

Appendices



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Stainless steel grade chart



Grade	UNS No.	Chemical analysis (%) specified									Mechanical properties specified (Note 3)					ASTM standard and product use							Properties and typical applications
		C	Si	Mn	P	S	Cr	Mo	Ni	Other	Common form	Treatment	Tensile strength MPa (min.)	Yield strength (0.2% offset) MPa (min.)	Elongation % in 50mm (min.)	Hardness (max) (Note 2)	A167 A240 A666 sheet, coil, strip, plate	A312 A358 A409 pipe	A213 A249 A269 A554 tube	A403 buttweld fittings	A276 A582 bar and shapes	A313 A493 A580 wire	
Austenitic stainless steels																							
253MA	S30815	0.05 -0.10	1.1 - 2.0	0.8	0.040	0.030	20.0 - 22.0		10.0 - 12.0	N 0.14-0.20 Ce 0.03-0.08	Plate	Annealed	600	310	40	95 HRB							Excellent resistance to scaling and useful creep strength at temperatures up to 1150°C.
301	S30100	0.15	0.75	2.0	0.045	0.030	16.0 - 18.0		6.0 - 8.0	N 0.10	Sheet or coil	Annealed 1/4 to full hard	515 860 - 1275	205 515 - 965	40 25 - 9	95 HRB							Combination of strength and ductility to withstand severe forming methods. Corrosion resistance comparable to 302. Rail cars, automotive components.
302HQ	S30430	0.03	1.00	2.0	0.045	0.030	17.0 - 19.0		8.0 - 10.0	Cu 3.0-4.0	Wire 2.5mm dia. and over	Annealed Lightly drawn	605 max. 660 max.	-	-	-						Wire for severe cold heading such as the manufacture of cross recess screws. Corrosion resistance at least equivalent to type 304.	
303	S30300	0.15	1.00	2.0	0.20	0.15 min.	17.0 - 19.0		8.0 - 10.0		Bar	Cold finished Condition A				262 HB					Also UGIMA	Free machining grade. Domestic and mild industrial environment. Water low in chlorides. Nuts and bolts, shafts, fittings. Corrosion resistance lower than 304.	
304	S30400	0.08	0.75	2.0	0.045	0.030	18.0 - 20.0		8.0 - 10.5	N 0.10	Plate	Annealed	515	205	40	92 HRB					Also UGIMA	Good resistance to corrosion, good for malleability and weldability. Most commonly used grade. Wine storage, laundry and kitchen products, water, food, architectural, cryogenic and high temperature applications. UGIMA 304 – improved machinability bar with same properties.	
304L	S30403	0.030	1.00	2.0	0.045	0.030	18.0 - 20.0		8.0 - 12.0	N 0.10	Plate	Annealed	485	170	40	88 HRB						Corrosion resistance as for 304. Low carbon variation for heavy gauge welded sections.	
304H	S30409	0.04 - 0.10	0.75	2.0	0.045	0.030	18.0 - 20.0		8.0 - 10.5	N 0.10	Plate	Annealed	515	205	40	92 HRB						Corrosion resistance as for 304. High carbon gives improved high temperature strength.	
309S	S30908	0.08	1.00	2.0	0.045	0.030	22.0 - 24.0		12.0 - 15.0		Bar	Annealed	515	205	40	95 HRB						Excellent resistance to corrosion, particularly attack by hot sulphur compounds in oxidising gases. Sulphite liquors and acids such as acetic, citric, lactic and nitric. Welding wire for joining dissimilar steels.	
310	S31000	0.25	1.5	2.0	0.045	0.030	24.0 - 26.0		19.0 - 22.0		Plate	Annealed	515	205	40	95 HRB						Excellent corrosion resistance at normal temperatures. Good resistance to oxidation and carburising atmospheres in high temperatures over 850°C to 1100°C. Welding wire for joining dissimilar steels.	
316	S31600	0.08	0.75	2.0	0.045	0.030	16.0 - 18.0	2.0 - 3.0	10.0 - 14.0	N 0.10	Plate	Annealed	515	205	40	95 HRB					Also UGIMA	High corrosion resistance to the complex sulphur compounds used in pulp and paper processing. Also resists attack by marine and corrosive industrial atmospheres. Suitable for mild seacoast atmosphere, pulp and paper, heat exchangers, propeller shafts, dyeing equipment. UGIMA 316 improved machinability bar, with same properties.	
316L	S31603	0.030	0.75	2.0	0.045	0.030	16.0 - 18.0	2.0 - 3.0	10.0 - 14.0	N 0.10	Plate	Annealed	485	170	40	95 HRB						Corrosion resistance as for 316. Low carbon variation, suitable for heavy gauge welding.	
317L	S31703	0.030	0.75	2.0	0.045	0.030	18.0 - 20.0	3.0 - 4.0	11.0 - 15.0	N 0.10	Plate	Annealed	515	205	40	95 HRB						Improved corrosion resistance over type 316. Often successfully applied where type 316 has given only moderate performance. Applications such as acetic acid distillation, pulp and paper machinery, ink and dyeing processes. 317L is a variation of 317 suitable for heavy gauge welding.	
321	S32100	0.08	0.75	2.0	0.045	0.030	17.0 - 19.0		9.0 - 12.0	N 0.10 Ti=5x(C+N) min. 0.70 max.	Sheet	Annealed	515	205	40	95 HRB						Excellent corrosion resistance, equivalent to 304 in the annealed condition and superior if the application involves service in 425°C-870°C range. Typical applications include expansion joints, furnace parts, aerospace and power industries, heat exchangers and steam generators.	
347	S34700	0.08	0.75	2.0	0.045	0.030	17.0 - 19.0		9.0 - 13.0	Nb 10xC min. 1.0 1.0 max.	Plate	Annealed	515	205	40	92 HRB						This grade is resistant to chromium carbide precipitation. Most commonly found as a consumable for welding 321.	
904L	N08904	0.020	1.00	2.0	0.045	0.035	19.0 - 23.0	4.0 - 5.0	23.0 - 28.0	Cu 1.0-2.0	Plate	Annealed	490	220	35	70 - 90 NRB typical						"Super austenitic" grade with very high corrosion resistance, especially to strong acids and chlorides. Frequently used in sulphuric acid service.	

