

ASTM A240 specification covers stainless steel plates, sheets and strips for pressure vessels and general applications

This specification covers chromium, chromium-nickel, and chromium-manganese-nickel stainless steel plate, sheet, and strip for pressure vessels and for general applications including architectural, building, construction, and aesthetic applications.

2205 is the most widely used duplex (ferritic/austenitic) stainless steel grade. It finds applications due to both excellent corrosion resistance and high strength.

The original S31803 composition has over the years been refined by many steel suppliers, and the resulting restricted composition range was endorsed as UNS S32205 in 1996. S32205 gives better guaranteed corrosion resistance, but much of the S31803 currently produced also complies with S32205. It is recommended that grade 2205 always be clarified as S31803 or S32205, but note that ASTM A240 defines 2205 as S32205.

2205 is not generally suitable for use at temperatures above 300°C as it suffers from precipitation of brittle micro-constituents, nor below -50°C because of its ductile-to-brittle- transition.

Corrosion Resistance

Excellent general corrosion resistance; superior to Grade 316 in most environments. Excellent resistance to localised corrosion including intergranular, pitting and crevice corrosion; the CPT of 2205 is generally at least 35°C. The grade is also resistant to chloride stress corrosion cracking (SCC) at temperatures of up to about 150°C. Grade 2205 will often perform well in environments which cause premature failure of austenitic grades. It has better resistance to sea water than grade 316. Consult Atlas Technical Assistance for specific environmental recommendations.

Heat Resistance

Although 2205 has good high temperature oxidation resistance this grade, like other duplex stainless steels, suffers from embrittlement if held for even short times at temperatures above 300°C. If embrittled this can only be rectified by a full solution annealing treatment. Duplex stainless steels are almost never used above 300°C.

Heat Treatment

Solution treatment (annealing) Heat to 1020-1100°C and cool rapidly. This grade cannot be hardened by thermal treatment, but does work harden.

Welding

Weldable by all standard methods, but should not generally be welded without filler metal as this may result in excessive ferrite. AS 1554.6 pre-qualifies welding of 2205 with 2209 rods or electrodes to ensure that deposited metal has the correctly balanced duplex structure. Nitrogen added to the shielding gas will also assist in ensuring adequate austenite in the structure. Heat input must be kept low and no pre- or post-heat should be used. The lower co-efficient of thermal expansion of all duplex stainless steels compared with austenitic grades reduces distortion and associated stresses.

Machining

The high strength that makes 2205 useful in many applications also reduces its machinability. Cutting speeds are approximately 20% slower than for grade 304. There is as yet no "Ugima" Improved Machinability version of 2205.

The high strength of 2205 also makes bending and forming more difficult; these operations will require larger capacity equipment than would be required for austenitic stainless steels. The ductility of 2205 is less than that of an austenitic grade (but is not low when compared to most other structural materials), so severe forming operations, such as cold heading, are not generally possible. If severe cold working is required it is recommended that intermediate annealing be carried out.

Typical Applications

Chemical processing, transport and storage. Oil and gas exploration and processing equipment. Marine and other high chloride environments. Pulp & Paper digesters, liquor tanks and paper machines

Specified Properties

These properties are specified for flat rolled product (plate, sheet and coil) in ASTM A240/A240M. Similar but not necessarily identical properties are specified for other products such as pipe and bar in their respective specifications.

Composition Specification (%)

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
2205 (S31803)	min.	-	-	-	-	-	21.0	2.5	4.5	0.08
	max.	0.030	2.00	1.00	0.030	0.020	23.0	3.5	6.5	0.20
2205 (S32205)	min.	-	-	-	-	-	22.0	3.0	4.5	0.14
	max.	0.030	2.00	1.00	0.030	0.020	23.0	3.5	6.5	0.20

Mechanical Property Specification

Grade	Tensile Strength (MPa)	Yield Strength 0.2% Proof (MPa)	Elongation (% in 50mm) min	Hardness	
				Rockwell C (HRC)	Brinell (HB)
S31803	62	45	25	31 max	293 max
S32205	65	45	25	31 max	293 max

Physical Properties

(typical values in the annealed condition)

Grade	Density (g/cm ³)	Elastic Modulus (GPa)	Mean Coefficient of Thermal Expansion (μm/m/°C)			Thermal Conductivity (W/m·K) at 100°C	Thermal Conductivity (W/m·K) at 500°C	Specific Heat (J/kg·K)	Electrical Resistivity (μΩ·m)
			0-100°C	0-315°C	0-538°C				
2205	7800	200	13.7	14.7	-	19.0	-	450	850

Physical properties of S31803 and S32205 are identical.

