ASTM - A387/A387M Standard Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum

This specification covers chromium-molybdenum alloy steel plates intended primarily for welded boilers and pressure vessels designed for elevated temperature service.

✤ Manufacture :-

• Steelmaking Practice—The steel shall be killed.

✤ <u>Heat Treatment :-</u>

1. Except for Grade 91, all plates shall be thermally treated either by annealing, normalizing- and -tempering, or, when permitted by the purchaser, accelerated cooling from the austenitizing temperature by air blasting or liquid quenching, followed by tempering. Minimum tempering temperatures shall be as follows:

Grade	Temperature, °F [°C]
2, 12, and 11	1150 [620]
22, 22L, 21, 21L, and 9	1250 [675]
5	1300 [705]

- 2. Grade 91 plates shall be thermally treated, either by normalizing-and-tempering or by accelerated cooling from the austenitizing temperature by air blasting or liquid quenching, followed by tempering. Grade 91 plates shall be austenitized at 1900 to 1975°F [1040 to 1080°C] and shall be tempered at 1350 to 1470°F [730 to 800°C].
- 3. Grade 5, 9, 21, 21L, 22, 22L, and 91 plates ordered without the heat treatment required by point 1 shall be furnished in either the stressrelieved or the annealed condition.

* Chemical Requirements :-

• The steel shall conform to the requirements as to chemical composition shown in Table 1 unless otherwise modified in accordance with Supplementary requirement G.

* <u>Metallurgical Structure :-</u>

• Austenitic Grain Size—Grade 2 material shall have a coarse austenitic grain size.

	Table 1									
Grade and UNS	Grade 2	Grade 12	Grade 11	Grade 22	Grade 22L	Grade 21	Grade 21L	Grade 5	Grade 9	Grade 91
Number	S50460	K11757	K11789	K21590	K21590	K31545	K31545	S50200	K90941	K90901
Element					Compo	sition, %				
Carbon:										
Heat analysis	0.05-0.21	0.05–0.17	0.05–0.17	0.05–0.15 ^A	0.10 max	0.05–0.15 ^A	0.10 max	0.15 max	0.15 max	0.08–0.12
Product analysis	0.04–0.21	0.04–0.17	0.04–0.17	0.04–0.15 ^A	0.12 max	0.04–0.15 ^A	0.12 max	0.15 max	0.15 max	0.06–0.15
Manganese:										
Heat analysis	0.55–0.80	0.40-0.65	0.40-0.65	0.30-0.60	0.30-0.60	0.30-0.60	0.30-0.60	0.30-0.60	0.30-0.60	0.30-0.60
Product analysis	0.50-0.88	0.35-0.73	0.35–0.73	0.25–0.66	0.25–0.66	0.25–0.66	0.25–0.66	0.25–0.66	0.25–0.66	0.25–0.66
Phosphorus,										
max:										
Heat analysis	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.02
Product analysis	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Sulfur, max:					7					
Heat analysis	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.01
Product analysis	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.012
Silicon:										
Heat analysis	0.15-0.40	0.15-0.40	0.50–0.80	0.50 max	0.50 max	0.50 max	0.50 max	0.50 max	1.00 max	0.20-0.50
Product analysis	0.13–0.45	0.13–0.45	0.44–0.86	0.50 max	0.50 max	0.50 max	0.50 max	0.55 max	1.05 max	0.18-0.56
Chromium:										
Heat analysis	0.50-0.80	0.80–1.15	1.00-1.50	2.00-2.50	2.00-2.50	2.75-3.25	2.75-3.25	4.00-6.00	8.00-10.00	8.00–9.50
Product analysis	0.46-0.85	0.74–1.21	0.94–1.56	1.88-2.62	1.88-2.62	2.63-3.37	2.63-3.37	3.90-6.10	7.90–10.10	7.90–9.60
Molybdenum:										