Note 1: Single values are maxima unless otherwise stated.

Note 2: Hardness specification limits given are HRB = Rockwell B scale, HRC = Rockwell C scale, HB = Brinell Hardness.

Note 3: Mechanical properties shown are for the commonly available form listed; properties of other forms for the grade may vary.

Stainless steel grade chart



Grade	UNS No.	Chemical analysis (%) specified									Mechanical properties specified (Note 3)				ASTM standard and product use							Properties and typical applications	
		C	Si	Mn	P	S	Cr	Mo	Ni	Other	Form	Treatment	Tensile strength MPa (min.)	Yield strength (0.2% offset) MPa (min.)	Elongation % in 50mm (min.)	Hardness (max.) (Note 2)	A167 A240 A666 sheet, coil, strip, plate	A312 A358 A409 pipe	A213 A249 A269 A554 tube	A403 butt weld fittings	A276 A582 bar and shapes		A313 A493 A580 wire
Ferritic stainless steels																							
-	1.4003	0.03	1.00	1.50	0.040	0.015	10.5 - 12.5		0.3 - 1.0	N 0.03	Plate	Annealed	450 - 650	280 (>6mm) 320 (≤6mm)	18 (>6 mm) 20 (≤6mm)	220 HB (≤12mm) 250 (>12mm)							Useful corrosion resistance particularly in wet abrasion environments. Readily welded and formed into tanks, flues, bins, chutes, rail wagons, etc.
409	S40900	0.08	1.0	1.0	0.045	0.030	10.5 - 11.75		0.50	Ti 6xC min. 0.75 max.	Tube	Annealed	380	205	20	95 HRB							Resists atmospheric and automotive exhaust gas corrosion. Extensively used in auto exhaust systems.
430	S43000	0.12	1.0	1.0	0.04	0.030	16.0 - 18.0		0.75		Sheet	Annealed	450	205	22	89 HRB							Good combinations of corrosion resistance, formability and mechanical properties. Typical applications include automotive trims, element supports, cold headed fasteners, refrigerator doors.
430F	S43020	0.12	1.0	1.25	0.06	0.15 min.	16.0 - 18.0				Bar	Annealed	550	380	25	262 HB							430F is a free machining version of 430, suitable for high speed machining. Corrosion resistance is lower than 430.
F20S Note 4		0.02	0.1	0.2	0.03	0.003	20			N 0.01 Ti + Nb 0.3	Sheet and coil	Annealed	460	320	30	160 HV							Durionx F20S ia a newly developed ferritic alternative to 304.
F18MS (444)	S44400	0.025	1.0	1.0	0.040	0.030	17.5 - 19.5	1.75 - 2.50	1.00	N 0.035 Note 5	Sheet and coil	Annealed	415	275	20	96 HRB							Molybdenum improves the pitting resistance. 444 is a ferritic alternative to 316.
Ferritic/Austenitic (Duplex) stainless steels																							
2205	S31803	0.030	1.00	2.0	0.030	0.020	21.0 - 23.0	2.5 - 3.5	4.5 - 6.5	N 0.08 - 0.20	Plate	Annealed	620	450	25	31 HRC							2205 microstructure is approximately 50% ferrite and 50% austenitic, which results in the steel possessing high strength and hardness, and resistance to erosion, fatigue, stress corrosion cracking and pitting and crevice corrosion. Applications in marine, chemical and petrochemical industries.
