

ASTM B637 / ASME SB637

SPECIFICATION FOR PRECIPITATION-HARDENING NICKEL ALLOY BARS, FORGINGS, AND FORGING STOCK FOR HIGH-TEMPERATURE SERVICE

This specification covers hot- and cold-worked precipitation-hardenable nickel alloy rod, bar, forgings, and forging stock for high-temperature service.

A. Chemical Composition :-

The material shall conform to the requirements as to chemical composition prescribed in Table 1.

Table 1

Element	UNS N07252 (Formerly Grade 689)	UNS N07001 (Formerly Grade 685)	UNS N07718 (Formerly Grade 718)	UNS N07080 (Formerly Grade 80A)
Carbon	0.10–0.20	0.03–0.10	0.08 max	0.10 max
Manganese	0.50 max	1.00 max	0.35 max	1.00 max
Silicon	0.50 max	0.75 max	0.35 max	1.00 max
Phosphorus	0.015 max	0.030 max	0.015 max	...
Sulfur	0.015 max	0.030 max	0.015 max	0.015 max
Chromium	18.00–20.00	18.00–21.00	17.0–21.0	18.00–21.00
Cobalt ^B	9.00–11.00	12.00–15.00	1.0 max	...
Molybdenum	9.00–10.50	3.50–5.00	2.80–3.30	...
Columbium (Nb) + tantalum	...	...	4.75–5.50	...
Titanium	2.25–2.75	2.75–3.25	0.65–1.15	1.80–2.70
Aluminum	s	1.20–1.60	0.20–0.80	0.50–1.80
Zirconium	...	0.02–0.12	...	...
Boron	0.003–0.01	0.003–0.01	0.006 max	...
Iron	5.00 max	2.00 max	Remainder ^A	3.00 max
Copper	...	0.50 max	0.30 max	...
Nickel	Remainder ^A	Remainder ^A	50.0–55.0	Remainder ^A

Element	UNS N07500 (Formerly Grade 684)	UNS N07750 (Formerly Grade 688)	UNS N07752
Carbon	0.15 max	0.08 max	0.020–0.060
Manganese	0.75 max	1.00 max	1.00 max
Silicon	0.75 max	0.50 max	0.50 max
Phosphorus	0.015 max	...	0.008 max
Sulfur	0.015 max	0.01 max	0.003 max
Chromium	15.00–20.00	14.00–17.00	14.50–17.00
Cobalt	13.00–20.00	1.00 max ^B	0.050 max
Molybdenum	3.00–5.00	...	...
Columbium(Nb)+tantalum	...	0.70–1.20	0.70–1.20
Titanium	2.50–3.25	2.25–2.75	2.25–2.75
Aluminum	2.50–3.25	0.40–1.00	0.40–1.00
Boron	0.003–0.01...	0.007 max	
iron	4.00 max	5.00–9.00	5.00–9.00
Copper	0.15 max	0.50 max	0.50 max
Zirconium	...	...	0.050 max
Vanadium	...	...	0.10 max
Nickel	Remainder ^A	70 min	70 min

^A The element shall be determined arithmetically by difference.

^B If determined.

B. Mechanical Properties :-

1. Unless otherwise specified, the material shall be supplied in the solution treated condition, suitable for subsequent age hardening.
2. The solution treated material shall be capable of meeting the mechanical property requirements of Table 3, and the stress rupture requirements of Table 4, following the precipitation hardening treatment described in Table 2.

3. When the material is to be supplied in the solution treated plus aged condition, the requirements of Table 3 and Table 4 shall apply, with the precipitation hardening treatment of Table 2, or as agreed upon between the purchaser and the manufacturer as part of the purchase contract.

Table 2: Heat Treatment^A

Alloy	Recommended Annealing Treatment	Recommended Solution Treatment	Recommended Stabilizing Treatment	Precipitation Hardening Treatment
N07252	...	1950 ± 25°F (1066 ± 14°C) , hold 4 h, air cool	...	1400 ± 25°F (760 ± 14°C) , hold 15 h, air cool or furnace cool
N07001	...	1825 to 1900°F (996 to 1038°C) , hold 4 h, oil or water quench	1550 ± 25°F (843 ± 14°C), hold 4 h, air cool	1400 ± 25°F (760 ± 14°C) , hold 16 h, air cool or furnace cool
N07500	2150 ± 25°F (1177 ± 14°C) , hold 2 h, air cool (bars only)	1975 ± 25°F (1080 ± 14°C) , hold 4 h, air cool	1550 ± 25°F (843 ± 14°C), hold 24 h, air cool	1400 ± 25°F (760 ± 14°C) , hold 16 h, air cool or furnace cool
N07750 Type 1 (Service above 1100°F) (593°C)	...	2100 ± 25°F (1149 ± 14°C) , hold 2 to 4 h, air cool	1550 ± 25°F (843 ± 14°C), hold 24 h, air cool	1300 ± 25°F (704 ± 14°C) , hold 20 h, air cool or furnace cool
N07750 Type 2 (Service up to 1100°F) (593°C)	...	1800 ± 25°F (982 ± 14°C) , hold 1/2 h min, cool at rate equivalent to air cool or faster	...	1350 ± 25°F (732 ± 14°C) , hold 8 h, furnace cool to 1150 ± 25°F (621 ± 14°C) , hold until total precipitation heat treatment has reached 18 h, air cool
N07750 Type 3	...	1975–2050°F (1079–1121°C) , hold 1 to 2 h, air cool	...	1300 ± 25°F (704 ± 14°C) , hold 20 h, + 4 – 0 h, air cool
N07752 Type 1	...	1975 ± 25°F (1080 ± 14°C) , hold 1 to 2 h, cool by water or oil quenching	...	1320 ± 25°F (715 ± 14°C) , hold 20 h, + 2 – 0 h, air cool
N07752 Type 2	...	1975 ± 25°F (1080 ± 14°C) , hold 1 to 2 h, cool by water or oil quenching	...	1400 ± 25°F (760 ± 14°C) , hold 100 h, + 4 – 0 h, air cool
N07718	...	1700 to 1850°F (924 to 1010°C) , hold 1/2 h min, cool at rate equivalent to air cool or faster	...	1325 ± 25°F (718 ± 14°C) , hold at temperature for 8 h, furnace cool to 1150 ± 25°F (621 ± 14°C) , hold until total precipitation heat treatment time has reached 18 h, air cool
N07080	...	1950 ± 25°F (1066 ± 14°C) , hold 8 h, air cool	1560 ± 25°F (849 ± 14°C), hold 24 h, air cool	1290 ± 25°F (699 ± 14°C) , hold 16 h, air cool

