

ASTM F2281 Heat-Resisting and High-Temperature Bolts, Cap Screws and Studs — Material Data Sheet

ASTM F2281 — Bolts, Cap Screws, Studs — Stainless (304, 316, 321, 347, 309, 310, 330, 410, 416, 431, 430) and nickel alloys (600, 601, 660, 718)
Commercial stainless and nickel-alloy bolting for elevated temperature

The commercial high-temperature bolting specification: stainless and nickel-alloy bolts, cap screws and studs for heat-resisting service, from annealed 304 at 75 ksi to aged 718 at 185 ksi, with elevated-temperature properties as a supplementary requirement.

304 / 316, CONDITION A	75 ksi tensile · 30 ksi yield	660 (A-286), AH1–AH3	130 ksi · 85 ksi
410 / 416, CONDITION HT	160 ksi · 120 ksi	718, AH4	185 ksi · 150 ksi
431, CONDITION HT	180 ksi · 140 ksi	HIGH-TEMPERATURE TESTING	Supplementary requirement S8

Nominal composition

■ Fe balance ~ 40.0%	■ 72.0 min ~ 37.00%	■ 14.0–17.0 ~ 15.25%	■ — ~ 2.38%	■ — ~ 1.90%	■ — ~ 1.27%	■ 1.00 ~ 1.18%
■ 0.50 ~ 0.68%	■ 0.10, — trace					

Midpoints of the specification ranges, for orientation only. Limits are in the table.

Chemical composition — ASTM F2281 Type III nickel alloys 600, 660 and 718

Element	600	660 (A-286)	718
Carbon, max	0.10	0.08	0.08
Manganese, max	1.00	2.00	0.35
Silicon, max	0.50	1.00	0.35
Chromium	14.0–17.0	13.5–16.0	17.0–21.0
Nickel	72.0 min	24.0–27.0	50.0–55.0
Molybdenum	—	1.00–1.75	2.80–3.30
Titanium	—	1.90–2.30	0.65–1.15
Aluminium	—	0.35 max	0.20–0.80
Niobium + tantalum	—	—	4.75–5.50
Iron	6.0–10.0	balance	balance

Values per ASTM F2281-04 Table 1 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team. The stainless grades match their A276 compositions and are listed in the same table.

Physical properties (typical)

DENSITY	0.28 to 0.30 lb/in ³ by alloy
MODULUS OF ELASTICITY	28 to 31 × 10 ⁶ psi by alloy
MAGNETIC	Austenitic and nickel grades no; martensitic and ferritic grades yes
SERVICE	Per alloy; elevated-temperature properties under S8

Heat treatment

Austenitic and nickel grades: solution annealed (A), cold worked and annealed (CWA) or hot worked and annealed (HWA). Martensitic: hardened at 1800 to 1900 °F and tempered at 1050 °F minimum (H) or 525 °F minimum (HT). 660: solution treated and aged per AH1, AH2 or AH3. 718: solution treated 1725 to 1850 °F and double aged at 1325 and 1150 °F (AH4).

Mechanical properties at room temperature — ASTM F2281 (full-size tests)

Alloy · condition · marking	Tensile strength, min (ksi)	Yield strength, min (ksi)	Elongation, min (% machined specimen)	Hardness	—
304, 316 · A, CWA, HWA · F1A–F1F	75	30	30	65–95 HRB	
410, 416 · H · F1G	110	85	15	20–30 HRC	
410, 416 · HT · F1H	160	120	12	34–45 HRC	
431 · H · F1I	125	100	15	25–32 HRC	
431 · HT · F1J	180	140	10	40–48 HRC	
430 · A · F1K	55	30	—	65–95 HRB	
309, 310, 321, 347, 330 · A · F2A, F2D, F2G	75	30	30	85–95 HRB	
309, 310, 321, 347, 330 · CWA, HWA · F2B, F2C, F2E, F2F, F2H, F2I	75	30	30 (20 for CWA of 321, 347, 330)	65–95 HRB	
600, 601 · A · F3A–F3C	80	25	35	65–85 HRB	
660 · AH1, AH2, AH3 · F3D–F3F	130	85	15	22–37 HRC	
718 · AH4 · F3G	185	150	12	36–48 HRC	

Values per ASTM F2281-04 Table 2 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team.

Applicable standards

ASTM F2281	Stainless steel and nickel alloy bolts, hex cap screws and studs for heat resistance and high-temperature applications
ASTM F2281 S8	Elevated-temperature mechanical property testing
ASTM A193 / A453	Pressure-code equivalents for the same alloys
ASTM F2282 / F467	Matching nuts

Forms we supply in F2281

- Hex and heavy hex bolts and cap screws
- Studs and threaded rod
- Nuts and washers to match
- Machined specials to drawing

Typical applications

- Furnace, kiln and heat-treatment fixtures
- Exhaust, turbocharger and flue hardware
- Boiler and burner assemblies outside the pressure boundary
- Gas-turbine ground equipment
- Process equipment running hot in corrosive atmospheres