

S7 Shock Resisting Tool Steel – Technical Material Specification

1.0 Material Overview & Common Uses

S7 is a shock-resisting tool steel known for its exceptional toughness and impact resistance, combined with moderate wear resistance and good hardenability. It is air-hardening, which minimizes distortion during heat treatment, and can be heat treated to a hardness range of 48–58 HRC depending on the application. S7 is commonly used in applications subject to high impact and shock loads, such as punches, chisels, shear blades, forging dies, and cold forming tools. It is also used in plastic injection molds and die casting dies where high toughness is required.

2.0 Core Technical Properties & Sizing

- Density: 7.85 g/cm³ (0.284 lb/in³)
- Melting point: Approximately 1425°C (2600°F)
- Hardness (annealed): 187–229 HB (Brinell)
- Hardness (hardened & tempered): 48–58 HRC (Rockwell C)
- Modulus of elasticity: 207 GPa (30 × 10⁶ psi)
- Thermal conductivity: 24.6 W/m·K at 100°C
- Coefficient of thermal expansion: 11.5 µm/m·°C (20–200°C)
- Standard stock sizes: Round bar diameters from 6.35 mm (0.25 in) to 305 mm (12 in); flat bar thicknesses from 3.18 mm (0.125 in) to 152 mm (6 in); lengths typically 3.66 m (12 ft) or 4.88 m (16 ft)
- Tolerances: Round bar diameter tolerance ±0.13 mm (±0.005 in) for sizes up to 76 mm (3 in); flat bar thickness tolerance ±0.25 mm (±0.010 in); length tolerance +13 mm (+0.5 in) / -0 mm
- Surface finish: Supplied in hot-rolled, annealed, or pre-machined condition; typical surface roughness Ra 3.2–6.3 µm

3.0 Processing, Machinability & Application

S7 tool steel is machinable in the annealed condition (187–229 HB) using conventional methods. In the hardened condition, machining is difficult and typically limited to grinding or EDM. Carbide tooling is recommended for all machining operations. For turning and milling, use coated carbide inserts with a positive rake geometry. For drilling, use high-speed cobalt or carbide drills with a 118–135° point angle. For grinding, use aluminum oxide or CBN wheels. For EDM, use copper or graphite electrodes with a roughing current of 5–10 A and finishing current of 1–3 A. For welding, preheat to 315–425°C (600–800°F) and use S7 filler metal or a high-nickel electrode; post-weld stress relieve at 595–650°C (1100–1200°F) for 1 hour per 25 mm of thickness. For heat treatment, preheat to 650–760°C (1200–1400°F), austenitize at 940–980°C (1725–1800°F), quench in air or forced air, and temper at 205–540°C (400–1000°F) depending on desired hardness.

- Turning: Use coated carbide inserts (ISO class P20–P30) with a cutting speed of 60–90 m/min (200–300 SFM), feed rate of 0.15–0.30 mm/rev (0.006–0.012 in/rev), and depth of cut of 1.5–4.0 mm (0.060–0.160 in).
- Milling: Use coated carbide end mills with a 30–45 degree helix angle; cutting speed 50–80 m/min (165–260 SFM), feed per tooth 0.05–0.15 mm (0.002–0.006 in), and depth of cut 1.0–3.0 mm (0.040–0.120 in).
- Drilling: Use carbide or cobalt HSS drills; cutting speed 20–30 m/min (65–100 SFM), feed rate 0.05–0.15 mm/rev (0.002–0.006 in/rev); peck drilling recommended for holes deeper than 3× diameter.

- Grinding: Use aluminum oxide or CBN wheels; wheel speed 25–35 m/s (5000–7000 SFM), infeed 0.01–0.03 mm (0.0004–0.0012 in) per pass; flood coolant with water-soluble oil at 5–10% concentration.
- EDM: Use copper or graphite electrodes; roughing current 5–10 A, finishing current 1–3 A; dielectric fluid with a flushing pressure of 0.5–1.5 bar; recast layer typically 0.05–0.15 mm.
- Welding: Preheat to 315–425°C (600–800°F); use S7 filler metal (AWS A5.5 class E11018-M or similar) or high-nickel electrode (AWS A5.11 class ENiCrFe-3); post-weld stress relieve at 595–650°C (1100–1200°F) for 1 hour per 25 mm of thickness; cool slowly in still air.
- Heat treatment: Preheat to 650–760°C (1200–1400°F); austenitize at 940–980°C (1725–1800°F) for 30–60 minutes; quench in air or forced air; temper immediately at 205–540°C (400–1000°F) for 2 hours per 25 mm of thickness; double tempering recommended for critical applications.

4.0 Common Defects & Quality Control

- Reject if surface cracks or seams are visible under 5× magnification; any crack deeper than 0.05 mm (0.002 in) is cause for rejection.
- Reject if surface pitting exceeds 0.25 mm (0.010 in) in depth or if pits cover more than 5% of the surface area.
- Reject if decarburization depth exceeds 0.25 mm (0.010 in) on annealed stock or 0.13 mm (0.005 in) on pre-machined stock.
- Reject if out-of-round exceeds 50% of the diameter tolerance (e.g., for a 25 mm bar with ±0.13 mm tolerance, reject if out-of-round > 0.065 mm).
- Reject if flat bar is out-of-square by more than 0.5° or if twist exceeds 1 mm per 300 mm of length.
- Reject if hardness in the annealed condition exceeds 229 HB or is below 187 HB.
- Reject if microstructure shows excessive carbide segregation (carbide banding > ASTM A561 No. 3) or retained austenite > 5% after heat treatment.
- Reject if non-metallic inclusions exceed ASTM E45 Method A rating of 2.0 for Type A (sulfides), Type B (aluminates), Type C (silicates), or Type D (globular oxides).
- Reject if ultrasonic inspection reveals any internal flaw larger than 0.5 mm (0.020 in) in diameter or if multiple flaws are present within a 50 mm (2 in) length.

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, indoor environment with relative humidity below 60% to prevent surface rust; ideal temperature range 10–30°C (50–86°F).
- Shelf life is indefinite under proper storage conditions; however, FIFO (first-in, first-out) inventory rotation is recommended to avoid prolonged exposure to humidity.
- Apply a light rust-preventive oil (e.g., mineral oil or water-displacing spray) to machined surfaces if storage exceeds 30 days.
- WHMIS classification: Not classified as a hazardous material in solid form; however, dust, fumes, or grinding swarf may be hazardous. Refer to Safety Data Sheet (SDS) for detailed information.
- Mandatory PPE during machining or grinding: Safety glasses with side shields, hearing protection (if noise > 85 dBA), and cut-resistant gloves (ANSI A4 or higher) when handling sharp edges. Use a NIOSH-approved N95 respirator if airborne dust or fumes are present.
- During welding, use local exhaust ventilation and wear welding helmet with appropriate shade lens (shade 10–12), welding gloves, and flame-resistant clothing.
- In case of fire, use Class D extinguishing media (dry powder) for metal fires; do not use water as it may cause hydrogen explosion.
- Dispose of waste material (cuttings, swarf, used grinding wheels) in accordance with local environmental regulations; S7 steel is recyclable as scrap metal.

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