UR52N ⁺	S32520 S32550	0.030	0.80	1.50	0.035	0.020	24.0 - 26.0	3.0 4.0	5.5 - 8.0	N 0.20-0.35 Cu 0.5-2.0	Plate	Annealed	770	550	25	310 HRB							'Super Duplex' grade exhibiting exceptional resistance to hot chlorides and sulphides with high strength. Applications in marine, chemical and petrochemical industries.
Martensitic stainless steels																							
410	S41000	0.15	1.00	1.00	0.040	0.030	11.5 - 13.5		0.75		Plate	Annealed	450	205	20	96 HRB							Resists dry atmospheres, fresh water, mild alkalines and acids, steam and hot gases. Must be hardened for maximum heat and corrosion resistance. Typical applications include cold heading, bolts, nuts and screws, pump parts and shafts, steam and gas turbine parts, mine ladder rungs.
420	S42000	0.15 min	1.00	1.00	0.040	0.030	12.0 - 14.0				Bar	Annealed	655 typical	345 typical	25 typical	241 HB							Good resistance in the hardened condition to the atmosphere. Food, fresh water and mild alkalines or acids. Higher carbon hardenable grade. Typical applications include cutlery, surgical instruments, shear blades, needle valves.
431	S43100	0.20	1.00	1.00	0.04	0.030	15.0 - 17.0		1.25 - 2.50		Bar	Annealed	860 typical			285 HRB							Excellent resistance to a wide variety of corrosive media, approaching that of 304. High tensile and torque strength. Pump and boat shafts, nuts, bolts and marine hardware.
Precipitation hardening steel																							
630	S17400	0.07	1.00	1.00	0.04	0.03	15.0 - 17.5		3.0 - 5.0	Cu 3.0-5.0 Nb + Ta 0.15-0.45	Bar	Solution treated	1105 typical	1000 typical	15 typical	38 HRC							Precipitation hardening ('aging') treatment after machining gives high strength without distortion. Corrosion resistance similar to type 304. Pump shafts and valve spindles.

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Note 3: Mechanical properties shown are for the commonly available form listed; properties of other forms for the grade may vary.

Note 4: Chemical composition and mechanical properties of F20S are typical.

Note 5: Ti + Nb = 0.20 + 4 (C+N) min, 0.80 max



Product specifications

Stainless steel wire

Standard	Description
ASTM A313	Chromium-nickel stainless and heat resisting steel spring wire.
ASTM A493	Stainless and heat resisting steel for cold heading and cold forging wire.
ASTM A580	Stainless and heat resisting steel wire.
ASTM A581	Free machining stainless and heat resisting steel wire and wire rods.
ASTM A555/A555M	General requirements for stainless and heat resisting steel wire and wire rods.
JIS G4309	Stainless steel wires.
JIS G4314	Stainless steel wires for springs.
Welding wire	
AWS A5.4	Specification for covered corrosion resisting chromium and chromium-nickel steel welding electrodes.
AWS A5.9	Specification for corrosion resisting chromium and chromium-nickel steel bare and composite metal cored and stranded welding electrodes and welding rods.