^A The purchaser shall designate on the purchase order or inquiry any partial stage of heat treatment required on material to be shipped.

Table 3: Tensile And Hardness Requirements^A

Alloy	Heat Treatment	Tensile Strength, min, psi (MPa)	Yield Strength (0.2% offset) min, psi (MPa)	Elongation in 2 in. (50 mm) or 4D, min, %	Reduction of Area, min, %	Brinell Hardness
N07252	solution + precipitation harden	160000 (1100)	90000 (620)	20	18	310 min
N07001	solution + stabilize + precipitation harden	160000 (1100)	110000 (760)	15 ^B	18 ^B	310 min
N07500 (rod and bar)	anneal + solution + stabilize + precipitation harden	175000 (1205)	105000 (725)	15	15	310 min
N07500 (forgings)	solution + stabilize + precipitation harden	170000 (1170)	100000 (690)	20	18	310 min
N07750 Type 1	solution at 2100°F (1149°C) + stabilize + precipitation harden	140000 (965)	90000 (620)	8	...	262 min
N07750 Type 2 ^C	solution at 1800°F (982°C) + precipitation harden	170000 (1170)	115000 (790)	18	18	302 to 363
N07750 Type 2 ^D	solution at 1800°F (982°C) + precipitation harden	170000 (1170)	115000 (790)	15 (10) ^E	15 (12) ^E	302 to 363
N07750 Type 3	solution anneal at 2000°F (1093°C) + precipitation harden	160000 (1103), min	100000 (689), min	20	20	267–363, Bm
		185000 (1276), max	130000 (896), max			27–40, Rc
N07752 Type 1	solution anneal at 1975°F (1080°C) + precipitation harden	160000 (1103), min	100000 (689), min	20	20	267–363, Ba
		185000 (1276), max	130000 (896), max			27–40, Rc
N07752 Type 2	solution anneal at 1975°F (1080°C) + precipitation harden	140000 (965)	85000 (585)	20	20	...
N07718	solution + precipitation harden	185000 (1275)	150000 (1034)	12 (6) ^E	15 (8) ^E	331 min
N07080	solution + stabilize + precipitation harden	135000 (930)	90000 (620)	20	...	...

^A The supplier shall demonstrate that the material will meet fully heat-treated properties after full heat treatment in accordance with Table 2.

^B Forgings.

^C Up to 2.50 in. (63.5 mm), exclusive.

^D 2.50 to 4.00 in. (63.5 to 101.6 mm), exclusive.

^E These values apply for tension specimens machined tangentially from near the center of large disk forgings over 50 in.2 (1270 mm²) in cross section or radially from rings 3 in. (76.2 mm) or more in thickness.

Table 4: Stress-Rupture Requirements^A

Alloy	Heat Treatment	Test Temperature, °F (°C)	Stress, psi (MPa) ^B	Minimum Hours	Elongation in 2 in. or 50 mm (or 4D), min, %
N07252	solution + precipitation harden	1500 (816)	30 000 (205)	100	10
N07001	solution + stabilize + precipitation harden	1500 (816)	33 000 (230)	100	5
N07500 (rod and bar)	anneal+ solution + stabilize + precipitation harden	1500 (816)	38 000 (260)	100	5
N07500 (forgings)	solution + stabilize + precipitation harden	1500 (816)	38 000 (260)	100	5
N07750 Type 1	solution at 2100°F (1149°C) + stabilize + precipitation harden	1350 (732)	45 000 (310)	100	5 (3 if hours exceed 136)
N07718	solution + precipitation harden	1200 (649)	100 000 (690)	23	5
N07080	solution + stabilize + precipitation harden	1400 (760)	47 000 (325)	23	3.5

^A The supplier shall demonstrate that the material will meet fully heat-treated properties after full heat treatment in accordance with Table 2.

^B Test specimens meeting minimum requirements may be overloaded to produce rupture in a reasonable and practical time period.

C. Cut Lengths :-

1. A specified length to which all rod and bar will be cut with a permissible variation of +1/8 in. [3.18 mm] , -0 for sizes 8 in. [203 mm] and less in diameter or the distance between parallel surfaces.
2. For larger sizes, the permissible variation shall be +1/4 in. (6.35 mm), -0.

D. Test Methods :-

Determine the chemical composition and mechanical and other properties of the material as enumerated in this specification, in case of disagreement, in accordance with the following methods:

<u>Test</u>	<u>ASTM Designation</u>
Chemical analysis	E 1473
Tension	E 8
Rounding procedure	E 29
Stress-rupture	E 139

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