

ASTM A453 Grade 660 (A-286) — Material Data Sheet

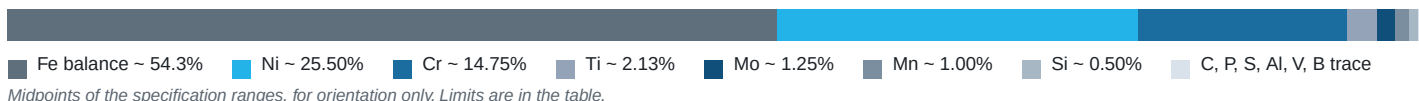
ASTM A453 / ASME SA-453 · UNS S66286 · A-286 (Incoloy® alloy A-286)

Precipitation-hardening iron-nickel-chromium superalloy bolting, solution treated and aged (Classes A, B, C, D)

A-286 bolting for the hottest joints — 130 ksi at room temperature and rated by stress-rupture at 1200 °F, for gas and steam turbines, exhaust and high-temperature process equipment.

TENSILE, CLASSES A–D (≤2½ IN.)	130 ksi min (Class D over 2½ in.: 120)	STRESS RUPTURE (A, B, C)	56 ksi at 1200 °F, 100 h min
YIELD, CLASSES A–C / D	85 / 105 ksi min (≤2½ in.)	COMPANION NUT	A453 660 (same grade)
HARDNESS	24–37 HRC (A, B, C) · 24–35 HRC (D)	TYPICAL SERVICE	Up to 1300 °F

Nominal composition



Chemical composition — ASTM A453 Grade 660 (A-286, UNS S66286)

Element	Symbol	Min %	Max %
Carbon	C	—	0.08
Manganese	Mn	—	2.00
Phosphorus	P	—	0.040
Sulfur	S	—	0.030
Silicon	Si	—	1.00
Nickel	Ni	24.0	27.0
Chromium	Cr	13.5	16.0
Molybdenum	Mo	1.00	1.50
Titanium	Ti	1.90	2.35
Aluminum	Al	—	0.35
Vanadium	V	0.10	0.50
Boron	B	0.001	0.010

Values per ASTM A453/A453M-17 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team.

Physical properties (typical)

DENSITY	0.287 lb/in³ (7.94 g/cm³)
MODULUS OF ELASTICITY	29.1 × 10 ⁶ psi (201 GPa)
THERMAL EXPANSION (70–1000 °F)	9.7 µin/in·°F
MAGNETIC	No

Heat treatment

Solution treated and precipitation hardened per the class ordered (see table). Hardness is checked after aging; stress-rupture specimens are tested per heat-treat lot.

Mechanical properties at room temperature — ASTM A453 Grade 660

Class and size	Tensile strength, min (ksi)	Yield strength 0.2% offset, min (ksi)	Elongation in 4D, min (%)	Reduction of area, min (%)	Hardness
Class A — all sizes	130	85	15	18	248–341 HBW / 24–37 HRC
Class B — all sizes	130	85	15	18	248–341 HBW / 24–37 HRC
Class C — all sizes	130	85	15	18	248–341 HBW / 24–37 HRC
Class D — 2½ and under	130	105	15	18	248–321 HBW / 24–35 HRC
Class D — over 2½	120	95	15	18	248–321 HBW / 24–35 HRC

Values per ASTM A453/A453M-17 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team.

Stress-rupture requirements — ASTM A453 Grade 660 Classes A, B and C (not required for Class D)

Test temperature	Stress (ksi)	Time to rupture, min (h)	Elongation, min (%)
1200 °F (650 °C)	56	100	5

Values per ASTM A453/A453M-17 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team.

Heat treatment by class — ASTM A453 Grade 660

Class	Solution treatment	Precipitation (aging) treatment
A	1650 ± 25 °F (900 °C), 2 h min, liquid quench	1325 ± 25 °F (720 °C), 16 h, air cool
B	1800 ± 25 °F (980 °C), 1 h min, liquid quench	1325 ± 25 °F (720 °C), 16 h, air cool
C	1800 ± 25 °F (980 °C), 1 h min, oil quench	1425 ± 25 °F (775 °C), 16 h, air cool, then 1200 ± 25 °F (650 °C), 16 h, air cool
D	1650 ± 25 °F (900 °C), 2 h min, or 1800 ± 25 °F (980 °C), 1 h min; liquid quench	1325 ± 25 °F (720 °C), 16 h, air cool; second age 1200 ± 25 °F (650 °C), 16 h, if needed for properties

Per ASTM A453/A453M-17 Table 4. The certified heat-treat record travels with every lot.

Applicable standards

ASTM A453 / ASME SA-453	High-temperature bolting with expansion coefficients comparable to austenitic stainless steels
AMS 5731 / 5732 / 5737	Aerospace A-286 bar and forgings
ASTM A638	Precipitation-hardening iron-base superalloy bars (Grade 660)
ASME B16.5 / B16.47	Flange bolting — stud bolt lengths and quantities

Forms we supply in A453 660

- Full-thread studs and stud bolts
- Hex and 12-point bolts
- Socket head cap screws
- Heavy hex nuts in the same grade
- Machined components from certified bar

Typical applications

- Gas turbine casing, combustor and exhaust bolting
- Steam turbine bolting above the range of B16
- Turbochargers and engine exhaust manifolds
- High-temperature process reactors and furnaces
- Cryogenic-to-1300 °F service where thermal expansion must match stainless