Stainless steel bar

Standard	Description
ASTM A276	Stainless and heat resisting steel bars and shapes.
ASTM A564/A564M	Hot rolled and cold finished age-hardening stainless and heat resisting steel bars and shapes.
ASTM A582	Free machining stainless and heat resisting steel bars and hot rolled or cold finished.
ASTM A193/A193M	Alloy steels and stainless steel bolting materials for high temperature service.
ASTM A194/A194M	Carbon and alloy steel nuts for bolts for high pressure and high temperature service.
ASTM A320/A320M	Alloy steel bolting materials for low temperature service.
ASTM A453/A453M	Bolting materials, high temperature 345 to 827MPa yield strength with expansion co-efficients comparable to austenitic steels.
ASTM A479/A479M	Stainless and heat resisting steel bars and shapes for use in boilers and other pressure vessels.
ASTM A484/A484M	General requirements for stainless and heat resisting steel bars, billets and forgings.
EN 10088-3	Stainless steels – Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes.

Stainless steel hollow bar

Standard	Description
ASTM A511	Seamless stainless steel mechanical tubing.
ASTM A450/A450M	General requirements for carbon, ferritic alloy and austenitic alloy tubes.
DIN 17 456	General purpose seamless circular stainless steel tubes – ferritic and austenitic.

Stainless steel flat product

Standard	Description
ASTM A167	Stainless and heat resisting chromium-nickel steel plate, sheet and strip.
ASTM A176	Stainless and heat resisting chromium steel plate, sheet and strip.
ASTM A240/A240M	Chromium and chromium-nickel stainless steel plate, sheet and strip for pressure vessels and general applications.
ASTM A263	Corrosion resisting chromium steel clad plate, sheet and strip.
ASTM A264	Stainless chromium-nickel steel clad plate, sheet and strip.
ASTM A265	Nickel and nickel base alloy clad steel plate.
ASTM A666	Austenitic stainless steel sheet, strip, plate and flat bar for structural applications.
ASTM A480/A480M	General requirements for flat rolled stainless and heat resisting steel plate, sheet and strip.
EN 10088-2	Stainless steels – Part 2: Technical delivery conditions for sheet/plate and strip for general purposes.
Higher austenitic	
ASTM B625	UNS N08904 plate, sheet and strip.

Stainless steel pipe

Standard	Description
ASTM A312/A312M	Seamless and welded austenitic stainless steel pipe.
ASTM A358/A358M	Electric-Fusion-Welded (EFW) austenitic chromium-nickel alloy steel pipe for high temperature service.
ASTM A409/A409M	Welded large diameter austenitic steel pipe for corrosive or high temperature service.
ASTM A731/A731M	Seamless and welded ferritic and martensitic stainless steel pipe.
ASTM A790/A790M	Seamless and welded ferritic/austenitic stainless steel pipe.
ASTM A450/A450M	General requirements for carbon, ferritic alloy and austenitic alloy steel tubes.
ASTM A530/A530M	General requirements for specialised carbon and alloy steel pipe.
ASTM A999/A999M	General requirements for alloy and stainless steel pipe.
JIS G3459	Stainless steel pipes.
ANSI/ASME B36.19M	Stainless steel pipe.
Higher austenitic	
ASTM B673	UNS N08904 welded pipe.
ASTM B677	UNS N08904 seamless pipe and tube.

Low alloy steel bar

Standard	Description
AS 1444	Wrought alloy steels – standard and hardenability (H) series and hardened and tempered to designated mechanical strengths.
ASTM A331	Steel bars, alloy, cold finished.
ASTM A434	Steel bars, alloy, hot wrought or cold finished, quenched and tempered.
ASTM A29/A29M	Steel bars, carbon and alloy, hot wrought and cold finished; general requirements.
ASTM A304	Steel bars, alloy, subject to end quench hardenability requirements.

Stainless steel pipe fittings and flanges

Standard	Description
ASTM A182/A182M	Forged or rolled alloy steel pipe flanges, forged fittings and valves and parts for high temperature service.
ASTM A403/A403M	Wrought austenitic stainless steel piping fittings.
ASTM A815/A815M	Wrought ferritic, ferritic/austenitic and martensitic stainless steel piping fittings.
AS 2129	Flanges for pipes, valves and fittings.
ASME B1.20.1	Pipe threads, general purpose (inch).
ANSI B16.5	Steel pipe flanges and flanged fittings.
ANSI B16.9	Factory-made wrought steel butt-welding fittings.
ANSI B16.11	Forged steel fittings socket-welding and threaded.
ANSI B16.25	Butt-welding ends.
MSS SP43	Wrought stainless steel butt-welding fittings.
BS21	BSP Threading - refer also AS ISO 7-1
ISO 4144	Stainless steel fittings threaded to ISO 7-1.

