
316/316L Marine Grade Stainless Steel – Technical Material Specification

1.0 Material Overview & Common Uses

316 and 316L are austenitic stainless steels containing molybdenum, which provides superior corrosion resistance compared to 304 stainless steel, particularly against chlorides and marine environments. The 'L' grade (316L) has a lower carbon content (max 0.03%) to minimize carbide precipitation during welding, making it the preferred choice for welded fabrications. Common applications include marine hardware, boat fittings, coastal architectural cladding, chemical processing equipment, pharmaceutical piping, food processing machinery, and medical implants.

2.0 Core Technical Properties & Sizing

- Density: 8.00 g/cm³ (0.289 lb/in³)
- Melting range: 1371–1399°C (2500–2550°F)
- Tensile strength (316): 515 MPa min (75 ksi min)
- Tensile strength (316L): 485 MPa min (70 ksi min)
- Yield strength (0.2% offset): 205 MPa min (30 ksi min) for both grades
- Elongation in 50 mm: 40% min for both grades
- Hardness (Rockwell B): 95 max for 316, 95 max for 316L
- Modulus of elasticity: 193 GPa (28,000 ksi)
- Thermal conductivity (100°C): 16.3 W/m·K
- Coefficient of thermal expansion (0–100°C): 16.0 µm/m·°C
- Electrical resistivity (20°C): 0.74 µΩ·m
- Standard available forms: plate, sheet, bar, pipe, tube, fittings
- Standard plate thicknesses: 3/16" to 4" (4.76 mm to 101.6 mm) in 48" or 96" widths
- Standard sheet thicknesses: 0.025" to 0.1875" (0.635 mm to 4.76 mm) in 36" or 48" widths
- Round bar diameters: 1/4" to 12" (6.35 mm to 304.8 mm) in 12' or 20' lengths
- Flat bar widths: 1/2" to 8" (12.7 mm to 203.2 mm) in 1/4" to 2" thickness
- Pipe schedule: 5S, 10S, 40S, 80S in sizes 1/8" to 12" nominal
- Tolerances per ASTM A240 (plate/sheet): thickness ±0.005" for < 0.060", ±0.0075" for 0.060–0.125", ±0.010" for 0.125–0.250"
- Flatness tolerance: 1/4" in any 36" length for annealed plate
- Cut length tolerance for bar: +1/8", -0" for lengths up to 12'

3.0 Processing, Machinability & Application

316/316L stainless steel is considered moderately difficult to machine due to its high work-hardening rate and low thermal conductivity. It requires sharp tooling, rigid setups, and adequate coolant to prevent work hardening and tool wear. Welding is

excellent with all standard methods, but 316L is preferred for heavy sections to avoid sensitization. The material can be formed by bending, rolling, and stamping, but springback is higher than carbon steel.

- Use carbide tooling (C2 or C6 grade) for turning and milling; high-speed steel tools are not recommended for production runs.
- Recommended cutting speed for turning: 60–90 SFM (18–27 m/min) with carbide inserts; reduce by 20% for interrupted cuts.
- Feed rate for turning: 0.005–0.015 in/rev (0.13–0.38 mm/rev) for roughing, 0.002–0.005 in/rev (0.05–0.13 mm/rev) for finishing.
- Depth of cut: 0.050–0.150 in (1.27–3.81 mm) for roughing, 0.010–0.030 in (0.25–0.76 mm) for finishing.
- Use a 30-degree helix end mill for slotting and profiling; climb milling preferred to reduce work hardening.
- Drilling: use 135-degree split point cobalt or carbide drills; peck cycle recommended for depths > 3x diameter.
- Coolant: flood coolant with high-pressure (300–500 psi) recommended; use water-soluble oil at 5–10% concentration.
- Welding: use 316L filler metal (ER316L for TIG/MIG, E316L-16 for stick) to maintain corrosion resistance.
- Preheat not required for sections under 1" (25.4 mm); for thicker sections, preheat to 150–200°F (65–93°C).
- Post-weld heat treatment (solution annealing) at 1900–2100°F (1038–1149°C) followed by rapid quench may be required for maximum corrosion resistance in severe environments.
- Bending: minimum bend radius of 2x material thickness for sheet; use mandrel bending for tube to prevent collapse.
- Passivation: treat with 20% nitric acid at 120°F (49°C) for 30 minutes to restore chromium oxide layer after machining or welding.

4.0 Common Defects & Quality Control

- Reject if surface pitting exceeds 0.005 inch (0.127 mm) depth or 0.020 inch (0.508 mm) diameter on visible surfaces.
- Reject if scratches or gouges deeper than 10% of material thickness are present on any surface.
- Reject if delamination or laminations are detected via ultrasonic testing on plate thicker than 1/2" (12.7 mm).
- Reject if out-of-flatness exceeds 1/4" in any 36" span for plate up to 1/2" thick; 3/8" for thicker plate.
- Reject if out-of-square exceeds 1/16" per foot of width for sheared plate edges.
- Reject if chemical composition deviates from ASTM A240 limits: Cr 16.0–18.0%, Ni 10.0–14.0%, Mo 2.0–3.0%, C ≤0.08% (316) or ≤0.03% (316L).
- Reject if hardness exceeds Rockwell B 95 for either grade.
- Reject if tensile or yield strength falls below minimums specified in section 2.0.
- Reject if intergranular corrosion is detected per ASTM A262 Practice E (for 316L, sensitization at 675°C for 1 hour).
- Reject if weld porosity exceeds 5 pores per linear inch or any pore larger than 1/16" (1.6 mm) diameter.
- Reject if heat tint or oxide scale is present on weld surfaces intended for corrosive service (must be mechanically removed and passivated).
- Reject if magnetic permeability exceeds 1.02 (measured per ASTM A342) for applications requiring non-magnetic properties.

5.0 Storage, Handling & WHMIS Guidelines

- Store indoors in a dry, climate-controlled environment below 60% relative humidity to prevent surface staining.
- Do not store in direct contact with carbon steel or iron to avoid cross-contamination and surface rusting; use wood, plastic,

or rubber separators.

- Shelf life: indefinite under proper storage conditions; no FIFO rotation required for solid forms, but maintain lot traceability.
- Handle with clean, dry gloves to avoid fingerprints and chloride contamination; use cotton or nitrile gloves.
- Use lifting straps or padded clamps for handling plate and bar to avoid surface damage; never use chains without protection.
- WHMIS classification: Not classified as a hazardous product under WHMIS 2015 in solid form. Dust, fume, or swarf from machining may be hazardous.
- Hazardous combustion products: Chromium(VI) compounds and nickel oxides may be generated during welding or grinding; use local exhaust ventilation.
- Mandatory PPE for machining/welding: Safety glasses with side shields, welding helmet with appropriate shade (10–12 for arc welding), hearing protection, flame-resistant clothing, and leather welding gloves.
- Respiratory protection: Use N95 respirator or half-face respirator with P100 filters when grinding or welding in confined spaces or without adequate ventilation.
- First aid: For skin contact with hot material, cool with water for 15 minutes and seek medical attention for burns. For eye contact with dust, flush with water for 15 minutes.
- Spill procedure: Solid material does not require special spill cleanup; sweep up machining chips and dispose in metal recycling bin. Do not allow dust to accumulate.
- Disposal: Scrap metal is recyclable; check local regulations for disposal of grinding dust containing chromium and nickel.

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