

ASTM A540 Grades B21, B22, B23, B24 Bolting (Pressure Vessel and Nuclear) — Material Data Sheet

ASTM A540 SAME SAMPLES: 108 in. (B21), 108 in. (B22), E4340H (B23), 4340 Mod (B24)

Alloy steel bolting with special impact and hardness classes, 120 to 165 ksi

The pressure-vessel and nuclear bolting specification: four alloy steels in five strength classes from 120 to 165 ksi, with Charpy impact requirements and tight chemistry — the material behind SA-540 B23 Class 2 studs on reactor and compressor closures.

TENSILE, CLASS 5	120 ksi min	CHARPY AT +10 °F	35 / 30 / 25 ft·lbf by class and size
TENSILE, CLASS 3	145 ksi min	SIZES	To 4 in. (B22) · 8 in. (B21) · 9½ in. (B23, B24) · 11 in. (B24V)
TENSILE, CLASS 1	165 ksi min	MATCHING NUT	Same grade, or A194 4 / 7

Nominal composition

■ Fe balance ~ 97.1% ■ — ~ 0.78% ■ 0.80–1.15 ~ 0.70% ■ 0.45–0.70 ~ 0.63% ■ 0.36–0.44, 0.025, 0.025, 0.15–0.35, 0.50–0.65 trace

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

Chemical composition — ASTM A540 Grades B21, B22, B23, B24

Element	B21 (Cr-Mo-V)	B22 (4142H)	B23 (E4340H)	B24 (4340 Mod)
Carbon	0.36–0.44	0.39–0.46	0.37–0.44	0.37–0.44
Manganese	0.45–0.70	0.65–1.10	0.60–0.95	0.70–0.90
Phosphorus, max	0.025	0.025	0.025	0.025
Sulfur, max	0.025	0.025	0.025	0.025
Silicon	0.15–0.35	0.15–0.35	0.15–0.35	0.15–0.35
Chromium	0.80–1.15	0.75–1.20	0.65–0.95	0.70–0.95
Nickel	—	—	1.55–2.00	1.65–2.00
Molybdenum	0.50–0.65	0.15–0.25	0.20–0.30	0.30–0.40
Vanadium	0.25–0.35	—	—	—

Values per ASTM A540/A540M-15 Table 1 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team.

Physical properties (typical)

DENSITY	0.284 lb/in ³ (7.85 g/cm ³)
MODULUS OF ELASTICITY	29.0 × 10 ⁶ psi (200 GPa)
THERMAL EXPANSION (68–212 °F)	6.5 µin/in·°F
MAGNETIC	Yes

Heat treatment

Quenched in liquid and tempered at 850 °F minimum (A540 clause 6.2) after all forming; final machining and threading after heat treatment. Stress relief after straightening at not lower than 100 °F below the tempering temperature (clause 6.3).

Mechanical properties — ASTM A540 Grade B23 by class (representative sizes)

Class and diameter (in.)	Tensile strength, min (ksi)	Yield strength 0.2% offset, min (ksi)	Elongation in 2 in., min (%)	Reduction of area, min (%)	Surface hardness (HBW) · Charpy
Class 5 — to 6	120	105	15	50	248–311 · 35 ft·lbf avg
Class 4 — to 3	135	120	13	45	269–341 · 35 ft·lbf avg
Class 3 — to 3	145	130	12	40	293–363 · 30 ft·lbf avg
Class 2 — to 3	155	140	11	40	311–388 · information only
Class 1 — to 3	165	150	10	35	321–415 · information only

Values per ASTM A540/A540M-15 Table 2 (verified against the specification). Confirm the edition called out on your purchase order with our estimating team. Grades B21, B22 and B24 carry the same class strengths with their own size limits and Charpy notes; see the specification for the full table.

Applicable standards

ASTM A540 / ASME SA-540	Alloy-steel bolting for special applications
ASME SECTION III / VIII	Nuclear and pressure-vessel code use of SA-540
ASTM A194 GRADES 4 AND 7	Alternative nuts where same-grade nuts are not specified
ASTM A370	Tension, hardness and Charpy testing

Forms we supply in A540 B21–B24

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

Typical applications

- Reactor vessel and steam-generator closure studs
- Compressor and pump casing bolting
- Heat-exchanger and pressure-vessel closures
- Turbine and generator coupling bolts
- Large studs where B7 strength and toughness are insufficient