Grade Specification Comparison

Grade	UNS No	Euronorm		Swedish SS	Japanese
		No	Name		
2205	S31803 / S32205	1.4462	X2CrNiMoN22-5-	2377	SUS

These comparisons are approximate only. The list is intended as a comparison of functionally similar materials **not** as a schedule of contractual equivalents. If exact equivalents are needed original specifications must be consulted. ASTM grade S31803 is a closer equivalent to most other specifications than is S32205.

ASTM-A480 › Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

Table A2.17 Permitted Variation in Thickness of Hot-Rolled Mill Plate (Quarto Plate)*,

Width (w), in. [mm]

Specified Thickness (t), in. [mm]	w ≤ 84 [2134]	84 [2134] < w ≤ 120 [3048]	120 [3048] < w ≤ 144 [3658]	w > 144 [3658]
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Tolerance Over Specified Thickness, * in. [mm]**

t < 3/16 [4.76]	0.055 [1.35]	0.070 [1.78]	—	—
3/16 [4.76] ≤ t < 3/8 [9.52]	0.045 [1.14]	0.050 [1.27]	0.085 [2.16]	—
3/8 [9.52] ≤ t < 3/4 [19.05]	0.055 [1.40]	0.060 [1.52]	0.085 [2.16]	0.090 [2.29]
3/4 [19.05] ≤ t < 1 [25.04]	0.060 [1.52]	0.065 [1.65]	0.085 [2.16]	0.100 [2.54]
1 [25.40] ≤ t < 2 [50.80]	0.070 [1.78]	0.075 [1.90]	0.095 [2.41]	0.115 [2.92]
2 [50.80] ≤ t < 3 [76.20]	0.125 [3.20]	0.150 [3.80]	0.175 [4.45]	0.200 [5.08]
3 [76.20] ≤ t < 4 [101.6]	0.150 [3.81]	0.160 [4.06]	0.200 [5.08]	0.225 [5.72]
4 [101.6] ≤ t < 6 [152.4]	0.180 [4.75]	0.200 [5.08]	0.335 [8.50]	0.355 [9.02]
6 [152.4] ≤ t < 8 [203.2]	0.235 [6.00]	0.255 [6.48]	0.355 [9.02]	0.435 [11.0]
8 [203.2] ≤ t < 10 [254.0]	0.315 [8.00]	0.335 [8.50]	0.435 [11.0]	0.550 [14.0]

* Thickness is measured along the longitudinal edges of the plate at least 3/8 in. [9.52mm], but not more than 3 in. [76.20 mm], from the edge.

** For plates up to 10 in. [254.0mm], excl, in thickness, the tolerance under the specified thickness is 0.010 in. [0.25 mm].

*** For circles, the over thickness tolerances in this table apply to the diameter of the circle corresponding to the width ranges shown. For plates of irregular shape, the over thickness tolerances apply to the greatest width corresponding to the width ranges shown.

Below is the Tolerance for Flatness taken from ASTM A480
(Understand that this covers Mill Plates and not cut pieces)

Table A2.20 Permitted Variations in Flatness of Plate Mill Plate (Quarto Plate)

Note 1 — Tolerances in this table apply to any length, not necessarily the rolling direction, up to 36 in. [914mm] and to any 36 in. [914mm] of longer lengths in the plane of the plate measured while the plate rests on a flat surface with the concavity of the curvature upward.

Note 2 — If the longer dimension is under 36 in. [914mm], the tolerance is not greater than 1/4 in. [6.4mm].

Note 3 — for plates with specified minimum yield strengths of 35 ksi [240MPa] or more, the permitted variations are increased to 1 1/2 times the amounts shown.

Specified Thickness (t), in. [mm]	Flatness Tolerance for Thicknesses Given, in. [mm]
$t < 1/4$ [6.35]	7/16 [11]
$1/4$ [6.35] $\leq t < 3/8$ [9.52]	3/8 [9.5]
$3/8$ [9.52] $\leq t < 1/2$ [12.70]	5/16 [7.9]
$1/2$ [12.70] $\leq t < 3/4$ [19.05]	5/16 [7.9]
$3/4$ [19.05] $\leq t < 1$ [25.40]	5/16 [7.9]
1 [25.40] $\leq t < 1\ 1/2$ [38.10]	1/4 [6.4]
$1\ 1/2$ [38.10] $\leq t < 4$ [101.60]	1/4 [6.4]
$t \geq 4$ [101.60]	1/4 [6.4]