Stainless steel tube and fittings

Standard	Description
ASTM A213/A213M	Seamless ferritic and austenitic alloy steel boiler, superheater and heat exchanger tubes.
ASTM A249/A249M	Welded austenitic steel boiler, superheater, heat exchanger and condenser tubes.
ASTM A269	Seamless and welded austenitic stainless steel tubing for general purposes.
ASTM A270	Seamless and welded austenitic stainless steel sanitary tubing.
ASTM A450/A450M	General requirements for carbon, ferritic alloy and austenitic alloy steel tubes.
ASTM A554	Welded stainless steel mechanical tubing.
ASTM A791/A791M	Welded unannealed ferritic stainless steel tubing.
ASTM A789/A789M	Seamless and welded ferritic/austenitic stainless steel tubing for general service.
AS 1163	Structural steel hollow sections (dimensional tolerances).
AS 1528, Parts 1 to 4	Tubes (stainless steel) and tube fittings for the food industry.
Higher austenitic	
ASTM B674	UNS N08904 welded tube.
ASTM B677	UNS N08904 seamless pipe and tube.

Carbon and alloy steel hollow bar

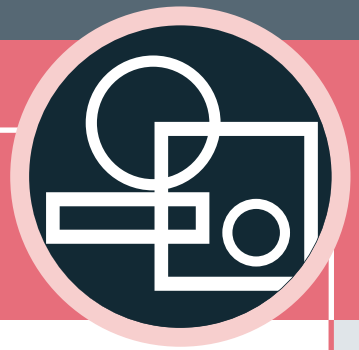
Standard	Description
ASTM A519	Seamless carbon and alloy steel mechanical tubing.
ISO 2938	Hollow bars for machining.
DIN 1629	Seamless circular unalloyed steel tubes – special purposes.

Carbon steel bar products

Standard	Description
AS 1442	Carbon steels and carbon manganese steels – hot rolled bars and semi-finished product.
AS 1443	Carbon steels and carbon manganese steels – cold finished bars.
ASTM A576	Steel bars, carbon, hot wrought, special quality.
JIS G4051	Carbon steels for machine structural use.

Carbon steel pipe, tube and fittings

Standard	Description
ASTM A179/A179M	Seamless cold drawn low alloy steel heat exchanger and condenser tubes.
API 5L	Line pipe.
ASTM A53M	Black and zinc coated welded and seamless steel pipe.
ASTM A106M	Seamless carbon steel pipe for high temperature service.
ASTM A105M	Carbon steel forgings for piping applications.
ASTM A234M	Piping fittings of wrought carbon steel and alloy steel for moderate and high temperature service.
BS 3799	Steel pipe fittings, screwed and socket welding for the petroleum industry.
AS 1163	Structural steel hollow sections.
AS 1074	Steel tubes and tubular for ordinary service.
BS 13872	Screwed and socketed steel tube and tubulars.
EN 10241	Steel threaded pipe fittings.
ASME B36.10M	Welded and seamless wrought steel pipe.



Grade Colour Codes

Grade Colour Codes

Grade colour codes							
Stainless steels				Alloy steels		Carbon steels	
Grade	Colour	Grade	Colour	Grade	Colour	Grade	Colour
303	Light blue	AtlasCR12	No colour	4140	Blue+green	U1004	No colour
304	Lilac	409	Blue	X4150	Hot pink+green	1010	Black
304L	Aqua green	410	Grey	4340	Orange+green	1020	Yellow
310	Brown	416	Beige	En25	Green+green	1030	White
316	Dark green	420	Hot pink	En26	Black+green	1040	Tan
316L	Orange	430	White	4620	Grey+red	1045	Green
321	Black	431	Red	8620	White+red	X1112	Light green
253MA	Serpentine	440C	Yellow	17CrNiMo6	Black+red	1146	Orange
2205	Lime green	630 (17/4PH)	Sunflower	En36A	Red+red	1214	Hot pink
				En39B	Yellow+red	12L14	Purple