Heat analysis	0.45-0.60	0.45-0.60	0.45–0.65	0.90-1.10	0.90–1.10	0.90-1.10	0.90-1.10	0.45-0.65	0.90-1.10	0.85-1.05
Product analysis	0.40-0.65	0.40-0.65	0.40-0.70	0.85–1.15	0.85–1.15	0.85-1.15	0.85-1.15	0.40-0.70	0.85-1.15	0.80-1.10
Nickel, max:										
Heat analysis										0.4
Product analysis		•••								0.43
Vanadium:										
Heat analysis									0.04 max	0.18-0.25
Product analysis								•••	0.05 max	0.16-0.27
Columbium:										
Heat analysis		•••					•••	•••	•••	0.06-0.10
Product analysis		•••						•••	•••	0.05-0.11
Boron:										
Heat analysis		•••						•••		
Product analysis		•••				•••		•••		
Nitrogen:										
Heat analysis				- iii						0.030– 0.070
Product analysis										0.025 - 0.080
Aluminum, max:										
Heat analysis						•••		•••		0.02
Product analysis						•••		•••		0.02
Titanium, max:										
Heat analysis										0.01
Product analysis										0.01
Zirconium, max:										
Heat analysis										0.01

	Product analysis				•••	•••		•••			0.01
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^A The carbon content for plates over 5 in. [125 mm] in thickness is 0.17 max on product analysis.

* Tension Test Requirements :-

- The material as represented by the tension test specimens shall conform to the applicable requirements of Table 2 or Table 3, as specified on the order.
- A characteristic of certain types of alloy steels is a local disproportionate increase in the degree of necking down or contraction of the test specimens during the tension test, resulting in a decrease in the percentage of elongation as the gage length is increased. The effect is not so pronounced in thicker plates. For such material, if so stated in the applicable product specification for plates up to 3/4 in. [20 mm], inclusive, in thickness, if the percentage of elongation of an 8-in. [200-mm] gage length test specimen falls not more than 3 percentage points below the amount prescribed, the elongation shall be considered satisfactory if the percentage of elongation in 2 in. [50 mm] across the break is not less than 25 %.

	Grades 2 and 12	Grade 11	Grades 22, 21, 5, 9, 21L, 22L
Tensile strength, ksi [MPa]	55 to 80 [380 to 550]	60 to 85 [415 to 585]	60 to 85 [415 to 585]
Yield strength, min, ksi [MPa]	33 [230]	35 [240]	30 [205]
Elongation in 8 in. [200 mm], min, %	18	19	
Elongation in 2 in. [50 mm], min, %	22	22	18
Reduction of area, min, %	I		$45^{\mathbf{A}}40^{\mathbf{B}}$

Table 2- Tensile Requirements for Class 1 Plates

A Measured on round test specimens.

B Measured on flat specimen.

Table 3- Tensile Requirements for Class 2 Plates A

	Grade 2	Grade 11	Grade 12	Grades 22, 21, 5,9	Grade 91
Toncilo strongth Iroi [MBa]	70 to 90	75 to 100	65 to 85	75 to 100	85 to 110
rensne strengtil, ksi [wir a]	[485 to 620]	[515 to 690]	[450 to 585]	[515 to 690]	[585 to 760]
Yield strength, min, ksi [MPa]/(0.2 % offset)	45 [310]	45 [310]	40 [275]	45 [310]	60 [415]
Elongation in 8 in. [200 mm], min, %	18	18	19		
Elongation in 2 in. [50 mm], min, %	22	22	22	18	18

Reduction of area, min, %			45 ^B 40 ^C	
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^A Not applicable to annealed material.

^B Measured on round test specimens. ^C Measured on flat specimen.

* <u>Supplementary</u> Requirements :- A.

Additional Tension Test.

- B. Charpy V-Notch Impact Test.
- C. Drop Weight Test (for Material 0.625 in. [16 mm] and over in Thickness).
- D. High-Temperature Tension Test.
- E. Ultrasonic Examination.
- F. Magnetic Particle Examination.
- G. Vacuum Carbon-Deoxidized Steel :- Material shall be vacuum carbon-deoxidized, in which case the silicon content at the time of vacuum deoxidizing shall be 0.12 % maximum, and the content of deoxidizers such as aluminum, zirconium, and titanium should be kept low enough to allow deoxidation by carbon.

Keyword

- astm a387 pdf
- astm a387 grade 11
- astm a387 grade 11 pdf
- astm a387 grade 12
- astm a387 steel
- astm a387 grade 5
- astm a387 specification
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