	Si	P	S	Cr	Ni	Mo	Ti	Ai	V	B	
Min	-	-	-	-	-	13.5	24.0	1.00	1.90	-	0.10	0.0001	%
Max	0.08	2.00	1.00	0.040	0.030	16.0	27.0	1.50	2.35	0.35	0.50	0.01	%
Var	+0.01	+/- 0.04	+/- 0.05	+ 0.005	+/- 0.005	+/- 0.20	+/- 0.20	+/- 0.05	+/- 0.05	+/- 0.05	+/- 0.03	- 0.0004 +0.001	%

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# BRODER METALS GROUP Alloy 286/660

We stock the following sizes:

12.7 mm	15.87 mm	19.05 mm	22.23 mm	25.4 mm
28.575 mm	31.75 mm	34.93 mm	38.1 mm	41.275 mm
44.45 mm	47.625 mm	50.8 mm	57.15 mm	63.5 mm
69.85 mm	76.2 mm	88.9 mm	101.6 mm	127 mm

However, we can also convert billet to customer specific sizes, or to fill in gaps between mill deliveries. Please enquire.

## Alloy 286 Heat Treatment

Temperature monitoring methods:

- > Solution Treatment: heat sink or contact thermocouples
- > Hardening: furnace and/or contact thermocouple or heat sink thermocouple

Grade 660 Class	Solution Treatment			
	Temp deg F	Temp deg C	Hold for	Cooling Method
A and D	1650 +/- 25	900 +/- 14	2 hours min to 3 hours max	Liquid Quench
B	1800 +/- 25	980 +/- 14	1 hour min	Liquid Quench
C	1800 +/- 25	980 +/- 14	2 hours min	Oil Quench

## Alloy 286 Mechanical Properties

Grade 660 Class	Hardening Treatment			
	Temp deg F	Temp deg C	Hold for	Cooling Method
A and D*	1325 +/-25	720 +/- 14	16 hours	Air Cool
B	1325 +/-25	720 +/- 14	16 hours	Air Cool
C	1425 +/-25	775 +/- 14	16 hours	Air Cool
	1200 +/- 25	650 +/- 14	16 hours	Air Cool

Hardening -: furnace and/or contact thermocouple or heat sink thermocouple. Grade D – if necessary to achieve properties, second age @ 1200 +/- Deg F (650 +/- 14 Deg C), hold 16 hours, air cool.

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**Tensile Properties – As per specification of ASTM A 453 / A 453M – 08**

Gr 660 Class	Tensile Strength, min		Yield Strength (0.2% offset) min		Elongation in 4X Dia min %	Reduction in Area Min %
	Ksi	Mpa	Ksi	Mpa		
-					-	-
A and D	130	895	105	725	15	18
B and C	130	895	85	585	15	18

**Stress Rupture Test\* - As per specification of ASTM A 453 / A 453M – 08,**

Gr 660 Class	Temperature		Stress min		Time to rupture	Elongation
	Deg F	Deg C	Ksi	MPa		
-					Min h	Min %
A,B,C,D	1200	650	56	385	100	5

Under ASTM A453 / A453M – 08 does not require a stress rupture test for Class D

**Hardness Test - As per specification of ASTM A 453 / A 453M – 08**

Gr 660 Class	Brinell Hardness Number	Approx Rockwell Hardness	
		Min	Max
-	-		
A,D	248-321	29 HRC	35 HRC
B,C	248-341	24 HRC	37 HRC

Alloy 286 is just one of a range of corrosion resistant materials stocked by Broder Metals Group Ltd – please see our website for the full range stocked: [www.broder-metals-group.com](http://www.broder-metals-group.com)

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